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To see or not to see: A creativity feature to enhance business model ideation using business model development software

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Abstract

Successful business model innovation is dependent upon the generation of new ideas that can challenge traditional mechanisms of value creation, delivery, and capture. However, during the cognitive process of idea generation, individuals tend to overlook the majority of potentially valuable business model ideas, and there is currently hardly any software available to facilitate the ideation process. Drawing on cognitive psychology, creativity, and information systems research, I address this issue by proposing a creativity feature for a software-based business model development tool, as well as a randomized controlled experiment to evaluate its effectiveness. This innovative creativity feature is intended to enhance business model development tools, both quantitatively and qualitatively, by guiding individuals through their exploration of the solution space for business model ideas. Measuring business model idea quality was not possible because the experts consulted for this experiment did not reach a sufficient consensus. The findings on business model idea quantity indicate that the creativity feature was not able to enhance the creativity of business model ideas significantly. I additionally discuss implications for future experimental research on features of business model development tools. In the long run, I hope that other researchers will benefit from the experiences and that prescriptive knowledge can be derived that will benefit both academics and practitioners interested in the development of software-based tools for business model innovation.

Keywords: Business model innovation; Business model development tool; Creativity support system; Idea generation; Experiment; Search for ideas in associative memory; Chance configuration theory

JEL classification: O3; L86; M15; D83; C91; C88

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1 Introduction

Business model (BM) innovation has become a decisive success factor for sustaining and expanding the competitiveness of organizations (Massa et al. 2017). All innovation starts with a creative idea (Amabile 1996; Hansen and Birkinshaw 2007; Kornish and Ulrich 2014), and BM ideas are at the very core of organizations' BM innovation (Baden-Fuller and Morgan 2010; Martins et al. 2015; McGrath 2010).

When individuals generate ideas, they tend to utilize the solution space only to a limited extent (see initial perspective in Figure 1), typically considering only a small number of ideas and rarely thinking beyond the bounded areas of their memory (Gettys et al. 1987; Knoll and Horton 2011; Mednick 1962). As a result, a large range of ideas remains overlooked in the solution space (Nijstad and Stroebe 2006). This makes BM idea generation a challenging creative task because to be truly innovative – and hence successful – BMs rarely follow established traditional value creation, delivery, and capture mechanisms (Chesbrough 2010; Doz and Kosonen 2010; Teece 2010). Consequently, the potential BM ideas that lie beyond the "well-trodden thought paths" (Knoll and Horton 2011, p. 91) of habitual idea generation form a valuable reservoir for an organization's BM innovation (see initial and new perspective in Figure 1 for business model ideas before and after creativity feature).

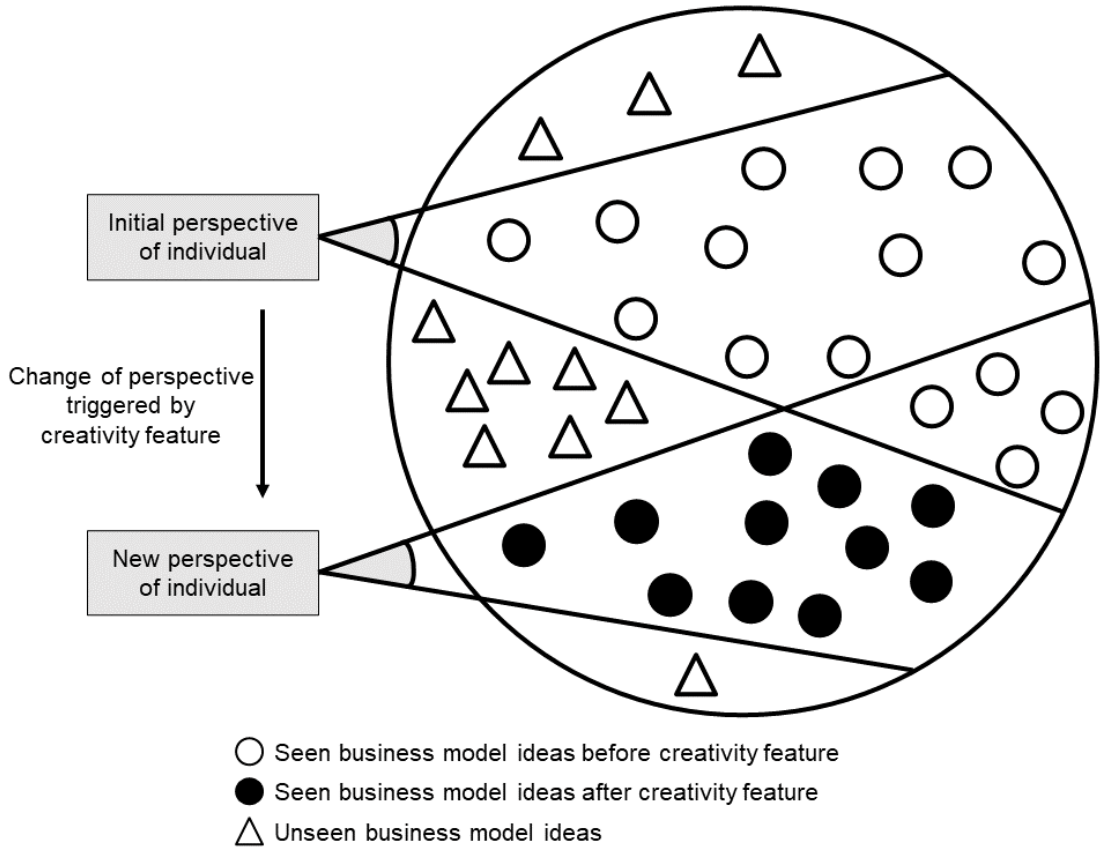


Figure 1: Solution space of business model ideas adapted from Knoll and Horton (2011)

Leveraging the reservoir of overlooked BM ideas presents a key challenge for organizations of all sizes and across industries. Indeed, the majority of executives lament their organization's "difficulties in defining an effective BM to support new ideas and make them profitable" (GE 2018, p. 91). Despite being challenging, the exploration of a greater section of the solution space of BM ideas holds great promise. In particular, organizations that fundamentally question the basic assumptions about their current BM, and look to adopt a radically new BM, would be set to benefit not only from innovating their BM but also from accelerating their digital transformation progress (Gartner 2019). Furthermore, practitioners agree that BM idea generation must be addressed both urgently and extensively, with almost 80% of executives "recogniz[ing] they must change their BMs significantly over the next three years" (Gartner 2020).

Software-based tools for supporting BM innovation have sparked great interest among academics and practitioners alike (e.g., Bouwman et al. 2020; Szopinski et al. 2020; Terrenghi et al. 2017). Although software-based business model development tools (BMDTs) are said to have great potential (e.g., Alt and Zimmermann 2014; Ebel et al. 2016; Osterwalder and Pigneur 2013; Veit et al. 2014), with some already having gained considerable popularity in practice (e.g., the Strategyzer app), these tools have not yet been the subject of in-depth studies in terms of their ability to support the fundamental task of BM idea generation. This is somewhat surprising because, unlike paper-based tools, BMDTs enable users to draw on a potentially much higher number and variety of stimuli for a more thorough exploration of the solution space of BM ideas. Furthermore, organizations often hire consultants for BM innovation workshops, which are costly and limited in the number of participants they can accommodate. BMDTs, on the other hand, have the potential to reduce these costs while being highly scalable. Also, BMDTs can be used independently of the place of work (e.g., in a home office). In the long run, BMDTs could even be integrated into open innovation strategies that utilize crowdsourcing-based ideation and can thereby assist the individual creativity of a large pool of crowd workers (Blohm et al. 2011; Leimeister et al. 2009; Lipusch et al. 2020). More recently, Athanasopoulou and De Reuver (2020) emphasize the importance of having tools that specifically promote creativity in BM idea generation. However, the tools currently available for BM innovation are either not software-based (i.e., paper-based) or are 'passive'. By 'passive' I mean that these BMDTs merely act as digital whiteboards with features for representing, sharing, versioning, and annotating BMs, but fall short of features that help individuals to think outside the box and overcome occupational blindness when generating ideas (Knoll and Horton 2011). In sum, currently available BMDTs do not adequately support individuals in unlocking the potential of overlooked BM ideas, and academics, as well as practitioners, lack prescriptive knowledge that tells them how to implement such BMDTs.

As BM idea generation is less about doing things *better* and more about doing things *differently*, I implement a creativity feature for BMDTs that supports individuals to invent BM ideas that they have hitherto not considered. The creativity feature prompts individuals using a BMDT to explore the solution

space for BM ideas more thoroughly, by being given cognitive stimuli. The feature thus nudges the user to leave well-trodden paths of BM innovation and thinking outside the box. For this purpose, in BMDTs with the creativity feature, both the human and the computer co-creatively work on BM ideas. This could lead to both a greater number of BM ideas as well as more creative ones. Hence, this study seeks to answer the research question: "*Can a creativity feature in a software-based business model development tool enhance the quality and quantity of business model ideas?"*

For this study, I first review previous research on BMDTs. Grounded in *Search of Ideas in Associative Memory* and *Chance Configuration Theory*, I then implement the creativity feature, before developing an experiment design for its rigorous evaluation. Performing the randomized controlled experiment allows empirical data to be collected to investigate whether such a feature in BMDTs is conducive to enhancing the generation of BM ideas.

The findings of this study shed light on whether a creativity feature in a BMDT may support individuals in leaving the beaten tracks of their memory when generating BM ideas, and especially how such experimental research can be set up. This knowledge may inform academics and practitioners in researching and advancing BMDTs alike. This study thus paves the way for a theory-driven development and an empirically-driven evaluation of such tools. The proposed research contributes to information systems research (e.g., Veit et al. 2014) and innovation management (e.g., Schneider and Spieth 2013) as academics from both fields call for more research on software-based BM innovation tooling. It may enable software providers to draw on the prescriptive knowledge that informs them on how to advance their BMDTs, which currently lack creativity features, and BM developers and consultants to enrich their workshops by integrating BMDTs into ideation sessions. In this sense, this study addresses the novel problem of humans and computers working co-creatively on BM ideas and, accordingly, proposes a novel solution that involves a creativity feature that has a theory-driven design and will be rigorously evaluated through a controlled experiment. In this way, the creativity feature I propose for BMDTs could be viewed as an invention-like contribution (Gregor and Hevner 2013). While this study is not a traditional design science research project with multiple building and evaluation cycles, its main concern is to achieve truth in whether the proposed creativity feature in a BMDT can enhance the quality and quantity of BM ideas. Thereby, this study intends to derive prescriptive knowledge on how to design creativity feature for BMDTs.

2 Related Work

As a new unit of analysis (Zott et al. 2011), BM innovation complements more traditional dimensions of innovation such as product, process, and organizational innovation (Massa et al. 2017). Innovating an organization's BM is complex and ill-structured in nature (Chesbrough 2010; Foss and Saebi 2018; Massa et al. 2018). In view of this, to answer this study's research question I focus on two aspects. First, I use the interpretation of BMs as cognitive models. Second, I focus on the idea generation phase of BM

innovation. In the following, I describe both aspects before I move on to how software could support BM idea generation.

Business Models as cognitive models. In response to the complex and ill-structured nature as well as the interdisciplinary character of the BM concept, there are different interpretations of this concept concerning the meaning and function of BMs (see Massa et al. 2017 for a thorough description of these interpretations). For the theoretical foundation of this study, the cognitive interpretation of BMs is highly relevant. Grounded in cognitive psychology (Fiske and Taylor 1991), this interpretation considers BMs as cognitive models "that consist of concepts and relations among them that organize managerial understanding about the design of […] value-creation" (Martins et al. 2015, p. 105). It suggests that individuals create cognitive models of their and other organizations' BMs (Baden-Fuller and Morgan 2010; Loock and Hacklin 2015; Martins et al. 2015), which allows organizational members individually, and collectively, to innovate ways of doing business in their organizations. Thus, to conceive of BMs as cognitive models is highly relevant to this study because it provides a theoretical foundation for anchoring BMs in cognitive psychology and in strategy (Ward et al. 1997; Ward 2004). It allows understanding how individuals organize knowledge about BMs and how they re-organize this knowledge to generate new BM ideas, either by changing their existing cognitive models or by creating entirely new ones (George and Bock 2011; Martins et al. 2015).

Business Model Idea Generation. The generation of new ideas is an indispensable prerequisite for innovation (Amabile 1996; Hansen and Birkinshaw 2007; Kornish and Ulrich 2014) and BM ideas are an essential part of BM innovation projects (Ebel et al. 2016; Osterwalder and Pigneur 2010; Wirtz and Daiser 2018). This study responds to prior research which concludes that the BM idea generation phase is understudied (Schneider and Spieth 2013). This is surprising, considering how central BM ideas are to BM innovation (McGrath 2010), how poorly understood the process of idea generation is (Martins et al. 2015), and how hard it is to generate BM ideas from scratch (Baden-Fuller and Morgan 2010). In essence, the BM idea generation phase is particularly important because it provides a forward-looking perspective on BM innovation that can be leveraged for technological advancement (e.g., Baden-Fuller and Haefliger 2013), for environmental changes (e.g., Chesbrough 2010), and to meet customer needs in ways never before imagined (Eppler et al. 2011; Eppler and Hoffmann 2012).

Creativity Support Systems. Software that is designed to facilitate creative tasks is called *Creativity Support Systems* (CSS) (Massetti 1996; Shneiderman 2002). In principle, all creative tasks and their commonly assumed stages have the potential of being supported through software (e.g., Gabriel et al. 2016; Wang and Nickerson 2017), whether through divergent thinking (i.e., expanding the considered area of the solution space) or convergent thinking (i.e., narrowing the considered area of the solution space) (Müller-Wienbergen et al. 2011). Three characteristics proposed by Seidel et al. (2010) allow to distinguish CSSs:

(1) The *level of analysis* describes whether a CSS is intended to support the creativity of individuals (see Wang and Nickerson 2017 for a comprehensive review on individual CSSs), groups (see Gabriel et al. 2016 for a comprehensive review on group CSSs) or organizations (Seidel et al. 2010).
(2) The *perspective on creativity* describes whether a CSS is intended to support the creative person, the creative process, the creative product, and/or the creative environment (Couger et al. 1993; Seidel et al. 2010).
(3) The *role of the IT artefact* describes whether a CSS is intended to enhance productivity or alter information processing (tool view), whether it facilitates the interactions between the users and the IT artefact (ensemble view), and/or whether a study only refers to a CSS instead of actually researching it (nominal view) (Orlikowski and Iacono 2001; Seidel et al. 2010)[1].

The purpose of a CSS, then, is to facilitate the cognitive processes of humans that creative tasks require. In this way, "CSSs are important not only because they offer help to practitioners, but also because they are where theories of creativity become manifest" (Wang and Nickerson 2017, p. 140). Like IT artefacts in general (Hevner et al. 2004), CSSs are at their most effective when they are theory-driven, both for their development and their evaluation (Voigt et al. 2013). In the following, I begin to leverage this potential for BMDTs.

Business Model Development Tools. Even though BMDTs are a relatively new class of IT artefacts, I first identify previous contributions on BMDTs (see Appendix 1 for a detailed description of the search strategy). I reflect on these BMDTs on the basis of the project phase of BM innovation and the three characteristics for distinguishing CSSs that I have previously introduced (see Table 1). The review of this body of literature reveals that researchers have undertaken 21 studies revolving around two main clusters, namely (1) BMDTs that are not dedicated to any particular BM innovation project phase and (2) BMDTs that are dedicated to a particular BM innovation project phase. In both clusters, I consider models (i.e., descriptions of BMDTs as design principles) and instantiations (i.e., realizations of BMDTs as prototypes) (March and Smith 1995).

[1] Please note that Orlikowski and Iacono (2001) propose a total of five views on the role of an IT artifact, three of which Seidel et al. (2011) identified as being relevant for IT artifacts supporting creativity.

Study on business model development tool	Business model innovation phase	Level of analysis	Perspective on creativity	Role of the IT artefact
Fritscher and Pigneur 2009	Cross-phase	Group	-	Tool view
Fritscher and Pigneur 2014a	Cross-phase	Group	-	Tool view
Fritscher and Pigneur 2014b	Cross-phase	Group	-	Tool view
Ebel et al. 2016	Cross-phase	Group	-	Tool view
Schaffer et al. 2020a	Cross-phase	Group	-	Tool view
Schaffer et al. 2020b	Cross-phase	Group	-	Tool view
Schoormann et al. 2021	Cross-phase	Group	-	Tool view
Schwarz and Legner 2020	Cross-phase	Group	-	Tool view
Szopinski et al. 2020	Cross-phase	Group	-	Tool view
Athanasopoulou et al. 2018	Idea generation	Group	Creative person	Tool view
John 2016	Idea generation	Individual	Creative product	Tool view
Szopinski 2019a[2]	Idea generation	Individual	Creative product	Tool view
Szopinski 2019c[2]	Idea generation	Individual	Creative product	Tool view
Szopinski 2020[2]	Idea generation	Individual	Creative product	Tool view
Augenstein and Fleig 2017	Analysis	Individual	-	Tool view
Anke 2020	Evaluation	Group	-	Tool view
Dellermann et al. 2018	Evaluation	Individual	-	Tool view
Hamrouni et al. 2018	Evaluation	Individual	-	Tool view
Kajanus et al. 2014	Evaluation	Individual	-	Tool view
Rambow-Hoeschele et al. 2018	Evaluation	Individual	-	Tool view
Augenstein et al. 2017	Management	Individual	-	Tool view

Table 1: Results of the literature review on business model development tools

I identified nine studies in which the proposed BMDTs are not dedicated to any particular BM innovation project phase (i.e., cross-phase BMDTs). These BMDTs have generic features such as representing, sharing, annotating, and versioning BMs. Early work on BMDTs attempted to transfer the sticky note experience from paper-based tools to software-based tools (Fritscher and Pigneur 2009, 2014a, 2014b). The features proposed in these early works are still part of today's BMDTs and have inspired some research. Further pioneering research sought a more holistic and empirically-based conceptualization of BMDTs, which led to a framework for designing BMDTs (Ebel et al. 2016). This framework emphasizes BM innovation as a collaborative process and entails features that support sharing materials (e.g., training material and project documentation) and forming a community (e.g., messaging, friendships, and profiles). Such features can be helpful in all phases of BM innovation

[2] This article is a preliminary work for this study, both conceptually and technically.

projects. Other research on BMDTs that provide features for purposes that are not specific to any BM innovation project phase include studies that reflect on the sustainability of BMs (Schoormann et al. 2021) or on the use of the syntactic, semantic, and pragmatic capacities of BM tools as boundary objects (Schwarz and Legner 2020). Research on BMDTs to support modeling and simulation of dependencies within and between BMs is also not tied to a specific BM innovation project phase (Schaffer 2020a). An overview of BMDTs that have been developed either in academia or in practice reveals 43 distinct features that can be useful in all BM innovation phases (Szopinski et al. 2020). None of these features, however, is specifically intended to encourage creativity. By clustering design requirements and mapping design principles, a synthesis and update of BMDT features is provided (Schaffer et al. 2020b).

In addition to these cross-phase studies, I identified seven studies in which the proposed BMDTs are dedicated to a particular BM innovation project phase other than the idea generation phase. More specifically, the BMDTs considered here support users in one of the following three phases – analysis (Augenstein and Fleig 2017), evaluation (Anke 2020; Dellermann et al. 2018; Hamrouni et al. 2018; Kajanus et al. 2014; Rambow-Hoeschele et al. 2018), and management (Augenstein et al. 2017) – and they facilitate the administration of BM innovation projects in phases where one or more BM ideas exist or have already been implemented.

Furthermore, I found two studies (other than my own) that are dedicated to the phase of BM idea generation. As part of a research-in-progress, Athanasopoulou et al. (2018) propose three design principles for building a BMDT, one of which is aimed at increasing the perceived creativity of individuals working in groups. The creativity-related design principle offers templates with solution-based BM patterns and is prototypically implemented in Microsoft Excel. The prototype guides the users through several templates that offer checklists of potential changes to transform an initial BM into one that is based on the Internet-of-Things. John (2016) proposes a design theory with six design principles for a BMDT and describes how to build a BMDT that automatically generates BM ideas that are transferred to a crowd-working platform for evaluation. Whereas in the first study BM ideas are generated by the user, in the second study the ideas are generated by the computer. This study complements and extends currently available BMDTs that do not have creativity features that enable humans (i.e., BM developers) and computers (i.e., the BMDTs) to co-creatively work on BM ideas and thereby enable a more comprehensive exploration of the solution space. To better understand how such a creativity feature can alleviate the limitations of current BMDTs, I describe the underlying cognitive processes of individuals during idea generation.

3 Theoretical Background

The *Search for Ideas in Associative Memory* (SIAM) model provides a cognitive model for ideation and thereby the theoretical foundation for researching the underlying cognitive processes of individuals while being creative. When generating ideas, individuals search their memory for existing knowledge that is relevant to this creative task (Ward et al. 1997; Ward 2004). Such creative tasks are complex and ill-structured in nature (Mumford and Gustafson 2007; Reitman 1965) and they typically come with a vast range of possible solutions (Briggs and Reinig 2010; Voss and Post 1988). Both characteristics also apply to the task of BM idea generation.

Two different memory systems constitute SIAM from which individuals can retrieve knowledge: long-term memory and working memory. Whereas long-term memory is permanent and has unlimited capacity, working memory is temporary and has limited capacity (Knoll and Horton 2011). SIAM posits that knowledge is structured in the form of a highly interconnected multi-level network of images, which in turn are composed of concepts as well as relations that link images and concepts (see Figure 2). These images, concepts, and relations form a knowledge network that is characterized by fuzzy boundaries, overlapping parts, and mutual associations (Knoll and Horton 2011).

Two stages in SIAM describe the cognitive operations of individuals generating ideas: The knowledge loading stage and the idea generation stage (Nijstad and Stroebe 2006). In the knowledge loading stage, individuals retrieve relevant existing knowledge from long-term memory by temporarily transferring knowledge from long-term memory to working memory. That knowledge that will be retrieved depends on the search cues applied (e.g., knowledge already loaded in working memory, previously generated ideas, understanding of the problem). In the idea generation stage, individuals make use of knowledge now available in working memory (i.e., by applying images and concepts to a new domain) and (re-)combine it in novel and unusual ways (i.e., by forming new relations between images and concepts) (Nijstad and Stroebe 2006). Knowledge that is already transferred to working memory is likely to be used again for idea generation (Althuizen and Wierenga 2014; Ward et al. 1997). Over time, individuals increasingly (re-)combine knowledge that has already been employed for idea generation and the ideas increasingly resemble each other. Solving the situation of being ‘stuck in a rut’ will be at the core of our proposal for a creativity feature in BMDTs.

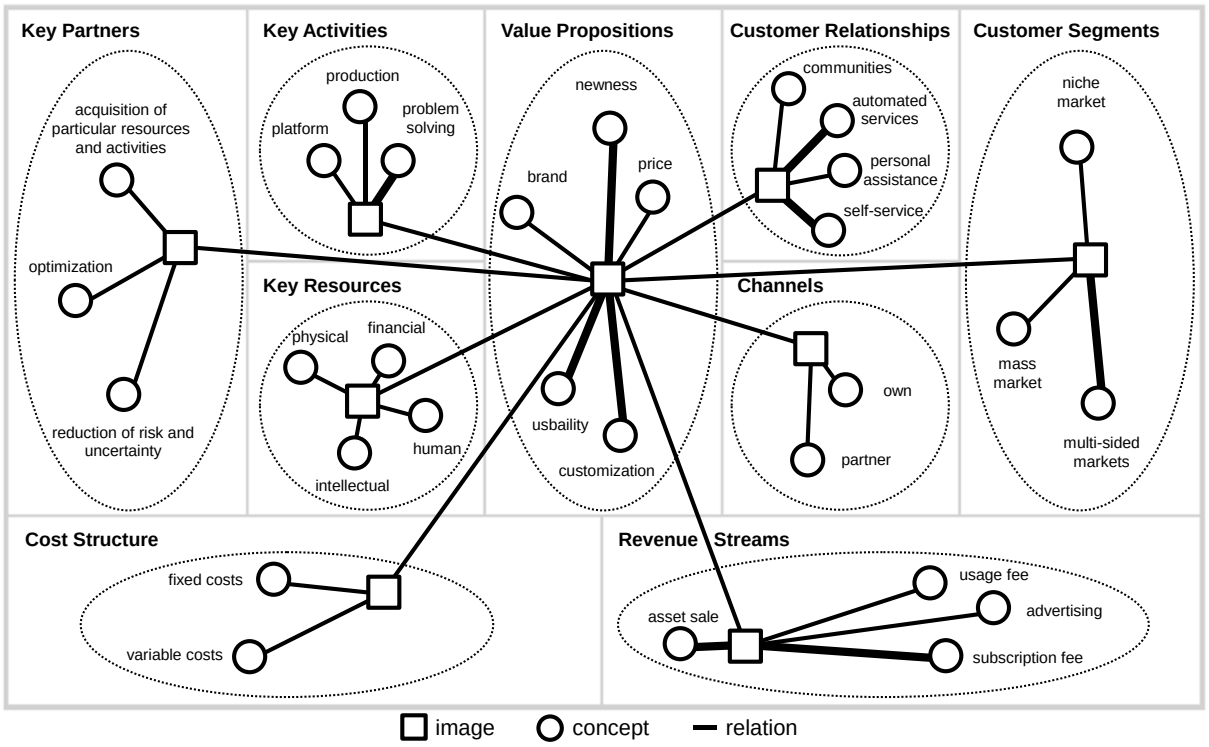


Figure 2: Business model knowledge network inspired by Knoll and Horton (2011) using the Business Model Canvas (Osterwalder and Pigneur 2010)[3]

Applied to the context of BM idea generation, individuals generating BM ideas will search their memory for relevant knowledge that they may have experience of (such as on BMs), either as a customer or as a developer. To contextualize SIAM for the task of BM idea generation, I employ the *Business Model Canvas* (Osterwalder and Pigneur 2010). Not only is this the quasi-standard for visualizing BMs and widely recognized by academics and practitioners alike (e.g., Massa et al. 2017; Spieth et al. 2014; Strategyzer 2015), but its nine components can also be considered as constituting a business-model-specific version of a knowledge network. In the sense of the SIAM model, images of an individual's knowledge network (see circles in Figure 2) represent the nine components of the *Business Model Canvas*. Correspondingly, the concepts (see squares in Figure 2) represent the sticky notes that are often used to describe the individual characteristics of the components of a specific BM. The lines connecting images and concepts represent the relations between them. The different widths of the lines indicate the relation's frequency (see lines in Figure 2). The widths of the connecting lines vary for different reasons such as the frequency of a line's traversal (e.g., not all BMs necessarily need to have key partners, but nearly all have revenue streams), the relatedness of certain images (e.g., the components customer segments, channel, and customer relationships are often thought about together), or whether it is a more

[3] For reasons of clarity, Figure 2 depicts both knowledge areas and the relations shown between images and concepts as not overlapping, in contrast with images or concepts that do. For illustration purposes, Figure 2 shows the relations of the 'value proposition' component to the other components. For a more detailed description of the cognitive BM knowledge network using the *Business Model Canvas* see Szopinski (2019a).

traditional, common relation (e.g., for the continuity of revenue streams, many BMs use subscription fees). Together, these images, concepts, and relations form the cognitive representation of a specific BM.

Chance Configuration Theory (CCT) (Simonton 1989) emphasizes the importance of random combination in creative thinking and thereby provides a theoretical foundation for researching idea generation by chance. In essence, CCT posits that creative thinking involves operations on cognitive elements that can be modified in some way (Simonton 1989). For ease of description, I subsume the images, concepts, and relations in SIAM as cognitive elements in CCT. Furthermore, I interpret the *knowledge loading stage* (i.e., retrieving knowledge) and the *idea generation stage* (i.e., combining knowledge) in SIAM as operations on these cognitive elements. According to CCT, newly evolving ideas are generated through random and spontaneous variations of cognitive elements. This means that CCT takes account of the fact that variations occur by chance. Moreover, knowledge loading and idea generation can be evoked by a myriad of determinants. Put differently, in the words of Simonton, "chance is a measure of ignorance, a gauge of the situation when the number of causes is so immense as to defy identification" (Simonton 1989, p. 172). Although knowledge loading and idea generation by chance imply unpredictability, they do not necessitate total randomness. As a result, not all cognitive elements are equiprobable and a large number of ideas in the solution space have a comparably low but non-zero probability (Simonton 1989).

Applied to the context of BM idea generation, individuals retrieve knowledge and (re-)combine this knowledge to new BM ideas for a variety of reasons. I illustrate this using an example: Imagine while working on the task of BM idea generation, an individual is exposed to a stimulus related to LEGO – the Danish toy production company best known for its interlocking plastic bricks. As the stimulus can trigger a multitude of possible cognitive operations, I illustrate three potential cognitive elements that an individual may consider from their BM knowledge network while being creative (inspired by Kohler 2015; Robertson and Hjuler 2009; Schlagwein and Bjorn-Andersen 2014):

- Cognitive element "open innovation": The ideation platform 'LEGO IDEAS' enables crowsourcing ideas for new LEGO sets. Customers can hand in ideas for new LEGO sets and vote for them. LEGO produces the winning ideas as part of their standard lines and customers receive a share of net sale.
- Cognitive element "do-it-yourself": Delegating a central part of the value proposition to the customer (here assembling the toy), as already successfully implemented by IKEA (for assembling furniture at home) and Wordpress (for developing websites using templates and drag'n'drop features).

- Cognitive element "licensing": LEGO started licensing intellectual property to manufacture *Star Wars* characters and vehicles. These LEGO sets have been sold millions of times, as have more recent LEGO sets, such as *Harry Potter* or *The Big Bang Theory*.

CCT emphasizes that random variation is an important cognitive operation in idea generation. As the size of the solution space for BM ideas has an extremely large number of potential ideas and while there is a plethora of reasons why a certain cognitive element is retrieved and (re-)combined with another specific stimulus, the search for ideas in an individual's BM knowledge network by chance can initiate what Müller-Wienbergen et al. (2011) call "serendipitous flashes of insight" (p. 720).

Summarizing, SIAM describes what is going on in an individual's memory during BM idea generation, namely that loading knowledge makes it possible to (re-)combine this knowledge into new BM ideas. CCT describes why randomly loading and (re-)combining knowledge is conducive to BM idea generation. In this way, the theories help understand how individuals can explore the solution space of BM ideas to a larger extent, which in turn informs how this can be translated into a creativity feature in a BMDT.

4 Hypotheses Development

To counteract the tendency of individuals to consider ideas only from a small area of the solution space of BM ideas and to think primarily within bounded areas of their memory, stimuli can be consciously used to create new search cues that individuals can apply to their knowledge network (Diehl et al. 2002; Nijstad and Stroebe 2006). Referring to the two stages of SIAM (i.e., knowledge loading and idea generation), stimuli can overcome the failure that can occur in each of the stages: the *knowledge loading failure* and the *idea generation failure* (see Figure 3).

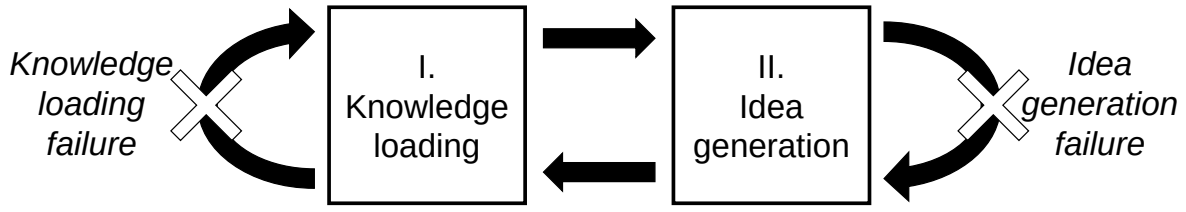


Figure 3: The two stages and their potential failures in the search for ideas in associative memory

The *knowledge loading failure* refers to the situation where an individual is limited in their idea generation capabilities due to a lack of knowledge. Here, stimuli can support individuals in consigning *new* knowledge to their working memory by guiding them towards unvisited areas of their BM knowledge network. The *idea generation failure* describes the situation where an individual is limited in their idea generation capabilities to (re-)combine knowledge. Here, stimuli can support individuals in considering *different* knowledge of their working memory by guiding them towards visited areas of their BM knowledge network and, in turn, revealing (re-)combinations of knowledge in these areas that the

individual has not considered before. Both types of stimuli – transferring *new* and considering *different* BM knowledge of the working memory – lead an individual to explore a larger range of alternative BM ideas in the solution space because the additional knowledge thus elicited becomes available for the generation of creative BMs ideas.

Grounded in *SIAM* and *CCT*, I propose stimuli consisting of two successive interrelated cognitive operations to be implemented as a creativity feature in a BMDT: one cognitive operation that makes individuals load knowledge (addressing the *knowledge loading failure*) and another that makes them (re-)combine this knowledge (addressing the *idea generation failure*). Therefore, each stimulus consists of two subsequent cognitive operations that expose an individual, first to knowledge, and then to the (re-)combination of that knowledge. Which stimuli an individual is exposed to, and in what order, is left to chance. In this way, individuals consider knowledge and (re-)combinations of knowledge that they otherwise would not have considered (Bonnardel 2000; Dugosh et al. 2000; Santanen et al. 2004). I assume that a creativity feature in a BMDT that exposes individuals to new/different knowledge and (re-)combinations of this knowledge will lead to a greater number of BM ideas because individuals search more areas of their BM knowledge network. I also expect this to lead to more creative BM ideas because individuals search more distant areas of their BM knowledge network.

Hypothesis 1: Individuals using a BMDT with a creativity feature will generate a greater number of business model ideas than individuals using a BMDT without such a feature.

Hypothesis 2: Individuals using a BMDT with a creativity feature will generate more creative business model ideas than individuals using a BMDT without such a feature.

5 Experiment

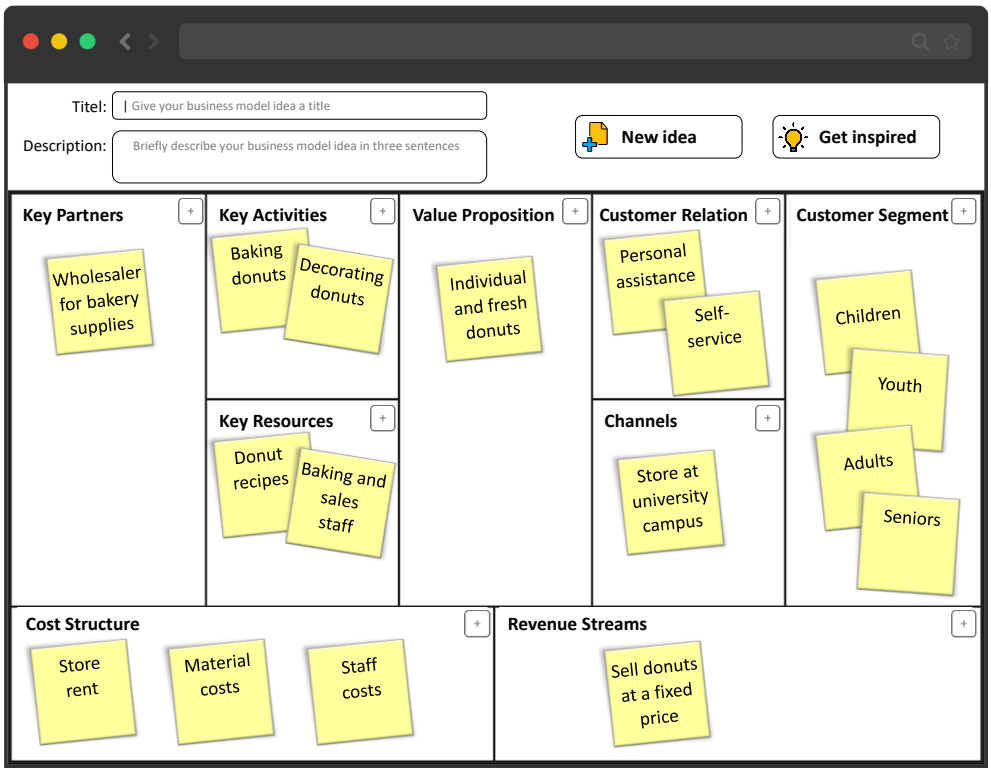
A randomized controlled experiment was conducted to provide empirical evidence for the use of a creativity feature in a BMDT. Experiments are considered as the 'gold standard' in research designs due to their high level of rigor (Bhattacherjee 2012) and have been used for evaluating information systems in general (e.g., Diederich et al. 2020; Lipusch et al. 2020) as well as creativity support systems in particular (e.g., Althuizen and Reichel 2016; Malaga 2000). Furthermore, conducting experiments is also in line with the current practice prevalent in research on paper-based tools for BM idea generation (e.g., Eppler et al. 2011; Eppler and Hoffmann 2012; John and Kundisch 2015).

Experiment design. This study employed a 1x2 between-subjects experiment design to investigate whether individuals generating BM ideas can benefit from a creativity feature in a BMDT. Therefore, I tested the effects of two different design alternatives of BMDTs by adhering to the principles of experiments: control (i.e., presence of a control group), randomization (i.e., subjects are randomly assigned to either the treatment or the control group), and manipulation (i.e., changing part of an artefact) (Mettler et al. 2014). The independent variable was the availability of the creativity feature in the BMDT.

Subjects were randomly assigned to one of two conditions: a treatment condition in which subjects generated BM ideas with a BMDT where the creativity feature was released, and a control condition in which this feature was not released. As to the dependent variables, there is a consensus in both information systems and creativity research on how to measure creative products (here, BM ideas) of creative tasks (here, BM idea generation) (Amabile 1996; Müller-Wienbergen et al. 2011; Seidel et al. 2010; Wierenga and van Bruggen 1998). Following this research, which also includes experiments with software (e.g., Althuizen and Reichel 2016; Malaga 2000; Massetti 1996), the two dependent variables in our experiment were the quantity and the quality of the generated BM ideas.

Experimental task. The BM idea generation task was based on "improving an ailing donut franchise" business case (MacCrimmon and Wagner 1994), which had previously been adapted to studying the effects of other creativity support systems (Althuizen and Reichel 2016). I adapted the business case for BM innovation (see Appendix 2). The description of the task included a short text on the current situation of the donut franchise and a *Business Model Canvas*. Subjects were asked to innovate the BM of the donut franchise (i.e., generate new BM ideas).

Business model development tool with creativity feature used in the experiment. A BMDT was implemented for the experiment that allows to realize and control the experiment (see Figure 4). The BMDT provides three basic features to its users that replicate the typical use of the *Business Model Canvas*: creating, moving, and deleting sticky notes. In addition to these three features, users in the treatment group can make use of the creativity feature. Clicking on a button makes the BMDT provide a stimulus that consists of the two successive interrelated actions previously derived: a brainstorming question that makes individuals load BM knowledge (addressing the *knowledge loading failure*) and a corresponding change of the BM idea currently being edited in the BMDT that exposes individuals to a new (re-)combination of BM knowledge (addressing the *idea generation failure*). To change the BM idea, the creativity feature adds at least two sticky notes that match the content of the brainstorming question. As brainstorming questions, I used so-called 'What-if' questions that had been tried and tested in workshops, coaching, and accelerator programs by *Board of Innovation*, an international innovation consultancy (Board of Innovation 2019). In the experiment, I used a set of 31 BM-specific questions that address at least two components of the *Business Model Canvas* (see Appendix 3). Each stimulus consists of a verbal (i.e., text) and a non-verbal (i.e., picture) element (Paivio 1991; Paivio and Lambert 1981). In Figure 4, I illustrate the editor that allows the user to enter their initial BM idea (see Figure 4a), the exposition of a brainstorming question that addresses the *knowledge loading failure* (see Figure 4b), and the exposition of a changed BM idea that addresses the *idea generation failure* (see Figure 4c).

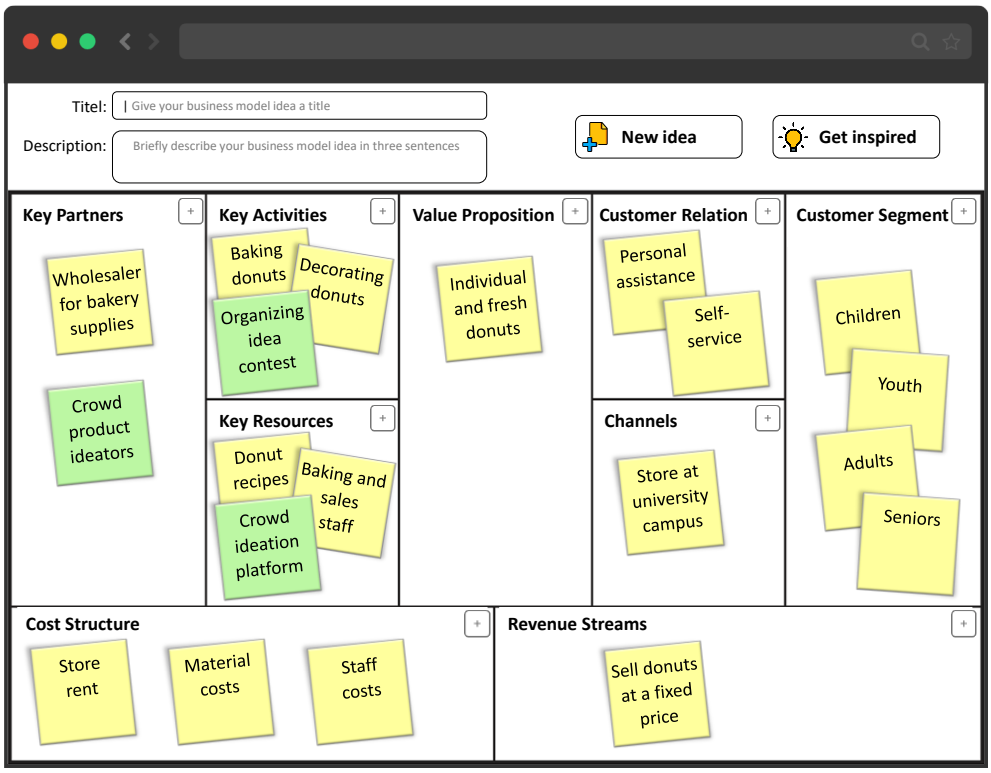


(a) Human-generated business model idea

Figure 4a: Functioning of the creativity feature in a business model development tool

(b) Brainstorming question

Figure 4b: Functioning of the creativity feature in a business model development tool



(c) Computer-changed business model idea

Figure 4c: Functioning of the creativity feature in a business model development tool

Subjects in the experiment. Typically, experimental research on creativity employs tasks that non-experts (e.g., students) can easily understand (Dahl and Moreau 2002; Franke et al. 2013; Girotra et al. 2010; Goldenberg and Mazursky 2002; Kornish and Ulrich 2011). In contrast, the task of BM idea generation requires some prior knowledge about BM innovation, without which subjects otherwise would not be able to meaningfully work on. Therefore, I recruited students from Paderborn University who enrolled in a bachelor course specifically dedicated to the topic of BM innovation (see Szopinski 2019b for a detailed course synopsis). As part of this course, all subjects must have spent several weeks on this topic and have analyzed, generated, and revised BM ideas using the *Business Model Canvas* in three different consecutive assignments, each lasting at least two weeks. These conditions are intended to ensure that subjects have a comparatively consistent understanding of the challenges and opportunities of BM innovation.

Participation in the experiment was a compulsory part of the course. From the students' point of view, the incentive to participate in the experiment was to qualify for the final exam at the end of the semester. On the one hand, rewards can increase creativity (Byron and Khazanchi 2012). On the other, previous experiments on BM idea generation have revealed that some subjects have questioned whether "We get 50 € and you become millionaires?!" (John 2018, p. 75). Other studies on BM idea generation do not report having offered any creativity-contingent rewards (e.g., Athanasopoulou et al. 2018; Eppler et al. 2011; Eppler and Hoffmann 2012). Nevertheless, as an additional performance-based incentive I offer

a monetary reward in form of a shopping voucher of 50,00 € be given to subjects (i.e., students) who hand in BM ideas that are among the three most creative ideas.

Opting for students as subjects in experiments is not free of limitations and limits the study's generalizability. On the one hand, the BM innovation course is geared towards teaching students in becoming experts on this topic. On the other hand, it would be presumptuous to compare students with experts who gained knowledge through experiential learning and practice (Armstrong and Mahmud 2008; Ericsson and Charness 1994). I decided to use students for mainly two reasons. First, the cognitive operations that creative tasks require (i.e., knowledge loading and idea generation) function in the same way, regardless of whether they are performed by experts or by non-experts (Nijstad and Stroebe 2006). Second, I recognize the differences in the knowledge networks on which experts and non-experts apply these cognitive operations with regard to knowledge structure and cognitive flexibility (Dane 2010), but take advantage of that. While the knowledge networks of experts are more accurate and more detailed (i.e., their knowledge networks consist of more images, concepts, and relations), it makes experts cognitively less flexible than students to search in their knowledge networks (Dane 2010). Therefore, if a creativity feature in a BMDT can facilitate the cognitive processes of non-experts, then I would expect this to apply to experts even more because they have potentially more knowledge and are cognitively less flexible in (re-)combining that knowledge into new BM ideas. Using students with smaller knowledge networks is therefore not a hindrance to the experiment.

Experimental procedure. The experiment was originally to be conducted in the university's experiment laboratory, which has more than thirty individual workstations, separated by partition walls, allowing to seat subjects so that they cannot talk to each other or see one another's screens. The coronavirus pandemic, unfortunately, made it impossible to carry out the experiment in the laboratory. The experiment was thus carried out as a remote experiment in a quasi 'distributed laboratory'. That is, the subjects participated in the experiment from home instead of visiting the laboratory. Although I was not able to control subjects in the same way as would have been possible in the laboratory (e.g., ensuring a quiet working atmosphere without distractions and identical screen and workstation size), there is no systematic bias as this applies to subjects from both the treatment and the control group. All subjects received an e-mail with a random code on the morning of the experiment that allowed each subject to log into the BMDT through a standard web browser. Upon registration in the BMDT, each subject was randomly assigned to one of the two conditions. Once all the subjects were registered, the experiment began. The experimental procedure comprised eight steps, including an onboarding (20 minutes), the actual BM idea generation (30 minutes), and an offboarding (10 minutes; see Appendix 4 for a step-by-step description).

6 Results

In November 2020, 175 students from a BM innovation course participated in the experiment. I eliminated the data from 12 subjects for the following reasons:

- 6 subjects because they had already participated in a pilot study in the previous semester in which I tested the technical feasibility of the BMDT experimental platform,
- 2 subjects because their BM ideas were incomplete (i.e., not having at least one element in each of the building blocks of the *Business Model Canvas*),
- 2 subjects because they reported implausible data (e.g., stating that they had generated 1,000 BMs in the last two years),
- 2 subjects because they had technical problems during the experiment and thus the questionnaire could not be transmitted.

This yielded a final sample of 163 subjects with at least 80 subjects in each of the two experimental groups. This number equals or exceeds the number of subjects in prior experimental research on the use of software in creative tasks (e.g., Althuizen and Reichel 2016; Malaga 2000; Massetti 1996).

To check whether randomization worked effectively and if subject characteristics were proportionally distributed across the experimental groups, I examined whether the treatment and control group systematically differ in terms of demographics (age, semester, gender, study program) and prior knowledge (with BMs, the *Business Model Canvas*, and BMDTs; see Appendix 7). As depicted in Table 2, the experimental groups do not exhibit statistically significant differences at any conventional levels across demographics and prior knowledge. I conclude that the subjects in the experimental groups are adequately balanced, which suggests that the results are not driven by inadequate randomization.

Variable	Treatment group (N = 82)		Control group (N = 81)		p-value of differences in M
	M	SD	M	SD	
Demographics					
Age*	22.49	3.38	22.46	2.33	.946
Semester*	5.34	1.97	5.43	1.88	.764
Gender§					.422
Study program§					.714
Prior knowledge					
Business Models*	3.95	1.04	3.78	1.24	0.352
Business Model Canvas*	4.48	1.20	4.23	1.37	0.222
Business Model Development Tools*	2.83	1.29	3.01	1.51	0.422

Table 2: Randomization checks for subject characteristics [p-value calculated by * t-test § Pearson's χ^2 test; M and SD omitted for Gender and Study program due to nominal scales]

To examine the differences in the generation of BM ideas between the experimental groups I analyzed the quantity and quality of BM ideas. While the former can be objectively measured, the latter requires expert evaluations.

Analyzing the effect of the creativity feature on BM idea quantity. Analysis for Hypothesis 1 consists of measuring the quantity of BM ideas. For this purpose, I calculated the mean number of BM ideas generated for each subject. The 82 subjects in the treatment group with the creativity feature in the BMDT (M = 2.55, SD = 1.00) are attaining slightly higher scores than 81 subjects in the control group without the creativity feature (M = 2.53, SD = 1.15). The median is identical in the treatment group and the control group (Median = 2, see Table 3 for more descriptive statistics). The descriptive statistics indicate that the difference in the BM idea quantity between the treatment and control group is of small size. The creativity feature has no economic significance for the BM idea quantity that humans generate when using a BMDT. In other words, the creativity feature makes no difference to the number of BM ideas that is available to an organization for further BM innovation. For the sake of completeness, I determined the statistical significance. I therefore tested for normal distribution using the *Shapiro-Wilk-Test*. The BM idea quantity in the treatment group was found to be normally distributed (W= .98, V = 1.329, p = .266), while the BM idea quantity in the control group was found to be not normally distributed (W = .94, V = 5.091, p = .001). Although the *T-Test* is relatively robust against violations of normality (Green and Salkind 2013), I tested for a significant difference for BM idea quantity between the two experimental groups with the *Mann-Whitney-U-Test* which, as a non-parametric test, is agnostic to the underlying data distribution. As a result, I found that the creativity feature did not reach statistical significance (z = -0.466, p = .643).

Variable	Treatment group (N = 82)	Control group (N = 81)
M	2.55	2.53
SD	1.00	1.15
Median	2	2
Min	1	1
Max	5	7

Table 3: Descriptive statistics BM idea quantity

As already described in Section *3 Theoretical Background*, BM idea generation is a special form of idea generation. With the aim of better understanding software-supported BM idea generation through experimental research, I looked at possible drivers of BM idea quantity. Well-received earlier experimental research shows that individual differences in subjects have the potential to explain the outcome of creative tasks (Althuizen and Reichel 2016). Therefore, I analyze the relationships between individual differences of subjects and the quantity of BM ideas. More specifically, the ability for divergent thinking through the 'Identical features test' (Schoppe 1975), openness to experience through

12 items taken from the Big Five personality inventory (Costa and McCrae 1992), and intrinsic motivation through two items (Deci and Ryan 1985) are likely to be relevant variables (Althuizen and Reichel 2016).

To analyze whether previous knowledge, personality traits, and perceived creativity-support of the BMDT (see Table 5) are correlated with the results of BM idea generation, I performed a regression analysis. I therefore checked whether the assumptions underlying a regression analysis are met (largely following Field 2013). The check of the assumptions (i.e., testing the linearity, homoscedasticity, independence, and normality) showed that the assumptions about homoscedasticity and normal distribution were violated. Thus, the model is determined using a bootstrap and homoscedasticity-consistent estimators (Field 2013). Multiple linear regression was calculated to predict BM idea quantity (*bmideaquantity*) based on the subjects' previous knowledge (*numbm, numbmc, numbmdt*), personality traits (*divergentthinkingability, big5_opennesstoexperience, intrinsicmotivation*), and perceived creativity-support through the BMDT (*csi_enjoyment, csi_exploration, csi_expressiveness, csi_immersion, csi_resultsworttheffort*). The results of the regression indicated that the model explained 18.5% of the variance ($adjR^2$ = .185) and that the model was a significant predictor of BM idea quantity (W^2 (11, 163) = 46.37, p < .000). Although modest in magnitude, divergent thinking ability (*divergentthinkingability*) and perceived creativity-support in terms of exploration (*csi_exploration*) are statistically significant predictors of BM idea quantity (see Table 4).

bmideaquantity	Observed coefficient	Bootstrap SE	z	p>|z|	95% CI	
					LL	UL
numbm	-.113	.073	-1.55	0.121	-.255	.030
numbmc	.104	.090	1.15	0.250	-.073	.280
numbmdt	.064	.087	0.74	0.458	-.106	.234
divergentthinkingability	.073	.021	3.40	0.001	.031	.115
big5_opennesstoexperience	-.117	.342	-0.34	0.733	-.788	.554
intrinsicmotivation	.074	.078	0.96	0.338	-.078	.226
csi_enjoyment	-.069	.082	-0.83	0.404	-.230	.093
csi_exploration	.265	.095	2.78	0.005	.078	.451
csi_expressiveness	.113	.098	1.15	0.249	-.079	.306
csi_immersion	.038	.053	0.72	0.474	-.067	.143
csi_resultsworttheffort	-.027	.083	-0.33	0.745	-.189	.135
_cons	.614	1.12	0.55	0.585	-1.59	2.82

Table 4: Regression table

This means that changes in divergent thinking ability and perceived creativity-support in terms of exploration are associated with changes in the number of BM ideas. Subjects who are generally able to generate more answers to a creative task (here the 'Identical features test') also generate more BM ideas. With the intention of increasing the effect on BM idea quantity, this might suggest that users undergo creativity training before using a BMDT (e.g., Meinel et al. 2019). Similarly, subjects who find it easy

to explore new BM ideas using the BMDT and perceive the BMDT as help generate more BM ideas. This might indicate that self-efficacy should also be considered when (re)designing BMDTs (e.g., Seo et al. 2015). Both variables (i.e., divergent thinking ability and perceived creativity-support in terms of exploration) can help understand – to a modest extent – what drives BM idea quantity. The other variables are not significantly correlated with BM idea quantity. In Section *7 Discussion* and in Szopinski (2020) I present suggestions for future (creativity) features of BMDTs that consider such elements as the prior knowledge and personality traits of BMDT users.

Analyzing the effect of the creativity feature on BM idea quality. Analysis for Hypothesis 2 consists of measuring the quality of BM ideas. Subjects were asked which of their BM ideas they considered their 'best' BM idea, and that one 'best' idea from each subject was evaluated by the expert jury regarding its quality. To measure the quality of BM ideas, I refer to a well-established conceptualization of the creativity of ideas, namely novelty and usefulness (e.g., Amabile 1996; Baer et al. 2010). The scale is based on creativity research and has been successfully used for expert evaluations of ideas by adopting the consensual assessment technique (Amabile 1996; Baer and McKool 2009; Magnusson et al. 2016). To benefit from the proven validity and robustness of this technique (see Bretschneider 2012 for a thorough description of measuring idea quality in entrepreneurial innovation contexts and their evaluation by experts), our experiment design fulfilled the technique's requirements concerning the creative task and the expert jury (Amabile 1996). First, BM ideas were presented visually in the form of the *Business Model Canvas* and textually in the form of a short description. Second, generating BM ideas does not require any specific knowledge about donuts, pastries, or the retail industry in general. Third, subjects were given free rein while generating BM ideas. Fourth, the expert jury consisted of four members who helped to assess the quality of BM ideas. Fifth, experts were very familiar with BM innovation and are highly experienced in evaluating BM ideas. Sixth, experts were not informed whether a BM idea has been generated by subjects from the control or the treatment group. The evaluation procedure comprised four steps and was started after the experiment was performed (following Simmert et al. 2019).

(1) Experts were introduced to the evaluation procedure and trained in applying the evaluation criteria for BM ideas (Hayes and Krippendorff 2007; Krippendorff 2004).
(2) Experts were asked whether the BM ideas are described in such a way that they felt able to evaluate them.
(3) Experts received an evaluation form for each BM idea (see Appendix 5). Each evaluation form presented a BM idea visually using the *Business Model Canvas* and textually as a short description. The evaluation form also listed the evaluation criterion. The sequence in which experts evaluate the BM ideas was random.

Variable	Scale	Item(s)	Source	Appendix
Prior experience with business models	0-n, cardinal scale, (*numbm*)	How many BMs have you generated in the last two years?		see Appendix 7 section 'Prior business model knowledge'
Prior experience with the *Business Model Canvas*	0-n, cardinal scale, (*numbmc*)	How many BMs have you generated in the last two years using the *Business Model Canvas* (and its components)?		
Prior experience with business model software	0-n, cardinal scale, (*numbmdt*)	How many BMs have you generated in the last two years using a business model software?		
Divergent thinking ability	0-40, cardinal scale, (*divergentthinkingability*)	The 'Identical features test' requires individuals to list as many words as possible that have similar semantic/functional meaning (e.g., What could a person use to 'move faster'? What is usually 'bendable'?).	Schoppe 1975	see Appendix 6
Openness to experience	1-7-Likert-Skala, ordinal scale, (*big5_opennesstoexperience*)	12 items taken from the Big Five personality inventory	Costa and McCrae 1992	see Appendix 7 section 'Individual preferences'
Intrinsic motivation	1-7-Likert-Skala, ordinal scale (*intrinsicmotivation*)	2 items: Did you find the task interesting? Was it enjoyable to work on?	adapted from Deci and Ryan 1985	see Appendix 7 section 'Overall impression'
Enjoyment	1-7-Likert-Skala, ordinal scale, (*csi_enjoyment*)	2 items: I would be happy to use this BMDT on a regular basis. I enjoyed using the BMDT.	adapted from Cherry and Latulipe 2014	see Appendix 7 section 'Business Model Development Tool'
Exploration	1-7-Likert-Skala, ordinal scale, (*csi_exploration*)	2 items: It was easy for me to explore many different ideas, options, designs, or outcomes using this BMDT. The BMDT was helpful in allowing me to track different ideas, outcomes, or possibilities.		
Expressiveness	1-7-Likert-Skala, ordinal scale, (*csi_expressiveness*)	2 items: I was able to be very creative while doing the activity inside this BMDT. The BMDT allowed me to be very expressive.		
Immersion	1-7-Likert-Skala, ordinal scale, (*csi_immersion*)	2 items: My attention was fully tuned to the activity, and I forgot about the BMDT that I was using. I became so absorbed in the activity that I forgot about the BMDT that I was using.		
Results Worth Effort	1-7-Likert-Skala, ordinal scale, (*csi_ resultsworttheffort*)	2 items: I was satisfied with what I got out of the BMDT. I was able to produce was worth the effort I had to exert to produce it.		

Table 4: Independent Variables

(4) Experts were asked to evaluate each BM idea individually and in detail by rating the evaluation criterion on a 5-point Likert-scale ranging from 1 (strongly disagree) to 5 (strongly agree). The item read: *This business model idea is creative (i.e., novel and useful)*.

After completion of the evaluation procedure by the expert jury, four individual expert assessments are available for the 'best' BM idea from each of the 163 subjects. To determine inter-rater reliability among the four experts regarding the ratings of the quality of the BM ideas, I calculated *Krippendorff's alpha coefficient*. There is little agreement among the four experts regarding the quality of the 163 'best' BM ideas ($\alpha = .240$). The reliability achieved by the expert jury is below the required threshold ($\alpha = .800$; Krippendorff 2004) and not acceptable. I also checked whether one of the four experts could be the cause of this low reliability, but this was not the case ($\alpha_{\text{without expert 1}} = .176$; $\alpha_{\text{without expert 2}} = .191$; $\alpha_{\text{without expert 3}} = .335$; $\alpha_{\text{without expert 4}} = .254$). Reliability remains low also with pairwise comparison (here α lies between .120 and .438). I conclude that the assessment of the BM idea quality in this experiment is not reliable and thus not valid. Therefore, Hypothesis 2 cannot be analyzed.

7 Discussion

Several researchers and practitioners emphasized the enormous potential of software-based tools for supporting BM innovation (e.g., Osterwalder and Pigneur 2013; Veit et al. 2014; Ebel et al. 2016;). In response to these scholarly and managerial calls, the objective of this study was to investigate whether a creativity feature in a BMDT can enhance the quality and quantity of BM ideas. To the best of my knowledge, this study on BMDTs is the first attempt to build a creativity feature for such software tools in a theory-driven way and to evaluate it empirically using a randomized controlled experiment. The challenges revealed in the course of the present study to rigorously determine the utility of a creativity feature suggest that theory-driven building and empirical evaluation of individual features and entire BMDTs is still in its infancy, in particular when it comes to supporting the early phase of BM idea generation. In the following, I discuss using the evaluation framework for design experiments of Mettler et al. (2014), more specifically, along with three cornerstones: the user, the use, and the utility of the researched BMDT. In doing so, I discuss both the results and the rigor of the experiment.

The user of the researched BMDT. Please recall that the subjects of the experiment were undergraduate students of a BM innovation course. Please also recall that the experiment could not be conducted in the laboratory, but that the subjects had to participate in the experiment from home due to the coronavirus pandemic. The study subjects and the experimental setting have already been described in detail in Section *5 Experiment*. As a result of analyzing the relationships between individual differences and quantity of BM ideas, it was found that divergent thinking ability influenced BM idea quantity, as did exploration. A possible explanation is that the provided creativity feature stimulated subjects who already are good in divergent thinking and can thus easily load and (re-)combine knowledge in general. More specifically, subjects with a high divergent thinking ability are likely to

explore the solution space of BM ideas more deeply and broadly (Plucker and Renzulli 1999; Althuizen and Reichel 2016). This suggests that they can easily generate BM ideas because they cognitively process new knowledge or (re-)combinations about BMs in the short time of the experiment. This is also consistent regarding the perceived creativity-support of the BMDT in terms of exploration because subjects for whom the BMDT was helpful in exploring many different BM ideas naturally generate more BM ideas. It stands to reason that subjects who feel supported by the BMDT will also generate more BM ideas. Whether the new BM ideas come from the new knowledge or from the new (re-)combinations cannot be observed. As a reliable and valid measurement of BM idea quality has not been achieved with the consensual assignment technique, a relationship between the proposed creativity feature and BM idea quality could therefore not be studied. This also applies to possible relationships between BM idea quantity and BM idea quality as well as to possible relationships to previous knowledge or personality traits. In summary, it seems that personality traits influence creativity in BM idea generation and that there may be other factors that are relevant specifically in the context of generating BM ideas. The operationalization of these factors and the interaction effects between them require future research.

The use of the BMDT. The key artefact characteristics of the BMDT used in the experiment are the visual representation of BMs through the *Business Model Canvas* and the reduction to three basic features (apart from the creativity feature in the treatment condition). The use of the BMDT thus essentially consisted of creating, moving, and deleting sticky notes. To control the experiment, all other possible characteristics (for a review of many other features see Szopinski et al. 2020) were not intended for use in the BMDT. Furthermore, the manipulation consisted in the (un-)availability of the BMDT's creativity feature. While the selection of the brainstorming question and the corresponding change of the BM idea through the BMDT is random, the use of the creativity feature itself is determined by its timing (i.e., the situation when users request the creativity feature from the BMDT). In a pre-test for the technical feasibility of the creativity feature (see Szopinski 2019c), I also tried forms of the creativity function in which the timing of the stimuli is not determined by the user (i.e., on demand), but by the software (Siangliulue et al. 2015). For example, users could be automatically presented with a stimulus when no sticky note had been added to the BM for 2.5 minutes in the editor of the BMDT (i.e., on idle) or at the beginning of the BM idea generation and thereafter every 5 minutes (i.e., on interval). However, users in the pre-test perceived this external timing to be a process disfluency (Mehta et al. 2012), as users reported that they had been considerably disturbed in their BM idea generation (Szopinski 2019c). The BMDT used in this study's experiment allowed users to request the creativity feature whenever they want. Most subjects in the treatment condition used the creativity feature when they ran out of BM ideas (37 subjects; 45%) or when they got bored (33 subjects; 44%). In addition, the creativity feature was used by subjects before they started generating a BM idea (11 subjects; 13%) and in the middle of coming up with new BM ideas (13 subjects; 16%) (multiple responses allowed; adapted from Siangliulue et al. 2015). I also asked BMDT users in the treatment group to what extent the creativity

feature was helpful to them in generating BM ideas. On the one hand, subjects reported that the creativity feature 'gave food for thought', made them 'question their own BM ideas', 'undoubtedly increased motivation', and 'opened up new horizons'. Also, subjects reported that the creativity feature helped them 'to not get stuck on one BM idea' and 'to transfer BMs from other industries'. On the other hand, such statements about perceived creativity are not yet proof that the designed BMDT with the creativity feature works better than existing solutions, such as BMDTs on the market that do not yet have creativity features. In addition to the self-reported data on BMDT use, the initial plan was to also collect real-time data on actual BMDT use (especially timing, frequency, and duration of stimuli). Unfortunately, these data were not saved correctly, due to a technical error. As desirable as it is to repeat the experiment in the long term, it is difficult to recruit a comparably large number of subjects in the short term. This is mainly because subjects who participated in the experiment now know the manipulation. For a rigorously conducted repetition of the experiment, it is necessary that future participants do not know the manipulation. Under this condition, the theory-based creativity feature, the BMDT experimentation platform and the experimentation design can be used.

The utility of the BMDT. The results of the experiment in this study did not show any significant increase in BM idea quantity for individuals generating BM ideas using a BMDT with a creativity feature. A possible explanation is that the provided creativity feature is too complex to use in the short time of the experiment. Both the introduction and the use time would perhaps have to be increased, to make users meaningfully utilize the BMDT in general, and the creativity feature in particular. Another possible explanation is that the creativity feature allowed subjects to search the solution space of BM ideas, but it cannot be observed how deep and how broad they search in the solution space of BM ideas. This depends on whether the subjects pursue weaker (i.e., more remote or distant) or stronger (i.e., more close or near) associations within their memory while generating BM ideas. Previous researchers found that humans intuitively follow strong associations, taking the line of least resistance (Althuizen and Reichel 2016; Briggs and Reinig 2010). Another possible explanation is that the creativity features may increase the depth and breadth of subjects' search in the solution space of BM ideas. While increasing the depth of exploration is said to increase the quality of ideas, increasing the breadth of exploration is said to increase the number of ideas (Rietzschel et al. 2007; Nijstad et al. 2010; Althuizen and Reichel 2016). The post-experiment survey among the subjects of the treatment group showed that the creativity feature led some subjects 'to create BM ideas that [they] wouldn't have come up with otherwise', while other subjects found 'the gap between the stimuli and the BM idea processed in the BMDT too large'. Therefore, the perceived utility of the creativity feature might depend on the distance between the stimuli and the BM idea currently being worked on in the BMDT. However, what distance is conducive to a specific BM idea in a given situation is a research question in its own right. Beyond the distance of stimuli, possibly the interlocking of knowledge loading and idea generation in the creativity feature of the BMDT was counterproductive. Alternatively, the creativity feature should

have been deliberately separated into a creativity feature for new knowledge and another for new (re-)combinations. Accordingly, it is also conceivable that the exposition of a brainstorming question (i.e., knowledge loading) and the exposition of a changed BM idea (i.e., idea generation) reciprocally cancel each other out (De Dreu et al. 2008; Nijstad et al. 2010; Althuizen and Reichel 2016).

Furthermore, the low agreement among the experts on the quality of the BM ideas does not allow drawing any conclusions about the quality of the BM ideas and whether the creativity feature in the BMDT is conducive to improving BM idea quality. In the following, I report on experiences with the experiment to inform future research, because null findings may well have a bearing on theories, hypothesis development, and experiment designs (Franco et al. 2014; Mehler et al. 2019). This applies to the future theory-driven building of features for BMDTs and its empirical evaluation; both for creativity features and for all other types of features. For suggestions on other creativity features see Szopinski (2020) and for suggestions on other types of features in BMDTs see Szopinski et al. (2020).

The evaluation of BM idea quality remains a challenge, and adaptations may be needed to apply the consensual assessment technique in future studies on BM idea generation with BMDTs. For example, instead of asking each expert to rate the quality of BM ideas individually, the experts could be asked to rate the quality of BM ideas collectively. The expert jury would therefore have to come to a joint verdict on the quality of each BM idea. This would require an enormous amount of time for the experts to discuss and evaluate all BM ideas together, and such experts are rare and usually do not have much time available. This would be an approach to measure the quality of BM ideas more reliably and validly. However, evaluating ideas in groups also has its own challenges (e.g., Rietzschel, et al. 2006; Faure 2011; Johnson and D'Lauro 2017). Regardless of how precisely the consensual evaluation technique is adapted for experimental studies in the future, reliable and valid determination of BM idea quality is a critical factor for exploring software-based BM idea generation. This may also include the use of more fine-grained metrics for BM idea quality such as the metric by Simmert et al. (2019) with its six items: novelty, originality, feasibility, acceptability, effectiveness, and elaboration.

Further research into the benefits of software in the context of creative tasks may also consider alternative experiment designs. Inspired by the usage scenarios of creativity support systems presented by Cherry and Latulipe (2014), I outline three alternative experiment designs for researching individual (creative) features or entire BMDTs. The first alternative involves experiment designs with subjects working on a (creative) task and using all (i.e., two or more different) BMDTs. Unlike in the between-subjects experiment design, in a within-subject experiment design subjects would be exposed to all conditions (i.e., all BMDTs). This type of research provides insights into how users perform the same task differently with different BMDTs. However, this requires counterbalancing possible ordering effects (e.g., by using BMDTs in different orders). The second incorporates experiment designs with subjects working on multiple (creative) tasks and using the same BMDT. In the context of creative tasks,

this could go beyond the task of purely generating BM ideas. Typically, creative tasks involve problem finding, information finding, idea finding, and solution finding (Wang and Nickerson 2017). This type of research provides insight into the extent to which a BMDT can support various tasks and which features are important for which tasks. The third alternative employs experiment designs with subjects working on a (creative) task and using a BMDT over a short or long period of time. Unlike a cross-sectional study, a longitudinal study on BMDTs allows researchers to investigate changes in using BMDTs over time. In addition, this type of research provides insights into how users gain more expertise in using BMDTs and whether novice and expert users use BMDTs differently, for example.

8 Limitations and future research

In the context of BM innovation, there is still a lot we do not know about creativity and how BM idea generation works exactly. This is partly because the BM idea generation process occurs at a cognitive, somewhat subconscious level. In response, this study presented a between-subjects experiment design to investigate a creativity feature in a BMDT. A clear benefit of the creativity feature in the generation of BM ideas could not be identified in this study, neither for their quality nor for their quantity. Despite the high rigor in developing the creativity feature and in designing the experiment, some limitations apply to this study and offer interesting opportunities for future research on BMDTs.

First, the theory used in this study served primarily to design the creativity feature (i.e., addressing the *knowledge loading failure* and the *idea generation failure*) and was only used to a limited extent to explain how, why, when, and where the creativity feature may be conducive to BM idea generation. Put differently, the creativity feature is understood as a 'black box' and, admittedly, I leave it to future research to take a look inside. Such future research may investigate how/why/when/where users of the creativity feature navigate in their solution space of BM ideas.

Second, as software itself never has any impact, it is the use of the software (here BMDTs) that induces impact. As there is neither a theory of BM innovation nor a theory of BM idea generation and as the focus is on the use and not the software itself, this requires further theory contextualization (Whetten et al. 2009; Hong et al. 2014). This, in turn, could mean that BM idea generation may not be different from other creative tasks.

Third, the proposed research focuses on individual BM idea generation. Typically, BM idea generation is a collaborative task. However, understanding how software can support individual BM idea generation is typically a prerequisite for understanding how software can support collaborative BM idea generation. In addition, idea generation in groups always includes a certain degree of individual ideation.

Fourth, the co-creative human-computer cooperation between the BMDT and its users constitutes a sociotechnical system. The (un-)availability of the creativity feature in the BMDT consists of two design alternatives that could be seen as completely different systems. This, in turn, may limit the

generalizability of the results. While this can only be resolved through further research, I am confident that experimentally investigating ‘a creativity feature vs. no creativity feature’ was a useful starting point for researching BMDTs in comparison to ‘software-based vs. non-software-based’.

Fifth, the creativity feature is intended to support divergent thinking (i.e., the process of generating a great number of unique ideas). Creativity features in BMDTs that are also intended to support convergent thinking (i.e., the process of determining what is the single best idea) will require evaluating which BM ideas are the most promising. I can imagine that future research will have the potential to integrate BMDTs that support the idea generation phase and specializing in the evaluation phase.

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References

Alt R, Zimmermann H-D (2014) Status of business model and electronic market research: An interview with Alexander Osterwalder. Electronic Markets 24:243–249

Althuizen N, Reichel A (2016) The effects of IT-enabled cognitive stimulation tools on creative problem solving: A dual pathway to creativity. Journal of Management Information Systems 33:11–44

Althuizen N, Wierenga B (2014) Supporting creative problem solving with a case-based reasoning system. Journal of Management Information Systems 31:309–340

Amabile TM (1996) Creativity in context: Update to the social psychology of creativity. Westview Press, Boulder, CO, USA

Anke J (2020) Enabling design-integrated assessment of service business models through factor refinement. In: Proceedings of the 15th International Conference on Design Science Research in Information Systems and (DESRIST 2020), Kristiansand, Norway

Armstrong SJ, Mahmud A (2008) Experiential learning and the acquisition of managerial tacit knowledge. Academy of Management Learning & Education 7:189–208

Athanasopoulou A, de Reuver M (2020) How do business model tools facilitate business model exploration? Evidence from action research. Electronic Markets 30:495–508

Athanasopoulou A, Haaker T, de Reuver M (2018) Tooling for internet-of-things business model exploration: A design science research approach. In: Proceedings of the 26th European Conference on Information Systems (ECIS 2018), Portsmouth, United Kingdom

Augenstein D, Fleig C (2017) Exploring design principles for a business model mining tool. In: Proceedings of the 38th International Conference on Information Systems (ICIS 2017), Seoul, South Korea

Augenstein D, Dellermann D, Fleig C (2017) Towards value proposition mining: Exploration of design principles. In: Proceedings of the 38th International Conference on Information Systems (ICIS 2017), Seoul, South Korea

Baden-Fuller C, Haefliger S (2013) Business Models and Technological Innovation. Long Range Planning 46:419–426

Baden-Fuller C, Morgan MS (2010) Business models as models. Long Range Planning 43:156–171

Baer M, Leenders RTAJ, Oldham GR, Vadera AK (2010) Win or lose the battle for creativity: The power and perils of intergroup competition. Academy of Management Journal 53:827–884

Baer J, McKool S (2009) Assessing creativity using the consensual assessment technique. In: Handbook of Assessment Technologies, Methods, and Applications in Higher Education. IGI Global, Hershey, PA, USA, pp 65–77

Bhattacherjee A (2012) Social science research: Principles, methods, and practices. Open textbook library. Scholar Commons, University of South Florida; Open Textbook Library, Tampa, FL, USA

Blank S (2020) Customer discovery in the time of the COVID-19 virus. Retrieved April 4th 2020 from https://steveblank.com/

Blohm I, Bretschneider U, Leimeister JM, Krcmar H (2011) Does collaboration among participants lead to better ideas in IT-based idea competitions? An empirical investigation. International Journal of Networking and Virtual Organisations 9:106–122

Board of Innovation (2019) Brainstorm cards. Retrieved April 30th 2019 from https://www.boardofinnovation.com/tools/brainstorm-cards/

Bonnardel N (2000) Towards understanding and supporting creativity in design: Analogies in a constrained cognitive environment. Knowledge-Based Systems 13:505–513

Bouwman H, Reuver M de, Heikkilä M, Fielt E (2020) Business model tooling: Where research and practice meet. Electronic Markets 30:413–419

Bretschneider U (2012) Die Ideen-Community zur Integration von Kunden in den Innovationsprozess: Empirische Analysen und Implikationen. Springer Gabler, Wiesbaden, Germany

Briggs RO, Reinig BA (2010) Bounded ideation theory. Journal of Management Information Systems 27:123–144

Byron K, Khazanchi S (2012) Rewards and creative performance: A meta-analytic test of theoretically derived hypotheses. Psychological bulletin 138:809–830

Cherry E, Latulipe C (2014) Quantifying the creativity support of digital tools through the creativity support index. ACM Transactions on Computer-Human Interaction (TOCHI) 21:1–25

Chesbrough H (2010) Business model innovation: Opportunities and barriers. Long Range Planning 43:354–363

Costa PT, McCrae RR (1992) Revised NEO personality inventory (NEO-PI-R) and NEO five-factor-inventory (NEO-FFI) manual. Psychological Assessment Resources, Odessa, FL, USA

Couger JD, Higgins LF, McIntyre SC (1993) (Un)structured creativity in information systems organizations. MIS Quarterly 17:375–397

Dahl DW, Moreau P (2002) The influence and value of analogical thinking during new product ideation. Journal of Marketing Research 39:47–60

Dane E (2010) Reconsidering the trade-off between expertise and flexibility: A cognitive entrenchment perspective. Academy of Management Review 35:579–603

Deci E, Ryan R (1985) Intrinsic motivation and self-determination in human behavior. Plenum, New York, NY, USA

De Dreu CKW, Baas M, Nijstad BA (2008) Hedonic tone and activation level in the mood-creativity link: Toward a dual pathway to creativity model. Journal of Personality and Social Psychology 94:739–756

Dellermann D, Lipusch N, Ebel PA, Leimeister JM (2018) Design principles for a hybrid intelligence decision support system for business model validation. Electronic Markets 19:359–378

Diederich S, Brendel AB, Kolbe LM (2020) Designing anthropomorphic enterprise conversational agents. Business & Information Systems Engineering 62:193–209

Diehl M, Munkes J, Ziegler R (2002) Brainstorming and cognitive stimulation: When does being exposed to the ideas of others facilitate or inhibit one's own idea generation? In: Proceedings of the 13th Conference of the European Association of Experimental Social Psychology, San Sebastian, Spain

Doz YL, Kosonen M (2010) Embedding strategic agility: A leadership agenda for accelerating business model renewal. Long Range Planning 43:370–382

Dugosh KL, Paulus PB, Roland EJ, Yang H-C (2000) Cognitive stimulation in brainstorming. Journal of Personality and Social Psychology 79:722–735

Ebel PA, Bretschneider U, Leimeister JM (2016) Leveraging virtual business model innovation: A framework for designing business model development tools. Information Systems Journal 26:519–550

Eppler MJ, Hoffmann F (2012) Does method matter? An experiment on collaborative business model idea generation in teams. Innovation: Management, Policy & Practice 14:388–403

Eppler MJ, Hoffmann F, Bresciani S (2011) New business models through collaborative idea generation. International Journal of Innovation Management 15:1323–1341

Ericsson KA, Charness N (1994) Expert performance: Its structure and acquisition. American Psychologist 49:725–747

Faure C (2004) Beyond brainstorming: Effects of different group procedures on selection of ideas and satisfaction with the process. Journal of Creative Behavior 38:13–34

Fiske ST, & Taylor SE (1991) Social cognition. McGraw-Hill, New York, NY, USA

Field, A (2013). Discovering statistics using IBM SPSS statistics. Sage Publications, Los Angeles, CA, USA

Foss NJ, Saebi T (2018) Business models and business model innovation: Between wicked and paradigmatic problems. Long Range Planning 51:9–21

Franke N, Keinz P, Klausberger K (2013) "Does this sound like a fair deal?": Antecedents and Consequences of Fairness Expectations in the individual's decision to participate in firm innovation. Organization Science 24:1495–1516

Franco A, Malhotra N, Simonovits G (2014) Publication bias in the social sciences: Unlocking the file drawer. Science, 345:1502–1505.

Fritscher B, Pigneur Y (2009) Supporting business model modelling: A compromise between creativity and constraints. In: Proceedings of the 8th International Workshop on Task Models and Diagrams for User Interface Design (TAMODIA 2009), Brussels, Belgium

Fritscher B, Pigneur Y (2014a) Computer aided business model design: Analysis of key features adopted by users. In: Proceedings of the 47th Hawaii International Conference on System Sciences (HICSS 2014), Waikoloa, HI, USA

Fritscher B, Pigneur Y (2014b) Visualizing business model evolution with the business model canvas: Concept and tool. In: Proceedings of the 16th IEEE Conference on Business Informatics (CBI2014), Geneva, Switzerland

Gabriel A, Monticolo D, Camargo M, Bourgault M (2016) Creativity support systems: A systematic mapping study. Thinking Skills and Creativity 21:109–122

Gartner (2019) Speed up your digital business transformation. Retrieved January 15th 2019 from https://www.gartner.com/smarterwithgartner/speed-up-your-digital-business-transformation/

Gartner (2020) CEO survey: The year of challenged growth. Retrieved February 4th 2020 from https://www.gartner.com/en/documents/3980616/leverage-augmented-analytics-to-drive-digital-business-m

George G, Bock AJ (2011) The business model in practice and its implications for entrepreneurship research. Entrepreneurship Theory and Practice 35:83–111

Gettys CF, Pliske RM, Manning C, Casey JT (1987) An evaluation of human act generation performance. Organizational Behavior and Human Decision Processes 39:23–51

Girotra K, Terwiesch C, Ulrich KT (2010) Idea generation and the quality of the best idea. Management Science 56:591–605

Goldenberg J, Mazursky D (2002) Creativity in product innovation. Cambridge University Press, Cambridge, United Kingdom

Green SB, Salkind NJ (2013) Using SPSS for Windows and Macintosh: International edition. Pearson, London, United Kingdom

Gregor S, Hevner AR (2013) Positioning and presenting design science research for maximum impact. MIS Quarterly 37:337–356

Hamrouni B, Korichi A, Bourouis A (2018) IDSS-BM: Intelligent decision support system for business models. In: Proceedings of the 7th International Conference on Software Engineering and New Technologies (ICSENT 2018), Hammamet, Tunisia

Hansen MT, Birkinshaw J (2007) The innovation value chain. Harvard Business Review 85:121–130

Hayes AF, Krippendorff K (2007) Answering the call for a standard reliability measure for coding data. Communication Methods and Measures 1:77–89

Hevner AR, March ST, Park J, Ram S (2004) Design science in information systems research. MIS Quarterly 28:75–105

Hong W, Chan FKY, Thong JYL, Chasalow LC, Dhillon G (2014) A framework and guidelines for context-specific theorizing in information systems research. Information Systems Research 25:111–136

John T (2016) Supporting business model idea generation through machine-generated ideas: A design theory. In: Proceedings of the 37th International Conference on Information Systems (ICIS 2016), Dublin, Ireland

John T (2018) Business model modeling languages as tools for innovation: Theory and empirical evidence. Dissertation, Paderborn University

John T, Kundisch D (2015) Why fit leads to surprise: An extension of cognitive fit theory to creative problems. In: Proceedings of the 36th International Conference on Information Systems (ICIS 2015), Fort Worth, TX, USA

Johnson BR, D'Lauro CJ (2018) After brainstorming, groups select an early generated idea as their best idea. Small Group Research 49:177–194.

Kajanus M, Iire A, Eskelinen T, Heinonen M, Hansen E (2014) Business model design: New tools for business systems innovation. Scandinavian Journal of Forest Research 29:603–614

Knoll SW, Horton G (2011) Changing the perspective: Using a cognitive model to improve thinkLets for ideation. Journal of Management Information Systems 28:85–114

Kohler T (2015) Crowdsourcing-based business models: How to create and capture value. California Management Review 57:63–84

Kornish LJ, Ulrich KT (2011) Opportunity Spaces in Innovation: Empirical Analysis of Large Samples of Ideas. Management Science 57:107–128

Kornish LJ, Ulrich KT (2014) The Importance of the raw idea in innovation: Testing the sow's ear hypothesis. Journal of Marketing Research 51:14–26

Krippendorff K (2004) Reliability in content analysis. Human Communication Research 30:411–433

Leimeister JM, Huber M, Bretschneider U, Krcmar H (2009) Leveraging crowdsourcing: Activation-supporting components for IT-based ideas competition. Journal of Management Information Systems 26:197–224

Lipusch N, Dellermann D, Bretschneider U, Ebel P, Leimeister JM (2020) Designing for crowdfunding co-creation. Business & Information Systems Engineering

Loock M, Hacklin F (2015) Business modelling as configuring heuristics. In: Baden-Fuller C, Mangematin V (eds) Business models and modelling. Emerald Group Publishing Limited, Bingley, United Kingdom, pp 187–205

MacCrimmon KR, Wagner C (1994) Stimulating ideas through creative software. Management Science 40:1514–1532

Magnusson PR, Wästlund E, Netz J (2016) Exploring users' appropriateness as a proxy for experts when screening new product/service ideas. Journal of Product Innovation Management 33:4–18

Malaga RA (2000) The effect of stimulus modes and associative distance in individual creativity support systems. Decision Support Systems 29:125–141

March ST, Smith GF (1995) Design and natural science research on information technology. Decision Support Systems 15:251–266

Martins LL, Rindova VP, Greenbaum BE (2015) Unlocking the hidden value of concepts: A cognitive approach to business model innovation. Strategic Entrepreneurship Journal 9:99–117

Massa L, Tucci CL, Afuah A (2017) A critical assessment of business model research. Academy of Management Annals 11:73-104

Massa L, Viscusi G, Tucci CL (2018) Business models and complexity. Journal of Business Models 6:59–71

Massetti B (1996) An empirical examination of the value of creativity support systems on idea generation. MIS Quarterly 20:83–97

McGrath RG (2010) Business models: A discovery driven approach. Long Range Planning 43:247–261

Mednick S (1962) The associative basis of the creative process. Psychological Review 69:220–232

Mehler DMA, Edelsbrunner PA, Matić K (2019) Appreciating the significance of non-significant findings in psychology. Journal of European Psychology Students, 10:1–7

Mehta R, Zhu R, Cheema A (2012) Is noise always bad? Exploring the effects of ambient noise on creative cognition. Journal of Consumer Research 39:784–799

Meinel M, Wagner TF, Baccarella CV, Voigt KI (2019) Exploring the effects of creativity training on creative performance and creative self-efficacy: Evidence from a longitudinal study. Journal of Creative Behavior 53:546–558.

Mettler T, Eurich M, Winter R (2014) On the use of experiments in design science research: A proposition of an evaluation framework. Communications of the Association for Information Systems 34:223–240

Müller-Wienbergen F, Müller O, Seidel S, Becker J (2011) Leaving the beaten tracks in creative work-a design theory for systems that support convergent and divergent thinking. Journal of the Association for Information Systems 12:714–740

Mumford MD, Gustafson SB (2007) Creative thought: Problem solving in a dynamic system. In: Creativity Research Handbook. Hampton, Cresskill, NY, USA, pp 33–77

Nijstad B A, Dreu CKW de, Rietzschel EF, Baas M (2010) The dual pathway to creativity model: Creative ideation as a function of flexibility and persistence. European Review of Social Psychology 21:34–77

Nijstad BA, Stroebe W (2006) How the group affects the mind: A cognitive model of idea generation in groups. Personality and Social Psychology Review 10:186–213

Orlikowski WJ, Iacono CS (2001) Research commentary. Desperately seeking the "IT" in IT research: A call to theorizing the IT artifact. Information Systems Research 12:121–134

Osterwalder A, Pigneur Y (2010) Business model generation: A handbook for visionaries, game changers, and challengers. Wiley, Hoboken, NJ, USA

Osterwalder A, Pigneur Y (2013) Designing business models and similar strategic objects: The contribution of IS. Journal of the Association for Information Systems 14:237–244

Paivio A (1991) Dual coding theory: Retrospect and current status. Canadian Journal of Psychology 45:255–287

Paivio A, Lambert W (1981) Dual coding and bilingual memory. Journal of Verbal Learning and Verbal Behavior 20:532–539

Plucker JA, Renzulli JS (1999) Psychometric approaches to the study of human

creativity. In: Handbook of Creativity. Cambridge University Press, Cambridge, United Kingdom, pp 35–61

Rambow-Hoeschele K, Nagl A, Harrison DK, Wood BM, Bozem K, Braun K, Hoch P (2018) Creation of a digital business model builder. In: Proceedings of the IEEE International Conference on Engineering, Technology and Innovation (ICE/ITMC 2018), Stuttgart, Germany

Reitman WR (1965) Cognition and thought: An information processing approach. Wiley, New York, NY, USA

Rietzschel EF, Nijstad BA, Stroebe W (2007) Relative accessibility of domain knowledge and creativity: The effects of knowledge activation on the quantity and originality of generated ideas. Journal of Experimental Social Psychology 43:933–946

Rietzschel EF, Nijstad BA, Stroebe W (2006) Productivity is not enough: A comparison of interactive and nominal brainstorming groups on idea generation and selection. Journal of Experimental Social Psychology 42:244–251.

Robertson D, Hjuler P (2009) Innovating a turnaround at LEGO. Harvard Business Review

Santanen EL, Briggs RO, Vreede G-J de (2004) Causal relationships in creative problem solving: Comparing facilitation interventions for ideation. Journal of Management Information Systems 20:167–198

Schaffer N, Engert M, Leontjevs G, Krcmar H (2020a) A tool to model and simulate dynamic business models. In: Proceedings of the 33rd Bled eConference, Bled, Slovenia

Schaffer N, Stähler O, Weking J (2020b) Requirements and design principles for business model tools, In: Proceedings of the 26th Americas Conference on Information Systems (AMCIS 2020), Salt Lake City, UT, USA

Schlagwein D, Bjorn-Andersen N (2014) Organizational learning with crowdsourcing: The revelatory case of LEGO. Journal of the Association for Information Systems 15:754–778

Schneider S, Spieth P (2013) Business model innovation: Towards an integrated future research agenda. International Journal of Innovation Management 17:1–34

Schoormann T, Stadtländer M, Knackstedt R (2021) Designing business model development tools for sustainability: A design science study. To appear in: Electronic Markets

Schoppe K (1975) Verbaler Kreativitätstest (V-K-T): Handanweisung. Hogrefe, Göttingen, Germany

Schwarz JS, Legner C (2020) Business model tools at the boundary: Exploring communities of practice and knowledge boundaries in business model innovation. Electronic Markets 30:421–445

Seidel S, Müller-Wienbergen F, Becker J (2010) The concept of creativity in the information systems discipline: Past, present, and prospects. Communications of the Association for Information Systems 27:217–242

Seo YW, Chae SW, Lee KC (2015) The impact of absorptive capacity, exploration, and exploitation on individual creativity: Moderating effect of subjective well-being. Computers in Human Behavior 42:68–82

Shneiderman B (2002) Creativity Support Tools: Establishing a framework of activities for creative work. Communications of the ACM 45:116–120

Siangliulue P, Chan J, Gajos KZ, Dow SP (2015) Providing timely examples improves the quantity and quality of generated ideas. In: Proceedings of the 8th ACM SIGCHI Conference on Creativity and Cognition (ACM C&C 2015), Glasgow, United Kingdom

Simmert B, Ebel PA, Peters C, Bittner EAC, Leimeister JM (2019) Conquering the challenge of continuous business model improvement. Business & Information Systems Engineering 61:451–468

Simonton DK (1989) The chance-configuration theory of scientific creativity. In: Gholson B, Shadish Jr. WR, Neimeyer RA, Houts AC (eds) The psychology of science: Contributions to metascience. Cambridge University Press, Cambridge, United Kingdom, pp 170–213

Spieth P, Schneckenberg D, Ricart JE (2014) Business model innovation: State of the art and future challenges for the field. R&D Management 44:237–247

Strategyzer (2015) The business model canvas: Why and how organizations around the world adopt it. Strategyzer field report

Szopinski D (2019a) Jumping, dumping, and pumping: Three mental principles for idea generation to activate software-based tools in business model innovation. In: Proceedings of the 32nd Bled eConference, Bled, Slovenia

Szopinski D (2019b) Squaring the circle: Business model teaching in large classroom settings. Journal of Business Models 7:90–100

Szopinski D (2019c) Can stimuli improve business model idea generation? Developing software-based tools for business model innovation. In: Proceedings of the ACM Creativity & Cognition 2019, San Diego, CA, USA

Szopinski D (2020) Exploring design principles for stimuli in business model development tools. In: Proceedings of the 41st International Conference on Information Systems (ICIS 2020), Hyderabad, India

Szopinski D, Schoormann T, John T, Knackstedt R, Kundisch D (2020) Software tools for business model innovation: Current state and future challenges. Electronic Markets 30:469-494

Teece DJ (2010) Business models, business strategy and innovation. Long Range Planning 43:172–194

Terrenghi N, Schwarz J, Legner C, Eisert U (2017) Business model management: Current practices, required activities and IT support. In: Proceedings of the 13th International Conference on Wirtschaftsinformatik (WI2017), St. Gallen, Switzerland

Veit D, Clemons E, Benlian A, Buxmann P, Hess T, Kundisch D, Leimeister JM, Loos P, Spann M (2014) Business models: An information systems research agenda. Business & Information Systems Engineering 6:45–53

Voigt M, Bergener K, Becker J (2013) Comprehensive support for creativity-intensive processes. Business & Information Systems Engineering 5:227–242

Voss JF, Post TA (1988) On the solving of ill-structured problems. In: Chi MTH, Glaser R, Farr MJ (eds) The nature of expertise. Lawrence Erlbaum Associates, Hillsdale, NJ, USA, pp 261–285

Wang K, Nickerson JV (2017) A literature review on individual creativity support systems. Computers in Human Behavior 74:139–151

Ward TB (2004) Cognition, creativity, and entrepreneurship. Journal of Business Venturing 19:173–188

Ward TB, Smith SM, Vaid J (1997) Conceptual structures and processes in creative thought. In: Ward TB, Smith SM, Vaid J (eds) Creative thought: An investigation of conceptual structures and processes. American Psychological Association, Washington, DC, USA, pp 1–27

Whetten DA, Felin T, King BG (2009) The practice of theory borrowing in organizational studies: Current issues and future directions. Journal of Management 35:537–563

Wierenga B, van Bruggen GH (1998) The dependent variable in research into the effects of creativity support systems: Quality and quantity of ideas. MIS Quarterly 22:81–87

Wirtz BW, Daiser P (2018) Business model innovation processes: A systematic literature review. Journal of Business Models 6:40–58

Zott C, Amit R, Massa L (2011) The business model: Recent developments and future research. Journal of Management 37:1019–1042

Appendix 1: Literature review on business model development tools

Undertaking a literature review is essential to researching phenomena in information systems research (Webster and Watson 2002). To identify relevant articles on business model development tools (BMDTs), I employed a three-staged search strategy that comprised (1) a keyword search, (2) a forward search, and (3) a backward search (see Table A1). I detail and summarize these stages as follows:

Stage	**Total number of results**	**Number of relevant results**	**References of relevant results**
(1) Keyword search	81	12	Anke 2020; Athanasopoulou et al. 2018; Ebel et al. 2016; Kajanus et al. 2014; Rambow-Hoeschele et al. 2018; Schaffer et al. 2020a; Schaffer et al. 2020b; Schoormann et al. 2021; Szopinski et al. 2020; Szopinski 2019a; Szopinski 2019c; Szopinski 2020
(2) Forward search	183	5	Augenstein et al. 2017; Augenstein and Fleig 2017; Dellermann et al. 2018; Hamrouni et al. 2018; Schwarz and Legner 2020
(3) Backward search	-	4	Fritscher and Pigneur 2009; Fritscher and Pigneur 2014a; Fritscher and Pigneur 2014b; John 2016

Table A1: Search strategy for identifying relevant articles on business model development tools

(1) Keyword search: For our initial sample of articles on BMDTs, I performed a keyword search on *Google Scholar* (ending in May 2020) guided by four search-related selection criteria (I-IV):

- (I) Search fields = *full text search*,
- (II) Search string = *"business model development tool" OR "business model tooling"*,
- (III) Document types = *any but patents*, and
- (IV) Timespan = *none*.

This keyword search yielded 81 articles. I continued removing articles that are non-English or neither journal nor conference articles (e.g., books, thesis, reports, or white papers). This reduced the sample to 54 articles and, after eliminating duplicates, to a total of 41 articles. A manual scan for relevance was performed by reading titles and abstracts and guided by two BMDT-related selection criteria (V-VI):

- (V) The article deals with at least one BMDT (i.e., a software-based tool for business model innovation).
- (VI) The article does so in a non-trivial and non-marginal way (i.e., authors do not merely mention or cite a software-based tool for business model innovation).

Applying these two additional selection criteria reduced the total number of articles identified through the keyword search to twelve articles.

(2) Forward search: I conducted a forward search on *Google Scholar* using the 'cited by' field for all articles identified in the first stage. Again, by applying the four search-related (I-IV) and the two BMDT-related selection criteria (V-VI) to the total of 183 citations, I identified a further five relevant articles.

(3) Backward search: For all relevant articles identified in the previous stages, I read the entire text and marked potentially relevant references. By applying the search-related and BMDT-related criteria, I identified another four relevant articles.

The final set of relevant articles that deal with BMDTs in a non-trivial and non-marginal manner consists of 21 articles. I then reviewed the 21 articles in close detail to synthesize the knowledge of BMDTs, bearing in mind the aim of this study being focused on designing a BMDT that encourages creativity.

Article	Business model innovation phase	Level of analysis[4]	Perspective on creativity	Role of the IT artifact	Research method	The BMDT described in the article supports…
Fritscher and Pigneur 2009	Cross-phase	Group	-	Tool view	Design research	… creating, moving, and deleting elements in a digitized *Business Model Canvas*.
Fritscher and Pigneur 2014a	Cross-phase	Group	-	Tool view	Design research	… grouping elements through colors, custom attributes of elements, and positioning mechanisms for elements in a digitized *Business Model Canvas*.
Fritscher and Pigneur 2014b	Cross-phase	Group	-	Tool view	Design research	… creating, comparing, and managing different versions of business models in a digitized *Business Model Canvas*.
Ebel et al. 2016	Cross-phase	Group	-	Tool view	Action design research	This article proposes a comprehensive framework for developing BMDTs with features that support sharing materials (e.g., training material and project documentation) and forming a community (e.g., messaging, friendships, and profiles).
Schaffer et al. 2020a	Cross-phase	Group	-	Tool view	Design requirements and principles	This article describes 59 different features in BMDTs realized as design requirements and principles.
Schaffer et al. 2020b	Cross-phase	Group	-	Tool view	Design research	… modeling and simulating interdependencies between business models in a BMDT.
Schoormann et al. 2021	Cross-phase	Group	-	Tool view	Design theory	… changing between economic, ecological, and social views on business models as well as assessing their sustainability.
Schwarz and Legner 2020	Cross-phase	Group	-	Tool view	Case and field study	This article studies the understanding and usage of BMDTs concerning their syntactic, semantic, and pragmatic capacities as boundary objects between different communities of practice.
Szopinski et al. 2020	Cross-phase	Group	-	Tool view	Taxonomy development	This article describes 43 different features in BMDTs.

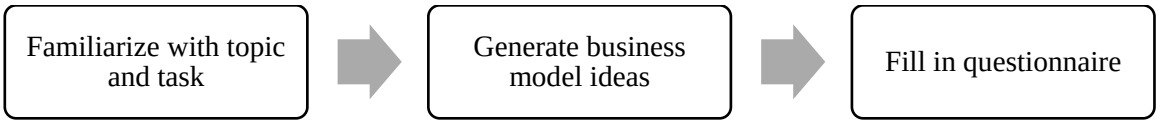
[4] It is not always possible to clearly classify BMDTs by *level of analysis*. I classified the BMDTs as follows: If the *level of analysis* is not further specified in the article, I assume that the BMDT is designed for single or multiple individual users and therefore classify the BMDT on an individual level. If the article reports collaborative features or explicitly names groups/teams as users, I classify the BMDT on a group level.

Article	Business model innovation phase	Level of analysis[4]	Perspective on creativity	Role of the IT artifact	Research method	The BMDT described in the article supports…
Athanasopoulou et al. 2018	Idea generation	Group	Creative person	Tool view	Questionnaire-based testing of hypothesis	… business model exploration through pre-filled business model templates, solution-based business model patterns, and evaluation metrics.
John 2016	Idea generation	Group	Creative product	Tool view	Design theory	… automatically generating business model ideas that are evaluated by crowd workers.
Szopinski 2019a	Idea generation	Individual	Creative product, process, and product	Tool view	Design research	This article describes three mental principles for creativity features in BMDTs.
Szopinski 2019c	Idea generation	Individual	Creative product, process, and product	Tool view	Technical feasibility test	This article is the technical feasibility test of the experimental platform used in this study to research the creativity feature for BMDTs.
Szopinski 2020	Idea generation	Individual	Creative person, process, and product	Tool view	Design requirements and principles	This article describes creativity features in BMDTs realized as design requirements and principles.
Augenstein and Fleig 2017	Analysis	Individual	-	Tool view	Design principles	… the manual and time-consuming process of determining an organization's current business model by automatically extracting it from the organization's information systems.
Anke 2020	Evaluation	Group	-	Tool view	Design research	… decision making by assessing financial and non-financial effects of business models.
Dellermann et al. 2018	Evaluation	Group	-	Tool view	Design principles	… creating a shared understanding among decision-makers, providing qualitative and quantitative feedback based on human assessment, and predicting the outcomes of business model decisions based on machine learning.
Hamrouni et al. 2018	Evaluation	Individual	-	Tool view	Design research	… decision making while evaluating business models.

Article	Business model innovation phase	Level of analysis[4]	Perspective on creativity	Role of the IT artifact	Research method	The BMDT described in the article supports…
Kajanus et al. 2014	Evaluation	Individual	-	Tool view	Conceptual paper	… rating the potential competitive advantage of business models along with their customer segments.
Rambow-Hoeschele et al. 2018	Evaluation	Individual	-	Tool view	Conceptual paper	… simulating the iterative adjustment of business models to constantly changing market conditions and consumer behavior
Augenstein et al. 2017	Management	Individual	-	Tool view	Design principles	… capturing and quantifying the constantly changing environment of business models and adapting business models to these changes.

Appendix 2: Experimental task

Today's session will consist of three stages. I will give you a signal five minutes before the end of each stage.



20 Minutes 30 Minutes 10 Minutes

Introduction: Business models

A business model describes the rationale of how an organization creates, delivers, and captures value. The success of an organization depends crucially on the generation of creative business model ideas.

The business model of an organization defines which customers the organization addresses. The goal is to solve the problems of these customers or to satisfy their needs with products and/or services. To achieve this, it must be decided how the organization can best inform (potential) customers about its products/services and how these products/services can best be delivered from the organization to the customers. In addition, it must be determined how intensively an organization wants to establish contact with its customers and for which characteristics of an organization's products/services the customer should pay.

To offer a business model means that an organization carries out a number of activities and provides the conditions for these activities to be undertaken as smoothly as possible. Since one organization alone usually cannot provide everything necessary to meet the customer's needs, it will work with other organizations if necessary. In addition, all business activities generate costs and it is important for an organization to know the biggest cost generators.

The following section describes in more detail what a business model consists of. The description is based on the following nine business model components:

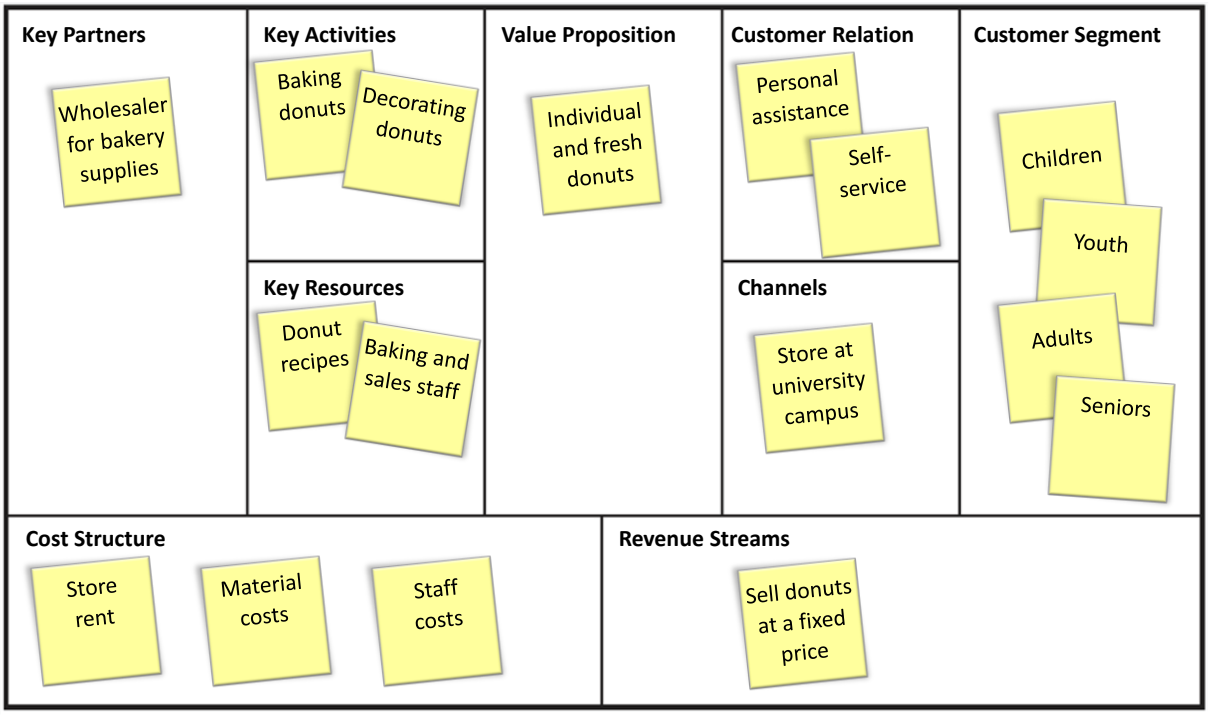
The business model component…

- **Customer segments** describes the different groups of people or organizations an enterprise aims to reach and serve.
- **Value propositions** describes the bundle of products and services that create value for a specific customer segment.
- **Channels** describes how a company communicates with and reaches its customer segments to deliver a value proposition.
- **Customer relationships** describes the types of relationships a company establishes with specific customer segments.

- **Revenue streams** describes the cash a company generates from each customer segment (costs must be subtracted from revenues to create earnings).
- **Key resources** describes the most important assets required to make a business model work.
- **Key activities** describes the most important things a company must do to make its business model work.
- **Key partners** describes the network of suppliers and partners that make the business model work.
- **Cost structure** describes all costs incurred to operate a business model.

Business model of 'the donut factory'

To illustrate the application of the Business Model Canvas (and its components), the following is an example of the business model for 'the donut factory', a bakery that specializes in donuts:



Task: Innovation of the business model for 'the donut factory'

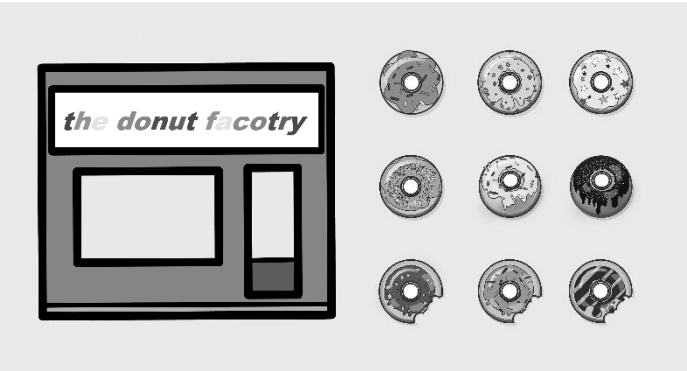
In a moment you will be introduced to a product and a related business model. Your task is to generate new, innovative business model ideas for this product. This requires your creativity. Deliberately detach yourself from the presented business model and other business models you are already familiar with. When generating your business model ideas, it is important that you take all nine business model components into account and consider the design options available for each of these components. You should also consider possible dependencies between the business model components and consider the design options that these dependencies may offer.

To support you in generating business model ideas, software with the *Business Model Canvas* is at your disposal. The software is basically a digitized version of the *Business Model Canvas* and provides the following three basic features: Create sticky notes (click the + symbol), move them (click, hold and release the sticky note) and delete them (click the X symbol).

[*This paragraph is only shown to subjects in the treatment group*.] In addition, the business model software provides you with different creativity impulses that you can request at any time during the task (e.g., when you have no new ideas or are stuck) by clicking on the 'Get inspired' button. After you click on that button, you will get a brainstorming question and the software will add some sticky notes to stimulate new business model ideas. These new sticky notes are only suggestions for new business model ideas, so feel free to accept, change, or ignore them. These creative impulses work best when you read them and then imagine how you can integrate the proposal into the business model idea you are thinking about.

Please keep in mind that this is about business model ideas. Such ideas do not need to be perfectly detailed. It is sufficient if there is at least one sticky note in each component of the *Business Model Canvas*. As soon as you think you think you have formulated a valid business model idea, we ask you to give it a title and to briefly describe it in three sentences. Then you can start working on a new business model idea by clicking on "Save idea and start new one".

Now, please imagine the following business case scenario:



You are the co-owner of 'the donut factory', an established store on campus that sells eight kinds of donuts. Like your main competitor, you are open from 8 a.m. to 9 p.m. You advertise that you do not sell donuts that are more than three hours old. Hence, after three hours, the old donuts have to be replaced by freshly made ones. The display case with the donuts is kept full at all times in order to attract customers. An inquiry has shown that 50% of all donuts are sold between 9 a.m. and 1 p.m. As a consequence, many donuts have to be disposed of during the remaining opening hours. A huge part of the sales revenues currently has to cover the raw material expenses for the disposed donuts, instead of increasing profit.

As a co-owner, you are not happy with the current business model of 'the donut factory'. Therefore, please think of brand-new, innovative business model ideas for the main product (i.e., donuts). You can be as creative as possible and change everything about the current business model as long as the product remains donuts. As a starting point for your considerations, you can refer to the current business model of 'the donut factory'.

References of experimental task: Please note that formulation of the experimental task is inspired and based on prior work by MacCrimmon and Wagner (1994) and John (2018). In addition, the description of the business model components was quoted verbatim from the Strategyzer website. To improve the readability of the text for the subjects participating in the experiment, I omitted the standard labeling of citations. Please find below the links to the Strategyzer websites.

The description of the business model component was retrieved on April 30th 2019 from…

Customer segments: https://www.strategyzer.com/business-model-canvas/customer-segments

Value propositions: https://www.strategyzer.com/business-model-canvas/value-propositions

Channels: https://www.strategyzer.com/business-model-canvas/channels

Customer relationships: https://www.strategyzer.com/business-model-canvas/customer-relationships

Revenue streams: https://www.strategyzer.com/business-model-canvas/revenue-streams

Key resources: https://www.strategyzer.com/business-model-canvas/key-resources

Key activities: https://www.strategyzer.com/business-model-canvas/key-activities

Key partners: https://www.strategyzer.com/business-model-canvas/key-partnerships

Cost structure: https://www.strategyzer.com/business-model-canvas/cost-structure

Appendix 3: Stimuli

This is a list of 49 brainstorming questions from Board of Innovation (2019) (see Table A3). As described earlier in the manuscript, each stimulus of the creativity feature proposed in this study consists of two successive interrelated actions addressing the *knowledge loading failure* and the *idea generation failure*. For the former, the creativity feature provides a verbal- (column 'Text') and a non-verbal (column 'Picture') element to a 'What if' brainstorming question. For the latter, the creativity feature provides two or more suggestions for additional sticky notes (column 'Business model change'). I consider those stimuli relevant that are business-model-specific and therefore address at least two components of the *Business Model Canvas* (components in brackets). This results in 31 business-model-specific stimuli (see link and sticky note suggestions) and 18 non-business-model-specific stimuli (see 'not applicable').

ID	Source of innovation	Text	Picture	Business model change
01	Customer trends	"You could increase inclusion? Imagine ways you can address disadvantaged groups [customer segments], and tailor your products and services to reduce the gap. Think of targeted discounts [revenue streams], or ad-hoc features [value propositions]. For example, Disney developed 'Feeling Fireworks', a tactile experience that gives the perception of fireworks for the visually impaired." (Board of Innovation 2019, p. 8)	Link	Customer segments: disadvantaged group Value propositions: new features for disadvantaged group Revenue streams: targeted discount for disadvantaged group
02	Customer trends	"You could only communicate in a visual language? When Zappos realized how boring their old handbook looked, they gathered a team of creatives [key resources] and re-designed it to look and feel like a comic book [key activities], making the content fun and readable." (Board of Innovation 2019, p. 9)	Link	Key resources: team of creatives Key activities: describe product/service as a comic book

ID	Source of innovation	Text	Picture	Business model change
03	Customer trends	"Your product was designed to only be used once? Imagine you throw away your product after using it once [value propositions]. Could your product be valuable for one use only? Revolut creates one-time credit card details for online purchases on websites you don't entirely trust." (Board of Innovation 2019, p. 10)		Not applicable
04	Customer trends	"Your product was so simple a child could use it? Imagine a way to change your product or service so that it doesn't need any explanation [value propositions]. Interfaces like the ones seen on Android and iOS are largely self-explanatory, and help every user find what they're looking for." (Board of Innovation 2019, p. 11)		Not applicable
05	Customer trends	"You could predict customer behavior? Think of ways to quickly answer customers' needs by predicting them [value propositions]. Amazon patented a system for predictive logistics [key resources]: based on buying trends, your searches, and regional data, they send products to warehouses close to you, even before you buy them." (Board of Innovation 2019, p. 12)	Link	Key resources: system for forecasting customer orders Customer relationships: automated customer orders
06	Customer trends	"You gave your customers something unexpected? Go the extra mile: surprise your customers with a present, a nice message or smart packaging [value propositions]. Tomorrowland, a world-famous music festival, delivers its tickets in an artsy box. Their stages feature detailed decors. Even their garbage collectors wear themed outfits [key activities]." (Board of Innovation 2019, p. 13)	Link	Value proposition: surprise customers Key activities: decor parts of the product/service
07	Customer trends	"Everyone lived in urban areas? By 2030, 60% of the world population will be living in cities. Imagine services that work best in these crowded hotspots known for traffic jams, apartment blocks and ubiquitous internet. Deliveroo conveniently employs young bikers [key resources] who can deliver food quickly regardless of car traffic [customer relationships]." (Board of Innovation 2019, p. 14)	Link	Key resources: cyclists who deliver product/service Customer relationship: fast delivery by cyclists

ID	Source of innovation	Text	Picture	Business model change
08	Customer trends	"You used gamification? Think of ways to make using your product or service fun for customers [value propositions]. You can add levels, social rankings, perks, awards, missions, and scores. Waze, a 'satnav' traffic measurement system [key resources], for example, awards points for every km driven or every report added. These reports are so accurate, many car manufacturers such as Honda are leaving TomTom for Waze." (Board of Innovation 2019, p. 15)	Link	Value propositions: using product/services is fun Key resources: gamification system
09	Customer trends	"You could reframe your service into bite-size components? Duolingo turns the lengthy process of learning a new language into a playful list of small, easy 5-minlessons. They make their service free [revenue streams] by using their students to translate bits and parts of articles [key activities]. Companies like CNN and Buzzfeedpay Duolingo for this service." (Board of Innovation 2019, p. 16)	Link	Revenue streams: product/service is for free Key activities: reframe product/service into bite-size components
10	Customer trends	"You turned the most annoying aspect of buying your product into an experience? Nike Korea's 2018 Air Max campaign had sneaker fans queue digitally using avatars and a hashtag. Digital agency PostVisual invented the first-ever hashtag queue [customer relationships] where fans waited in line on Instagram to win a chance to buy limited edition Nike Air Max [value propositions]." (Board of Innovation 2019, p. 17)	Link	Customer relationships: virtual queuing for product/service Value propositions: delivery of product/service is experience
11	Customer trends	"Your customers moved to a new country every week? Revolut banking service is fully global [value propositions]: it can be opened online anywhere in the world, accepts payments in every currency, and charges no, or very small, fees regardless of location." (Board of Innovation 2019, p. 18)		Not applicable
12	Customer trends	"You could offer full customization? Imagine ways of letting your customers customize their favorite product or service [value propositions], and producing or delivering that customization cheaply. The NikeiD online store [key resources] allows users to completely customize the look and feel of their shoes." (Board of Innovation 2019, p. 19)	Link	Value propositions: customized product/service Key resources: online store with customization system

ID	Source of innovation	Text	Picture	Business model change
13	Technological trends	"You could only interact with users through voice? Imagine you had no possibility of adding visual cues [customer relationships]. Smart assistants such as Alexa (Amazon), Google Assistant (Google), and Siri (Apple) only interact with users via voice [key resources]." (Board of Innovation 2019, p. 22)	Link	Customer relationships: customer communication through voice Key resources: voice communication system
14	Technological trends	"You used your user's DNA to customize your service? Spotify released a new feature that personalizes playlists that reflect the cultural music of users' heritage, based on their DNA test provided by the partner Ancestry [key partners]." (Board of Innovation 2019, p. 23)	Link	Value proposition: DNA-based customizing of product/service Key partners: DNA test provider
15	Technological trends	"You could use artificial intelligence? No business can avoid being disrupted by artificial intelligence. In the insurance industry, Lemonade uses artificial intelligence and chatbots [key resources] extensively to deliver insurance policies and handle claims. It takes only 90 seconds to get insured and less than 3 minutes to get [value propositions]." (Board of Innovation 2019, p. 24)	Link	Key resources: artificial intelligence and chatbot system Value propositions: speed up product/service delivery
16	Technological trends	"No staff was required? Amazon Go is rolling out unmanned stores; CitizenM hotels have self-service reception desks [customer relationships]; new underground metro lines like 'The lilac lane' in Milan have driverless trains [key resources]. How can you design your service to operate with not humans involved?" (Board of Innovation 2019, p. 25)	Link	Customer relationships: self-service Key resources: no staff
17	Technological trends	"You used biometrics for identification? Imagine using fingerprints, iris scans or a person's heartbeat [key resource] to make identification secure and convenient [value propositions]. Citibank uses voice biometrics to automatically identify customers as they explain their issues to customer representatives over the phone." (Board of Innovation 2019, p. 26)	Link	Key resource: system for automated recognition of customers Value propositions: convenience through personalized customer relationship

ID	Source of innovation	Text	Picture	Business model change
18	Technological trends	"Your products 'learned' each time a service or product got used? Imagine each time you use your service or product, it gets better and more aligned with your needs as the user [value proposition]. Stich Fix provides hand-selected outfits by a personal stylist. Keep what you like, send back what you don't. They learn from your behaviour to send you different proposals the next time [key resources]." (Board of Innovation 2019, p. 27)	Link	Value propositions: product/service automatically improves Key resources: system to learn from customer behaviour
19	Technological trends	"Your products could become a network? Imagine your solution becomes smarter the more it's used [value propositions], so that it can adapt to the user's needs. Tesla cars learn each time they are driven. They even operate as a network. When one car learns something, they all learn it, helping Tesla to create a better autopilot [key resources]." (Board of Innovation 2019, p. 28)	Link	Value propositions: product/service automatically adapts to customer's needs Key resources: system to coordinate products/services in a network
20	Technological trends	"You helped to reduce the use of technology? Imagine ways to help your customers use your product less [value propositions]. After great success with 3rd party apps, Apple included a Screen Time function to their devices, giving users an overview of how much time spent on the device, on which apps, and lets users set limits on their usage." (Board of Innovation 2019, p. 29)		Not applicable
21	Technological trends	"Everyone had a virtual assistant? Can you provide your users with digital assistants [key resources] (either chatbots or talking interfaces) that solve their issues and complete small tasks on a user's behalf [value propositions]? For example, Google Duplex is a technology that is able to make simple phone calls on your behalf, like booking a restaurant." (Board of Innovation 2019, p. 30)	Link	Key resources: chatbot or talking interfaces Value propositions: product/service involves a virtual digital assistant

ID	Source of innovation	Text	Picture	Business model change
22	Technological trends	"You delivered an augmented reality experience? Remember the hype of Pokémon Go? And the selfie filters? They were notable Augmented Reality applications [key resources], and they illustrated the power of adding a digital visual layer on top of the non-digital reality [value propositions]." (Board of Innovation 2019, p. 31)	Link	Key resources: augmented reality system Value propositions: product/service involves a digital visual layer
23	Market trends	"Customers shared your product or service offer? Imagine a setup that lets customers access an asset when they need it without owning it [value propositions], helping them split the cost amongst peers. Car sharing and bicycle sharing schemes [key resources] follow this principle." (Board of Innovation 2019, p. 34)	Link	Value propositions: customers share product/service Key resources: online sharing platform
24	Market trends	"You decrease quality slightly to significantly decrease price? Is there a way to make your product a lot cheaper without ruining the whole experience [value propositions, cost structure]? Ride sharing platform Via changed the Uber door-to-door idea to a close by drop-off point close by, decreasing the price of rides by almost 50%" (Board of Innovation 2019, p. 35)	Link	Value propositions: low price Cost structure: low costs
25	Market trends	"You owned nothing but delivered everything? Rappi is an on-demand delivery startup referred to as the 'everything store' [value propositions]. Its user interface looks like supermarket shelves where users can swipe any kind of item into their basket. Couriers can deliver everything on demand, from groceries, to cash from the ATM, or even dog walking sessions." (Board of Innovation 2019, p. 36)		Not applicable
26	Market trends	"You could lower the barriers to use? Grab reaches out to taxi drivers by signing them up at airports, taxi queues, depots, etc. To facilitate the use of their services, Grab installs booths where people can wait at strategic points, even if they do not have the Grab app installed [value propositions]. Where can you find your users and how can you help them to adopt your offering?" (Board of Innovation 2019, p. 37)		Not applicable

ID	Source of innovation	Text	Picture	Business model change
27	Market trends	"Your product or service had a premium option? Imagine adding a premium option [revenue streams] to what you already provide. How can you increase value by adding an extra feature or removing a hassle of your service [value propositions]? Gold members of the dating app Tinder, can skip people that aren't active users anymore, and only browse people who already liked them." (Board of Innovation 2019, p. 38)	Link	Revenue streams: usage fee for premium option Value propositions: premium option for product/service
28	Market trends	"Direct advertising was forbidden? Imagine a world without commercials [key activities]. Brand lovers would need to share their experiences with good products and services with others. Costco saves an estimated 2% a year in costs by not advertising [cost structure], allowing the company to lower prices for loyal members." (Board of Innovation 2019, p. 39)	Link	Key activities: no advertising Cost structure: no advertising costs
29	Market trends	"You went from ownership to rentals? Imagine ways to rent out your product or service [revenue streams] instead of people owning them [value propositions]. Rent the Runway is redefining the fashion industry by renting out designer dresses that can be returned after use." (Board of Innovation 2019, p. 40)	Link	Revenue streams: usage fee Value propositions: usage of product/service (no ownership)
30	Market trends	"You were charged a fee for delivering a bad customer experience? WhatsApp for Business charges companies if they fail to reply to their customers within 24 hours [value propositions]. This not only increases revenue for WhatsApp, but also nudges companies to create a better experience for their customers." (Board of Innovation 2019, p. 41)		Not applicable
31	Market trends	"Your customers were extremely wealthy? Imagine VIP features that would make you rich by selling them to just one client [value propositions]. Many crowdfunding campaigns allow donations of thousands of euros, in exchange for a priceless experience. A dinner with the CEO of a startup, for example." (Board of Innovation 2019, p. 42)		Not applicable

ID	Source of innovation	Text	Picture	Business model change
32	Market trends	"You turned from B2C to B2B (or vice versa)? Originally, Airbnb only designed a service for B2C [customer segments]. Later, they added B2B services, with Airbnb offering new standards for business travelers and Ryanair offering a business package [value propositions]." (Board of Innovation 2019, p. 43)	Link	Customer segments: B2C to B2B (or vice versa) Value propositions: new products/services
33	Market trends	"You offered a service rather than a just product? Ease your customer's experience by combining more services into your industry [value propositions]. Moovel created a platform that integrates public transport, bike sharing, car sharing, taxi companies, an overall search tool and payment solution. This all-in-one solution offers mobility as a service, not just a product." (Board of Innovation 2019, p. 44)		Not applicable
34	Market trends	"You allowed external providers into your service? Imagine ways to let other companies integrate [value propositions] their services into your service [key partners]. Slack allows hundreds of third-party extensions into its communication platform." (Board of Innovation 2019, p. 45)	Link	Value propositions: integrated product/services Key partners: other companies that fit the own product/service
35	Market trends	"Your company had only 5 employees? Imagine ways to offer your products and services with a small team [key resources, cost structure]. Consider automation, outsourcing, and other solutions. Instagram had 13 employees when Facebook acquired it for $1billion." (Board of Innovation 2019, p. 46)	Link	Key resources: 5 employees Cost structure: low staff costs
36	Market trends	"Your users were doing marketing for you? Imagine that instead of creating your own videos and marketing material, you let your users do the job for you [key partner, customer relationships]. Think of user-generated content or collaborations with social media influencers. GoPro, for example, extensively leverages real footage from users for its marketing purposes." (Board of Innovation 2019, p. 47)	Link	Key partners: customers become partners in Customer relationships: self-service

ID	Source of innovation	Text	Picture	Business model change
37	Market trends	"You had to have a partnership? Think of creating new solutions with a partner company [key partners]. Who would you work with? What would that create? Philips has a history of launching products in joint ventures with other companies, such as Senseo or Nivea." (Board of Innovation 2019, p. 48)		Not applicable
38	Market trends	"The public was willing to help you? Think of ways to tackle big challenges by using lots of helping hands. Think of crowd-funding/-sourcing/-investing/-lending. LEGO Ideas is an ideation platform [key resources] to crowdsource ideas for new products [key activities]: everyone can submit, everyone can vote, and the winning ideas gain 1% of net sales [key partners]." (Board of Innovation 2019, p. 49)	Link	Key resources: crowd ideation platform Key activities: organize idea contest Key partners: crowd product ideators
39	Market trends	"Your service was free for customers? Think of ways to earn money without asking users to pay, such as advertising, referral fees, partnerships, and freemium models [revenue streams]. Spotify's music library is entirely accessible for free, based on advertising sales and sponsored by the 30% of paying Spotify Premium users [customer segments]." (Board of Innovation 2019, p. 50)	Link	Revenue streams: advertising, referral fees Customer segments: premium customers
40	Market trends	"You helped your customer save money? Consider ways to help customers save money [value propositions]. Blink Health is a service that turns expensive branded prescriptions into generic prescriptions (up to 90% cheaper). They can be purchased online and picked up at a local drug store." (Board of Innovation 2019, p. 51)		Not applicable
41	Market trends	"You made your customers work for you? Consider activities that your users [cost structure] may help you complete in exchange for a reward, instead of hiring people to do the same [key resources]. Bird asks their users to 'hunt and charge' their scooters overnight. A user can earn 5-20$ for a single charge." (Board of Innovation 2019, p. 52)	Link	Cost structure: low costs Key resources: customers work for product/service

ID	Source of innovation	Text	Picture	Business model change
42	Market trends	"You could help your competitors? Think of ways to leverage cooperation [key partners]: share know-how, create alliances, or show some generosity. In 2014, Tesla made all their patents public, and in 2018 they published the full blueprint of all their cars. This way, even if their technology becomes the standard, they will always be ahead of the pack." (Board of Innovation 2019, p. 53)		Not applicable
43	Market trends	"You leveraged radical transparency? Everlane is shaking up retail by making sure they are fully aware of the exact cost of their product [value propositions]. Their complete transparency strategy involves sharing both the source of their clothing as well as showing cost breakdowns for each item, ranging from raw material costs to transport fees and labor." (Board of Innovation 2019, p. 54)		Not applicable
44	Regulation trends	"Your customers demanded that everything be made locally? Imagine customers would only buy from you if you could prove that your product was created within 100 miles of the store [value propositions, key partners, key activities]. Instead of providing a centralized service, 3DHubs, a platform for 3D printing, outsources production to people with 3D printers at home." (Board of Innovation 2019, p. 57)	Link	Value propositions: regional product/service Key partners: regional partners
45	Regulation trends	"You could influence the behaviour of your customers? There was a time that this was just a Black Mirror episode on Netflix, however, China plans to rank all its citizens based on their "social credit" by 2020, nudging their behaviour to make them perform as better citizens." (Board of Innovation 2019, p. 58)		Not applicable

ID	Source of innovation	Text	Picture	Business model change
46	Regulation trends	"You were 100% transparent? Think of ways to be truly honest and open to everyone in your value chain [value propositions]. What opportunities would it create? For example, Buffer shares the wage information of every employee online, while the startup Invisible Technologies documents every strategic decision live." (Board of Innovation 2019, p. 59)		Not applicable
47	Regulation trends	"You had access to your customers' personal data? Imagine a world without privacy concerns, where clients expected companies to use their data. For example, Root Insurance tracks a driver for a trial period before offering them an auto insurance premium quote. A car insurance rate based primarily on how you drive." (Board of Innovation 2019, p. 60)		Not applicable
48	Regulation trends	"The only driver to buy was sustainability? Imagine that each additional kg of CO^2 produced by your company makes you lose a customer. Think of products and services that have zero (or positive) impact on the planet. For example, Nike's Logistic Campus in Belgium is not only self-sufficient but also supplies energy for 1,500 additional households." (Board of Innovation 2019, p. 61)		Not applicable
49	Regulation trends	"You created your product to avoid a law? US skin care brand Ceramiracle has launched a stockless pop-up stores to avoid China's mandatory animal testing laws. Customers can try the products at the pop-up stores in China, but to buy them, they need to scan a QR code that orders the product from a warehouse in a free trade zone in China or Singapore." (Board of Innovation 2019, p. 62)		Not applicable

Table A3: Brainstorming questions from Board of Innovation (2019)

Appendix 4: Experimental procedure

Onboarding (20 minutes)

Step 1: Subjects sit at their individual workstation with the BMDT already running and have further material upside down in front of them (introduction, task description, questionnaires).

Step 2: Subjects are given the 'Identical features test' (see Appendix 6).

Step 3: Subjects are given ten minutes to familiarize themselves with the task of business model idea generation. For this purpose, they receive a summary of business model innovation including a short description of the nine building blocks of the *Business Model Canvas*. They are also handed out the problem description of the 'improving an ailing donut franchise' business case (see Appendix 2).

Step 4: Subjects are given an introduction on how to use the BMDT. More specifically, how to create, move, and delete sticky notes in the editor.

Step 5: Subjects are given an additional five minutes to familiarize themselves with the BMDT and are given the opportunity to ask questions on the BMDT's use.

Business model idea generation (30 minutes)

Step 6: Subjects are instructed to creatively solve the problem described in the business case and are given thirty minutes to generate as many business model ideas as possible. Their ideas are automatically saved by the BMDT throughout the course of the experiment.

Offboarding (10 minutes)

Step 7: Subjects complete the post-experimental questionnaire (see Appendix 7) that includes individual difference measures and feedback on the use of the BMDT. In addition, subjects are provided with the opportunity to report anything else that they consider to be relevant.

Step 8: The experiment is closed. The subjects who handed in business model ideas among the three most creative business model ideas are granted a shopping voucher for 50,00 €.

Appendix 5: Evaluation form for determining business model idea quality by experts

Evaluation form

Business Model ID:	_____
Expert ID	_____

Visual description:

Business Model Canvas of the business model idea

Textual description

Short description of business model idea

Evaluation

Please find below an evaluation criterion that may apply to the business model idea. For evaluation criterion, please indicate to what extent you agree.	**strongly disagree**				**strongly agree**
	1	**2**	**3**	**4**	**5**
This business model idea is creative (i.e., novel and useful).	☐	☐	☐	☐	☐

Appendix 6: Pre-experimental questionnaire

Warm-up
You will be told a property that can be found on very many things (e.g., 'round'). You are then asked to enter as many things as possible for the property mentioned, for which such a property is usually applicable (i.e., without any particular change, without the use of force). **List as many things as possible that have similar characteristics…**
Round 1: What could a person use to "move faster"? Round 2: What is usually "bendable"?

Appendix 7: Post-experimental questionnaire

The answers to the questions are completely anonymous. Therefore, I would like you to answer them as honestly as possible.

Demographics

Demographics			
Age:	_____	**Gender:**	☐ female ☐ male
Study program:	_____	**Semester:**	_____

Individual preferences

Please find below a number of characteristics that may apply to you. Please state for each of the following characteristic indicate to what extent you agree.	**strongly disagree**						**strongly agree**
	1	**2**	**3**	**4**	**5**	**6**	**7**
I am not particularly interested in art.	☐	☐	☐	☐	☐	☐	☐
I am interested in many things.	☐	☐	☐	☐	☐	☐	☐
I am inventive, I come up with ingenious solutions.	☐	☐	☐	☐	☐	☐	☐
I can get enthusiastic about art, music, and literature.	☐	☐	☐	☐	☐	☐	☐
I avoid philosophical discussions.	☐	☐	☐	☐	☐	☐	☐
I am not particularly inventive.	☐	☐	☐	☐	☐	☐	☐
I appreciate art and beauty.	☐	☐	☐	☐	☐	☐	☐
I enjoy thinking thoroughly about complex things and understanding them.	☐	☐	☐	☐	☐	☐	☐
I am not particularly imaginative.	☐	☐	☐	☐	☐	☐	☐
I find poetry and plays boring.	☐	☐	☐	☐	☐	☐	☐
I have little interest in abstract considerations.	☐	☐	☐	☐	☐	☐	☐
I am original, developing new ideas.	☐	☐	☐	☐	☐	☐	☐

Prior business model knowledge

How many business model ideas have you developed in the last two years?	_____
How many business model ideas have you developed in the last two years using the Business Model Canvas (and its components)?	_____
How many business model ideas have you developed in the last two years using a business model software?	_____

Business Model Development Tool (BMDT)

Please find below a number of characteristics that may apply to you. Please state for each of the following characteristic indicate to what extent you agree.	**strongly disagree**						**strongly agree**
	1	**2**	**3**	**4**	**5**	**6**	**7**
I would be happy to use this BMDT on a regular basis.	☐	☐	☐	☐	☐	☐	☐
I enjoyed using the BMDT.	☐	☐	☐	☐	☐	☐	☐
It was easy for me to explore many different ideas, options, designs, or outcomes, using this BMDT.	☐	☐	☐	☐	☐	☐	☐
The BMDT was helpful in allowing me to track different ideas, outcomes, or possibilities.	☐	☐	☐	☐	☐	☐	☐
I was able to be very creative while doing the activity inside this BMDT.	☐	☐	☐	☐	☐	☐	☐
The BMDT allowed me to be very expressive.	☐	☐	☐	☐	☐	☐	☐
My attention was fully tuned to the activity, and I forgot about the BMDT that I was using.	☐	☐	☐	☐	☐	☐	☐
I became so absorbed in the activity that I forgot about the BMDT that I was using.	☐	☐	☐	☐	☐	☐	☐
I was satisfied with what I got out of the BMDT.	☐	☐	☐	☐	☐	☐	☐
What I was able to produce was worth the effort I had to exert to produce it.	☐	☐	☐	☐	☐	☐	☐

Creativity Feature

When did you request the creativity feature?	
When I ran out of ideas.	☐
Before I started generating my own ideas.	☐
In the middle of coming up with new ideas.	☐
When I ran out of ideas.	☐

To what extent was the creativity feature helpful/not helpful?

Would you have liked more/ fewer/other creativity features?

Overall impression

To what extent do the following statements apply to your overall impression?	**strongly disagree**						**strongly agree**
	1	**2**	**3**	**4**	**5**	**6**	**7**
I find the business model idea generation task of 'the donut factory' interesting.	☐	☐	☐	☐	☐	☐	☐
I enjoyed working on the business model idea generation task of 'the donut factory'.	☐	☐	☐	☐	☐	☐	☐

Your feedback on the experiment is very welcome! (What was positive? What was negative?)