Abstract
Creativity has been addressed in a variety of research studies, with interest focusing on both individual and group creativity. In our research, we outline current studies analyzing the negative effects, which can arise when working collectively. Based on the design science research method, we developed an artifact, in order to prevent individuals from being negatively influenced by others. Our prototype implements an artificial intelligence-like system, which tries to act in a human manner and aims to support the user when he or she is working independently. In a field experiment, we evaluated the positive influence and negative effects, i.e. social loafing and free-riding phenomena, during the idea generation stage. The results show that no social loafing effects appear while interacting with our artificial intelligence support system. However, the benefits of a group process were still experienced by the participants.

1. Introduction and Motivation
Creativity is the source of innovation, which is inevitable for sustainable success of an organization and which determines the survival of an organization in a market [11]. Innovation is a constant process, which cannot be carried out only once and is therefore in continuous need of creative individuals and groups. In a competitive environment, creativity is highly questioned, which occasionally negatively affects the creative ability of individuals and groups [1].

Supporting creativity can enhance the individual or the group [38,14]. Specific group techniques for creativity support, such as brainstorming, can provide further benefits and also enable generated ideas to be evaluated [14]. Brainstorming, as proposed by Osborn (1957), consists of different principles designed to foster the process of idea generation [25]. During the stage of idea generation, all members of a group are asked to contribute by suggesting ideas, without being judged by other members and without self-criticism, with the aim being to collect a large quantity of ideas. This should stimulate the idea generation and increase overall creativity [25]. The convergent process of combining and improving generated ideas will then enable the evaluation of good approaches and forming of a singular, superior idea. Although Osborn claims that brainstorming is a more effective way of supporting creativity and the generation of ideas, this technique has been questioned in recent research [23,7,6,28]. Indeed, group creativity techniques, such as group brainstorming, can also result in productivity loss and production blocking in terms of individual creativity. In addition to different social processes, cognitive processes also appear in group creativity [21]. Individuals can be influenced simply by the presence of others with the size of the group affecting the degree of influence [5,13]. In our research, we focus on the productivity loss caused by social processes, such as production blocking, that occur during group creativity. Production blocking means that in a group only one individual can speak at the same time [8]. Various production blocking symptoms occur in real groups, which do not occur in nominal groups [10]. Asking members to contribute as many ideas as possible, without being self-critical and without being criticized by others, cannot eliminate the fear of negative evaluation (evaluation apprehension) [6,8]. Group members might even consider their ideas as less important to the final outcome and would therefore hold back their ideas (free-riding) [18,19]. Groups tend to rely on their similarities, not on individual strengths and knowledge. This can result in individuals’ creativity being suppressed, as they try to match the group’s opinion to maintain unity [16].

Although group brainstorming should not have any hierarchical order [25], different participants with different precedence affect group creativity. This ties in with the theory of social loafing identified by Karau and Williams (1993), which explains the tendency of individuals to expend less effort when working in a group than working individually. The presence of others (real or imagined) influences the individual in his or her idea generation stage, up to and including a possible production blocking effect [6,17].

Even
though nominal groups can address and amend productivity blocking effects, different negative phenomena still exist [6,8].

In addition to these effects, group techniques consist of a variety of advantages, e.g. a larger knowledge base, a variety of experiences, which support creativity in terms of idea evaluation, idea combination and idea improvement [40]. Approaches on community driven idea and innovation management use this wisdom of the crowd to produce more and improved ideas [35]. The strength of the crowd is immense and should be used especially in innovation management where different ideas are evaluated in terms of their capability, feasibility and practicability [6,35,41]. The following table shows the positive and negative effects of group creativity techniques.

<table>
<thead>
<tr>
<th>Positive effects</th>
<th>Negative effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulate idea generation [25,40]</td>
<td>Social loafing [17] and free-riding [19]</td>
</tr>
<tr>
<td>Evaluation support (combined and improved ideas) [25,40,35]</td>
<td>Evaluation apprehension [6,8]</td>
</tr>
<tr>
<td>Idea quantity [25]</td>
<td>Production blocking [6,8]</td>
</tr>
</tbody>
</table>

Table 1: Benefits and negative effects of group creativity techniques

Karau and Williams (1993) disclose in their paper several theories outlining the effect of social loafing. In particular they write about the lack of motivation and the realization that individuals exert less effort when working collectively. In our research, we concentrate on the effects of “dispensability of effort” or “free-riding” [18,19,17] and the integrated model of individual effort on collective tasks (CEM). CEM “suggests that individuals will be willing to exert effort on a collective task only to the degree that they expect their efforts to be instrumental in obtaining valued outcomes” [17, p. 684].

In our approach, we try to avoid these negative group effects by using different information technology techniques in order to build an artificial intelligence-like system that supports the individual in the idea generation stage. In the course of our design science research approach, we designed an innovative artifact that includes the functionality of idea generation, idea management and user interaction. This web-based prototype allows users to write and work on ideas in a community. A prior version of the prototype has been presented at the DESRIST 2014 conference and revised after the feedback of leading researchers. The main focus of this research was to support the idea generator during the divergent thinking stage. The goal was to stimulate cognitive processes by giving related, relevant, inspiring and supporting content to the idea generator [37]. However, in this paper we focus on social processes taking place during the interaction with an AI-like system.

2. Artificial intelligence in creativity support

Artificial intelligence (AI) describes systems, software and machines that try to achieve human-like intelligence in order to take action in solving problems or supporting individuals [26,33,29]. Research about AI in creativity processes is rare. In 1998, Boden published an article about creativity and artificial intelligence that shows to what extent an AI system can fulfill the depth of a creativity process. This includes the exploratory functionality of generating new content and the evaluation and improvement of ideas. The conclusion shows that creativity is a complex process, which cannot be done completely by an AI [2]. In our research we focus on the interaction with an AI. To support creativity, the system has to provide human-like support, contribute to ideas and even validate ideas. However, in trying to be supportive like a human, the stated negative group effects may not occur. As such, we hypothesize that an AI can provide the extra benefits of group creativity techniques without influencing the idea generator negatively.

The development of an AI is highly specialized. Current research divides into different fields of study, which all have to be considered [36]. One of these fields is the knowledge of an AI that is based on its data sources. Reasonable data sources are difficult to determine, as these depend on the manner of ideas being generated. An idea generation process often has a specific topic and aims to produce a certain kind of idea. Thus, all ideas can be categorized before the support measures are carried out and specific data sources can be determined. Databases shouldn’t rely on topic restrictions as supporting content can also be found in unrelated information sources [39].

Another aspect of AI is the ability to learn, plan and reason during the whole supporting stage [37]. A learning AI ensures a closer interaction with the idea generator and can better react to the input by the individual. A better learning process results in improved planning and reasoning by the AI, which enables the AI to better know when and how to support the idea generator. If capable of reasoning, the AI also becomes capable of making decisions, which is named as one of the main aspects of human beings. Choosing between various alternatives is a complex human
behavior and therefore difficult to adopt and integrate into an AI. The basic requirement for this to work is an effective communication between the individual and the AI, which is defined as natural language processing (NLP). NLP tries to enable computers to understand and process human language input [29,36].

The developed prototype implements an artificial intelligence-like system, including the abilities of natural language processing, learning and reasoning. The following chapter explains the functionality and our implementation of the AI fields in detail.

3. Web-based artifact

Developing and designing artificial intelligence-like systems is complex and comes with the fact that the intelligence of the artifact is only as intelligent as its designer [26]. Reasoning, language processing and decision-making algorithms are the representation of the designer’s view and therefore contradict the philosophical opinion, that decision-making and reasoning are different to each human being. As such, developing AI systems means not trying to mimic mankind in general, but imitating one defined person [26].

Research about creativity support systems is widespread. Voigt and Bergener proposed an integrated framework for group creativity support systems, implementing a set of components and functionalities assessing social and cognitive group processes [40]. Resnick et al. propose additional design principles for tools to support creative thinking [32]. Both publications consider social processes such as social loafing and production blocking, and propose methods to reduce these negative effects. Functionalities such as commenting and direct messaging are proposed to increase cognitive stimulation and the improvement of individual ideas. However, automation in creativity support systems is rare. An attempt of Ford implements information retrieval techniques to stimulate cognitive processes such as divergent thinking [12]. Kules uses search engines to help find inspiring material and special databases to build associations in order to extend the idea generator’s cognition [20]. Our developed creativity support system implements various functionalities based on the proposed design principles and it includes information retrieval techniques to offer inspiring and supporting content to the idea generator.

The web-based prototype has the capability of capturing (see Figure 2, S1), managing and supporting ideas in a community environment, which enables users to write and manage their ideas to get feedback from other users. The community can comment and rate the ideas, and thus improve and foster the thoughts of the idea generators. The following screenshot shows the start view of the idea generation tool, where all ideas of the community can be seen.

![Figure 1: Start view of the idea generation tool](image)

As the boundaries between support systems and AI systems are loose, we implemented various aspects to turn the system into a more artificial intelligence-like system by personifying it [4]. We gave the system the name “Alan” and the ability to talk to the user during the idea generating stage. Figure 1 shows the character design of Alan.

The idea is hidden to the community until published by the user. This ensures that no negative group effects apply during the first creative stage, as no other user can see and comment on other ideas. In this stage, the AI-like system offers support.

The system has the capability to understand written ideas by analyzing them with different algorithms. An information extraction algorithm (IE), based upon the bag-of-words model1, representing the idea in a pre-defined number of valued words, was integrated to represent the NLP functionality an AI should possess (see Figure 2, S2). This IE starts with a word count algorithm, splitting the text into single words and counting how often a word appears in the text. To filter the discriminative power of the words, a stop word removal algorithm removes all stop words based upon the “Full-Text Stopwords” list developed by MySQL for the English language [24]. As the word count algorithm cannot see the similarity between different lexemes e.g. plural and tense, a stemming algorithm was implemented.

Stemming is the process of reducing words to their stem in order to group words of the same root. Stemming algorithms exist in diverse types and differ in terms of performance and accuracy. A commonly

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1 The bag-of-words model is a document representation, where a text (document) is represented by an ordered set (bag) of words ordered according to the frequency of their occurrence in the text.
used algorithm proposed by M.F. Porter in 1980 was used in our approach [30]. The prototype uses a PHP encoding of the Porter Stemmer algorithm, implemented by Richard Heyes in 2005 [31] and extended by us with a look-up algorithm. This look-up algorithm checks the stemmed words in a given table to ensure that the word is correctly stemmed. The look-up table used in this approach is the WordNet lexical database developed by Princeton University [9]. This combination ensures a more precise approach and extends the word stemming. The following figure shows the process of idea generation and the algorithms implemented in the AI.

![Diagram of idea generation process]

**Figure 2: Idea generation and idea support process of the prototype**

After these steps, the text is represented by a finite list of words, where all words with the same root are seen as one term and the stop words are removed. The list is ordered according to the appearance of the word with a weightage relative to the number of all valued words (words without stop words). The outcome of this algorithm is a ranked list of valued terms, which represents the written idea. In a set of combinations, these valued terms will then be used to query several data sources (see Figure 2, S3).

Finding creativity supporting content, which is not related to any specific topic depends on the type of database. In our approach we decided to use social media applications as our data sources. The popularity of social media applications is immense, which results in a large amount of data created by users all over the globe, not to mention a wide range of topics. Our approach queries the services Facebook, Twitter and Tumblr via the API’s and their REST architectural hypermedia data system. All queries aim for the main text or message written by the users, e.g. the tweets, messages and posts.

The REST API’s allow us to access the data of the services with different query term-combinations. To ensure a valued outcome, different algorithms and term-combinations are implemented in the system. All services are queried with the same term combinations, beginning with the five most valuable words, followed by the four most valuable words and so on. To avoid duplicate query outcomes, a near-duplicate detection based on the Shingling-Jaccard algorithm was implemented [3]. In the next step, the results are presented to the idea generator in a spiral shape ordered according to their relevance (see Figure 2, S4 and Figure 3). For the sorting of the results we use the vector space model, in which we first collect all of the words of a result and then calculate the according frequency vector. The same is done with the words of the idea. We then calculate the distances between the points (idea frequency vector to result frequency vector) and sort this conclusion in ascending order, i.e. shorter distances are better. This also ensures that the results, which are more closely related are visually closer to the idea. The following screenshot shows the presentation view with Alan’s messages and the functionality used to mark and attach them to the idea.

![Screenshot of presentation view]

**Figure 3: Presentation view of Alan’s messages**

The messages are written by users and are thus of human nature, which supports the way the AI tries to act and express itself as a human-like being. The social media messages found by the algorithm are presented to the idea generator as messages from Alan. By giving the system a name and the ability to directly interact with the user, we attempt to strengthen the sense of an AI [4]. However, we did not attempt to design and implement a state-of-the-art AI in our research, we merely focus on the evaluation of the negative and positive effects in an artificial intelligence-like system.

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2 REST stands for Representational State Transfer and describes a concept of resource access for web applications.
Hence, no evaluation was conducted to determine whether the system can be seen as an AI.

The messages by Alan can be attached to the idea, and saved as an inspiration or a hint to improve the idea (see Figure 2, S5). Since the user is actively involved in this system and the requests are relatively short, we work with relevance feedback. We use the relevance feedback, when the user marks and saves a message from Alan to his or her idea, as our positive feedback to determine changes in the weights of the request [34]. In this way, the attached messages are used and re-analyzed in conjunction with the initial idea. This implementation represents the interaction and learning ability of the AI-like system. Whenever a user marks content as important or related to the idea, the system adapts to the input and includes it into its analysis.

4. Evaluation of the artifact

We aim to evaluate the utility of the artifact by a group of p=14 participants using the prototype to prove our main research question [15]. The focus of our research is to eliminate the negative phenomena, while still trying to achieve the benefits of a group creativity process. This main research question was divided into two hypotheses:

H1. The system can achieve the benefits of a group creativity process
   a. Stimulate idea generation
   b. Evaluation support and idea improvement

H2. The system can avoid negative group effects
   a. Free riding and dispensability of effort
   b. Outcome/Effort relation (CEM)

We evaluated the prototype in a field experiment over a time period of four days, where the participants were asked to solve a specific task with the help of Alan. The participants were between the age of 21 and 33 and students (undergraduate, graduate and postgraduate) of different field of studies, including information technology, business economics and engineering. Five participants were female and nine were male. Various tasks were issued to the participants, who were then asked to choose one task. The defined tasks were of different topics to avoid any need for specialist knowledge. For example, tasks such as: “How can we make children eat more fruit and vegetables?” and “How can we establish better recycling habits?” After introducing the participants to the system, they worked over a period of four days in their familiar environment (at home or at work) on one idea with constant support by Alan. The participants started their idea from scratch and developed it over the period. During these days, Alan’s assistance was used constantly. Log files of the system showed that the length of the ideas increased during the support. In addition to this, monitoring the use of Alan by means of the number of queries to Facebook, Twitter and Tumblr, showed that the help of the AI was intensive during all steps of idea generation. Furthermore, the number of messages marked and attached to the ideas (ø=5 attached messages from Alan to an idea) showed that the user makes use of Alan’s input. The idea generation stage was therefore highly influenced by Alan and can be seen as a collective work between the user and the AI-like system.

After the completion of the experiment, the participants were asked several questions regarding the support of the AI and as to whether they experienced any negative effects from interacting with the system. Our two hypotheses were formed into five questions and were posed to the participants after the four-day period of idea generation. We used a self-report questionnaire with direct questions, based on the social processes causing productivity losses. This type of questionnaire ensures a better attribution to every social process and thus allows a precise assignment to the hypothesis [27]. For the answers to the questionnaires, we used the psychometric Likert-scale approach to ensure a wider range of possible answers [22]. The following chapter presents the questions and the results of the experiment.

4.1 Results

For the validation of the first part of our hypothesis we asked the participants whether Alan was able to find content related to the user’s idea (without explicitly asking for supporting content), whether he found new content which was unknown to the user, and if he was able to explicitly support the idea generation. The majority of the participants answered that they agree (p=7) and strongly agree (p=5) that Alan was able to find content, which is related to the idea. One participant neither agreed nor disagreed (neutral) on this question and one disagreed. Similar results emerged at the questions as to whether Alan was able to find new and unknown content. Three strongly agreed, seven agreed and three were neutral. One participant disagreed. Fewer participants agreed (p=2) or strongly agreed (p=6) that Alan was able to find explicit supporting content. Two participants disagreed on this question and four neither agreed nor disagreed (neutral). The following table shows the questions for the first part of our hypothesis, whether the artifact was
able to achieve the benefits of a group creativity process. The answers strongly agree and agree are grouped (agree) as well as the answers strongly disagree and disagree (disagree).

Table 2: Evaluation results for H1

<table>
<thead>
<tr>
<th>Question</th>
<th>Answers (p_{total} = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did Alan offer content related to your idea?</td>
<td>Agree: 12</td>
</tr>
<tr>
<td></td>
<td>Neutral: 1</td>
</tr>
<tr>
<td></td>
<td>Disagree: 1</td>
</tr>
<tr>
<td>Did Alan offer new content, which was unknown to you?</td>
<td>Agree: 10</td>
</tr>
<tr>
<td></td>
<td>Neutral: 3</td>
</tr>
<tr>
<td></td>
<td>Disagree: 1</td>
</tr>
<tr>
<td>Did Alan offer supporting content?</td>
<td>Agree: 8</td>
</tr>
<tr>
<td></td>
<td>Neutral: 4</td>
</tr>
<tr>
<td></td>
<td>Disagree: 2</td>
</tr>
</tbody>
</table>

With a few exceptions, most participants experienced a benefit effect by using the prototype and found unknown content offered by Alan. Possible explanations for the participants who did not gain any benefits from Alan might be that a suggested idea was too specific or too short. This leads to fewer or even no query results from the services Twitter, Facebook and Tumblr.

When evaluating the negative group effects, we asked the participants whether they exerted less effort for their idea because they knew that they were being supported during their creative stage (addressing free-riding and dispensability of effort) and whether they exerted less effort because the outcome might not only be their work. The majority answered that they strongly disagree (p=6) and disagree (p=7) that they exerted less effort due to knowing about the support. The same results were obtained from the second questions (CEM). Six participants strongly disagreed and eight participants disagreed that they exerted less effort, because they expect their effort not to be attributed to themselves alone. The following table shows the questions for the second part of our hypothesis regarding the negative group effects:

Table 3: Evaluation results for H2

<table>
<thead>
<tr>
<th>Question</th>
<th>Answers (p_{total} = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you exert less effort for your idea, because you knew that Alan was supporting you?</td>
<td>Agree: 0</td>
</tr>
<tr>
<td></td>
<td>Neutral: 1</td>
</tr>
<tr>
<td></td>
<td>Disagree: 13</td>
</tr>
<tr>
<td>Did you exert less effort on your idea, because your effort is not instrumental obtained to the outcome?</td>
<td>Agree: 0</td>
</tr>
<tr>
<td></td>
<td>Neutral: 0</td>
</tr>
<tr>
<td></td>
<td>Disagree: 14</td>
</tr>
</tbody>
</table>

The results show that no free-riding or dispensability of effort effects occurred during the use of the prototype and the interaction with Alan. Although, we did not evaluate the users’ perception of Alan, the results show that an AI-like system does not affect the user in his or her creative stage in terms of free-riding or dispensability of effort.

6. Conclusion and outlook

The contribution of this paper is twofold: First, we developed an innovative artifact with the functionality to generate, manage and work on ideas inside of a community. Multiple users are able to comment on and rate ideas, in order to help improve and validate them. The possibility of isolating ideas from the community whenever the user needs to work on unfinished thoughts means that it is possible to ensure that no negative group effects can influence the idea generator. However, hiding an idea from the community prevents other users from contributing their input to foster or improve the idea. As such, we implemented an AI-like support system that tries to act human-like, attempts to understand what the idea is about and tries to support the idea generator during the creative stage.

No evaluation was carried out with regard to the users’ perception of the AI-like system; however, we implemented algorithms and methods, which are widespread and commonly used in AI systems. Our focus was not on developing a state-of-the art AI, but rather on finding out about social processes when interacting with AI-like systems. As such, our main efforts were not invested in the development of the AI but fulfilling the basic principles of AI.

The second contribution is the conducted experiment. The results show that the AI-like system was able to offer the idea generator new and unknown content and found information related to the idea. Furthermore, the majority of the participants said that the system was able to explicitly offer supporting content, which helped to improve or validate the idea. Despite this, the results for this question were not as significant as for the first questions. In can therefore be concluded that the AI needs to be improved in numerous fields. First of all, an improved NLP is required to insure a better understanding of the idea and an enhanced learning ability is needed to better interact with the user’s actions. Furthermore, various decision-making abilities and a bigger knowledge base have to be implemented. A longer experiment duration could result in more supporting content, as the queried services are highly active and new content arises every second. Also the services do not incorporate content older than seven days into the query results. The
experiment also showed that no free-riding and social loafing effects appeared while working with the AI-like system. Participants did not exert less effort on their ideas, because of the fact that an AI helped or influenced their ideas. In addition to this, the stated CEM by Karau and Williams had no effect on the participants. Even though this might be related to the users’ perception of the system, it shows that there are no negative side effects in an idea generation process that is supported by an AI-like system.

The conducted experiment and the implemented artifact presented in this paper are included in continuing research and will be further evaluated and improved. In particular, the small number of participants in our experiment hinders the generalizability of the results. An increased number of participants and a longer idea generation period could facilitate improved results. In addition to this, qualitative interviews could provide supplementary results to prove our hypotheses. The experiment will be extended to determine more group effects and supporting features of an AI-like system. In particular, the functionality of hiding an idea or working anonymously in a community will be evaluated. It can be noted that a variety of design principles for creativity support systems exist and automated creativity support can improve cognitive processes. However, the interaction with artificial intelligence in a creative stage is yet to be researched, especially in regard to social influence.

10. References


