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The effects of real-time feedback and goal-setting on electronic brainstorming task performance

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ABSTRACT

Electronic brainstorming systems have been used as idea management toolkits within various organisations to improve creativity and develop innovative ideas. Yet, these systems have been shown to have diverse levels of success within organisations, with the main difference in the success of the systems being attributed to the interface utilisation of design principles and organisation cultures. It has been suggested that when perceived as informational, the design principles within such a system, such as points, leader boards, and reaching a goal may afford feelings of competence and hence enhance intrinsic motivation and may even improve task performance. Computer-mediated communication has been found to overcome some of the limitations within traditional brainstorming groups, and have even shown improvement in the idea-generation process over traditional methods. A two-by-two factorial online experiment was conducted with professional business students, to systematically examine how performance feedback and explicit goals, as well as the participants' self-perceived sense of autonomy, competence affects task performance (quantity and quality) of an individual or groups. The findings are in line with previous research on the effectiveness of computer-mediated group brainstorming and are also equivalent with respect to the task performance (quantity and quality) of idea-generation. One of the recommendations for improving this task performance of individual or groups is based on mutual cognitive stimulation, which assumes that reading others' ideas could lead to satisfying a self requirement for psychological needs. Real-time feedback was found to intrinsically motivate participant towards improving their task performance, as where the setting of explicit goals showed no significant effects on task performance. Furthermore, no effect was observed with regards to social comparison between individual and group feedback setting, regardless of which design principles were applied.

KEYWORDS

Electronic brainstorming, individual/group creativity, idea-generation, motivational affordance, innovation management

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DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted before for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to carry out this research.

Name: Werner van der Merwe

Signature: ____________________

Date: 10 November 2019

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CHAPTER 1: INTRODUCTION TO RESEARCH PROBLEM

1.1. Ideas and innovation

Ideas are the starting point from where innovation begins, and they are a significant source of value creation for organisations (Baumann & Stieglitz, 2014). However, this requires that organisations enter the unknown, and that could result in a costly search for good ideas. Various systems, from relatively modest suggestion boxes to complicated social media platforms, have evolved to support the initial phase in the innovation process for the capturing, development, and enhancement of ideas (Kietzmann, Hermkens, McCarthy, & Silvestre, 2011). Organisations use idea management programs to generate, evaluate and select ideas from various vital sources within and outside the organisation (van den Ende, Frederiksen, & Prencipe, 2015). Because the business environment is so competitive, novel idea-generating activities have become vital to gain a competitive edge (van den Ende et al., 2015). Dynamic and highly technical environments have placed on managers and employees a necessity to innovate, as infrastructure and knowledge can rapidly become obsolete (Soto-Acosta, Popa, & Martinez-Conesa, 2018). There is subsequently a demand for innovative and creative employees in organisations to generate new ideas (Anderson, Potočnik, & Zhou, 2014; Chesbrough, 2003b; Svahn, Mathiassen, Lindgren, & Kane, 2017). Organisations have also started looking externally to add to the idea-generation process through the process of open innovation (Chesbrough, 2011; Saebi & Foss, 2015; Witt, 2017).

In order to stay competitive, organisations have had to reconsider how ideas were being generated, developed, manufactured, marketed and distributed. Numbered are the days when industrial enterprises' Research and Development (R&D) departments created a strategic barrier to entry against new competitors (Chesbrough, 2011). Anderson et al. (2014) and Baumann and Stieglitz (2014) have suggested that innovation allows societies and organisations to remain competitive and relevant within complex business environments. According to Wynen, Verhoest and Kleizen (2017), the culture of many large organisations discourages innovation and out-of-the-box thinking, because innovation comes from individuals who constitute a degree of risk to both the investor and organisation.

Organisations are faced with two primary interconnected challenges before benefits can be claimed from these open innovation platforms: firstly, motivating the individual or group to participate, as a high rate of involvement is required, and secondly, inspiring the individual or group to come up with creative ideas (Witt, 2017). The quality of each individual's contributions and user's characteristics are debatably the most critical factor for the idea-generation within a group-collaboration environment. These contributions dictate the success of the brainstorming idea-generation process (Al-Samarraie & Hurmuzan, 2018; Füller, 2010). Motivating employees during both stages of innovation (predevelopment and implementation), while creating a safe and positive environment that encourages openness and risk-taking, seems to be the formula that enables idea-generation and application (Baumann & Stieglitz, 2014; Wynen et al., 2017).

1.2. Research problem

Continually innovative organisations have to extend their boundaries to external sources (Chesbrough, 2003b; Majchrzak & Malhotra, 2013) in order to commercialise ideas through outside channels, to satisfy customer needs, develop new products, and improve processes. The emergence of digital technologies and social media changed the way that individuals and organisations participated in the co-creation, sharing, discussion and reshaping of experiences (Kietzmann et al., 2011; Svahn et al., 2017). Furthermore, this trend demanded that organisations adapt to how they innovate. This transition has occurred not solely due to the advancement and development of technology, but mainly due to a paradigm shift moving from a closed innovation system to a more collaborative open innovation system (Chesbrough, 2003a; Poot, Faems, & Vanhaverbeke, 2009).

The number of virtual teams in organisations has increased over the last two decades, and they are commonplace in today's business environments (Gilson, Maynard, Jones Young, Vartiainen, & Hakonen, 2015). In some organisations, these virtual groups are even more common than the traditional groups – by definition, groups that meet face-to-face, as opposed to the virtual groups that meet online (Anderson et al., 2014). This arrangement achieves a balance of incremental and radical types of service innovation, which ensures its survival and ability to generate value (Madjar, Greenberg, & Chen, 2011; Soto-Acosta et al., 2018).

Information technology has played a significant role in facilitating virtual group creativity and organisations' survival-growth strategies, and have therefore been the focus of considerable research (Gilson et al., 2015). An essential question that researchers in this field of study have tried to address is how to improve the fundamental elements of communication for group creativity. Unfortunately, the overall conclusion of this research is that due to the issues (face-to-face being synchronous in nature, causes production blocking during idea-generation) in the traditional communication process, people generate fewer ideas when they work together in groups, compared to when they work individually (Gilson & Litchfield, 2017; Jung, Schneider, & Valacich, 2010). The use of information technology and social media has improved primary the issue that occurs in traditional verbal interaction (Kietzmann et al., 2011; Paulus & Kenworthy, 2019; Perry-Smith & Mannucci, 2017).

The phenomenon of virtual-idea communities is relatively new in the business world, but they have assisted organisations in harnessing internal and external resources for collaboration on problem-solving and developing ideas (Scheiner, Haas, Bretschneider, Blohm, & Leimeister, 2017). These communities, in which scattered groups of individuals voluntarily focus on elaborating and sharing their ideas for innovation, are used by organisations to integrate external stakeholders and internal employees for new product development and process improvements, and is deeply rooted in the open innovation paradigm (Chesbrough, 2003a). Terms used for this process of sharing ideas within an open innovation context have changed over the years, as the context changed. Within the virtual-idea communities, it is commonly referred to as electronic brainstorming (EBS) platforms (Al-Samarraie & Hurmuzan, 2018; Scheiner et al., 2017). These types of platforms allow generating, responding and voting for ideas, which in theory should all lead to a more collaborative integration in the idea-generation process (Paulus & Kenworthy, 2019). Limited empirical studies have been done to examine the extent to which these EBS systems enhance group performance, compared to individual performance (Jung et al., 2010; Korde & Paulus, 2017; Paulus & Kenworthy, 2019).

Paulus and Kenworthy (2019), as the experts in the field of EBS, explicitly stated that they have not yet examined or seen any research on the extent to which these types of systems could enhance group performance compared to individual performance.

1.3. Research objective

Based on the preceding discussion, the primary goal of this research is to determine how the EBS web-based platform with collaborative group environments can be designed to motivate individuals during the creative idea-generation phase of the idea journey. A research process within the field of human-computer interaction and motivation is necessary in order to shed light on these design principles. The development and design of information systems is a crucial element influencing human needs (Witt, 2017; Zhang, 2008b). Following Zhang (2008b) and Scheiner et al. (2017) on motivational perspectives, they argued that motivation, through its influence will direct the energy of a user's towards a goal if the system implementation is done correctly. This has been proven to some degree in various empirical studies (Jung et al., 2010; Korde & Paulus, 2017; Mekler, Brühlmann, Tuch, & Opwis, 2017; Witt, Scheiner, & Robra-Bissantz, 2011), following this logic on how the interface design influences motivation towards desired outcomes, and drawing on the concept of motivation affordance (Zhang, 2008a) and goal-setting (Landers, Bauer, & Callan, 2017; Latham & Locke, 2007; Tondello, Premsukh, & Nacke, 2018). Two theoretical mechanisms will illustrate how task performance could be improved through leveraging; performance feedback, and explicit performance goals within an EBS web-based platform. The study will focus on the idea-generation environment and will concentrate on explaining the effect on results within this specific context. It will also aim to gain insights into how comparable interventions could be implemented when it comes to a more inclusive and complex group-collaboration environment.

The web-based computer-mediated idea-generation platform as a context for this study was created because of the foundational environment for group-collaboration, where various design mechanisms could influence the way that an individual participates in group-collaboration environments. These include interfaces within web-based instant message systems, such as WhatsApp, LinkedIn, Facebook, and Google docs.

1.4. Research importance

1.4.1 Research importance to business

The following two primary activities are included in the innovation process, namely innovation and innovation (Gilson & Litchfield, 2017). Innovation entails the implementation of these ideas into new processes and products, while creativity involves the generation of useful and novel ideas (Chesbrough, 2011). Thus, without novel and valuable ideas, the innovation process will be halted before it even starts. This study will focus on how to improve task performance by generating ideas through an open innovation business philosophy, providing useful insight on how to incorporate design principles within the predevelopment phase of the innovation management system.

1.4.2 Research importance to academia

Although the research on idea-generation is extensive, empirical studies are limited regarding the design aspects of EBS platform systems that aim to enhance the performance of idea-generation (Paulus & Kenworthy, 2019; Scheiner et al., 2017). The focus of this study is on contributing to the body of knowledge on how design can be leveraged within information communication technology to enhance the task performance and motivation of groups and individuals in the predevelopment phase of idea-generation.

CHAPTER 2: LITERATURE SURVEY

2.1. Introduction to the literature review

The purpose of this chapter is to both introduce and critique the literature on group-collaborative idea-generation within an open innovation environment. In this chapter, the motivational affordance and goal-setting will be introduced in order to elucidate the decision to test the principles of real-time performance feedback and explicit performance goals. In this context, this study should provide new and useful insights for the application of design principles within idea management systems, as a moderator of creativity and motivation. The figure below (Figure 1) illustrates the logical flow of the literature review and why it is necessary to refocus on the two previously mentioned principles within motivation affordance and goal-setting are.

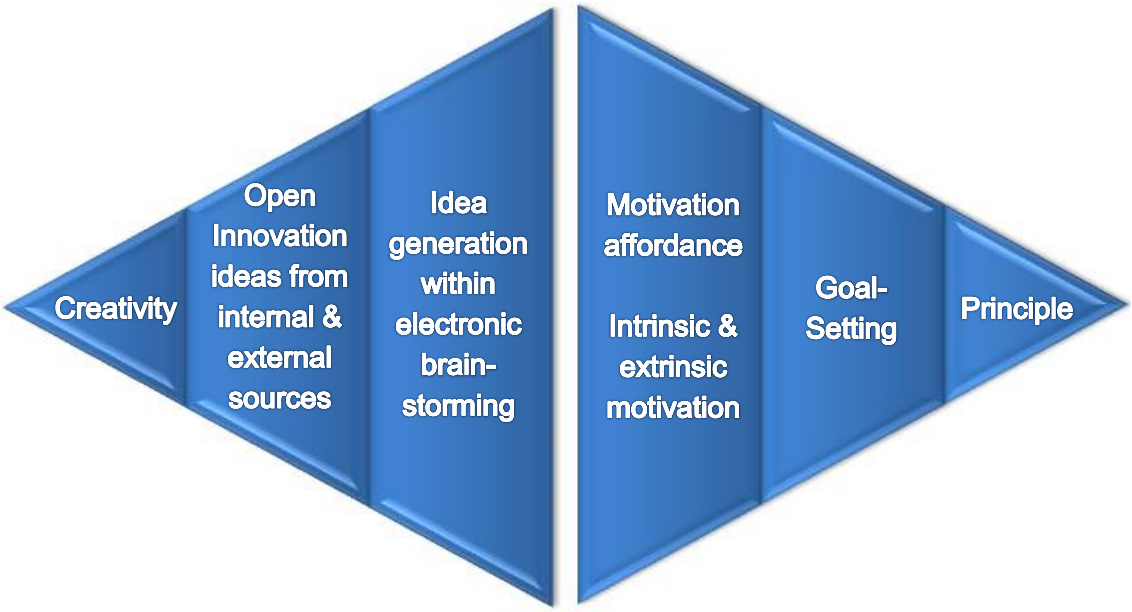

Figure 1. Literature review diamond

2.2. Creativity

The need for fast-paced decisions as well as the ability of individuals and organisations to be creative and innovative, is becoming increasingly important. Amabile (1982) defines creativity as a practice of using your imagination and skill to develop a unique or new service, product, process, object or thought. This definition highlighted three distinct types of creativity;

- creation of something new or unique,
- synthesis in combining old with new, or
- modification by solely changing the approach.

Creativity is at the root of generating and creating ideas that are both novel and useful, while ideas are the starting point from where innovation begins and is mainly related with the implementation of those ideas (Gilson & Litchfield, 2017; Perry-Smith & Mannucci, 2017; van den Ende et al., 2015). Anderson et al. (2014) introduced an integrative definition for both creativity and innovation: "*Creativity and innovation at work are the process, outcomes, and products of attempts to develop and introduce new and improved ways of doing things. The creativity stage of this process refers to idea-generation, and innovation refers to the subsequent stage of implementing ideas toward better procedures, practices, or products. Creativity and innovation can occur at the level of the individual, work for team, organisation, or at more than one of these levels combined but will invariably result in identifiable benefits at one or more of these levels of analysis*".

Thus a creative idea should be evaluated on both its uniqueness and effectiveness, while the employees with creative vision usually need to persistently break through bureaucratic barriers in an attempt to support their ideas through to implementation (Caniëls & Rietzschel, 2015; Gilson & Litchfield, 2017). Although creativity is viewed as a universal construct, one should recognise its multi-faceted nature. Creativity can range from radical new ideas, such as behavioural banking within the financial sector, to small incremental changes in existing ideas (Madjar et al., 2011; Paulus & Brown, 2003).

With an increase in the number of ideas available for implementation, the probability is expected to result in higher performance (Chevtchenko, 2013; van den Ende et al., 2015). As a result of this, organisations are continually looking for individuals with higher skill levels of creativity, which can increase the number of available ideas to choose from (Anderson et al., 2014; Baumann & Stieglitz, 2014). Since creative employees generate as many ideas as possible worth implementing, the majority of studies have focus on determining how to increase the creativity of employees (Caniëls & Rietzschel, 2015; Gilson & Litchfield, 2017; Thayer, Petruzzelli, & McClurg, 2018). It could be argued that creativity is useful only when a new and improved way of doing things has been implemented (Amabile, Conti, Coon, Lazenby, & Herron, 1996; Thayer et al., 2018) and that the generation of ideas is trivial in the grander innovation process; even when there is an abundance of ideas, only a limited amount of innovation will take place (Levitt, 2002). In a world of too many ideas, how do organisations ensure that the most creative ideas are generated and implemented?

Creative organisations are generally associated with autonomy, weak rules and few boundaries, whereas the success of stimulation of creativity through design constraints for human-computer interface design is mixed and inconclusive (Caniëls & Rietzschel, 2015; Haught-Tromp, 2017; Mekler et al., 2017). Increasingly, organisations have to rethink the fundamental ways in which they are generating ideas to compensate for the rising costs associated with Research and Development (R&D), and how to effectively use design mechanics to enable employees to be more creative. The drive within organisations to move away from the old model of closed innovation to a fresh approach of open innovation, which allows for the utilisation of resources within and outside of the organisation, could facilitate a competitive advantage in the generation of new and novel products, services, objects or processes (Majchrzak & Malhotra, 2013; Poot et al., 2009; Randhawa, Wilden, & Hohberger, 2016; Saebi & Foss, 2015; von Hippel & Katz, 2002; Witt, 2017).

2.2.1 Consensual assessment technique for creativity

The Amabile (1982) definition of creativity looks at the impressions an original object creates in outsiders, where the quality of the object being assessed is deemed creative if an independent peer evaluation agrees it is. Building on this understanding, the Consensual Assessment Technique (CAT) was developed as an evaluation tool to assess creativity, and due to its relative simplicity. is used frequently in research (Piller & Walcher, 2006; Witt et al., 2011). To assess creativity with the CAT, experts are asked to evaluate the creativity of objects independently of each other based on the same dimensions. The technique has been applied to many different purposes (Piller & Walcher, 2006). While experts within an assessment will receive the same dimensions for evaluation, the measurements between different estimates and for various objects can differ. Although the method is relatively simple, several requirements must be fulfilled for a valid application of the CAT (Amabile, 1982; Amabile et al., 1996).

2.3. Open Innovation

Open innovation is a means of opening organisations' boundaries in order to seamlessly collaborate with external or internal parties to accelerate the commercialisation of innovation through an exchange of knowledge. The inner expertise of employees can be used to enrich the current innovation practices as well as maximising the value generated from new ideas from exterior sources (Chesbrough, 2011; Randhawa et al., 2016). Consistently, research has defined open innovation as a set of practices that facilitate the exchange of knowledge between both purposive inflows (inbound) and outflows (outbound); thus generally open innovation incorporates both dimensions within the innovation processes (Saebi & Foss, 2015). While open outbound innovation refers to those innovation practices which is focused on leverage existing technological capabilities outside the organisation boundaries, whereas open inbound innovation relates to the usage of exterior knowledge of internal organisational purposes. Consequently, open innovation is about utilising external technology and expertise to enrich the capabilities of the organisation for opportunities both internally and externally, whereas ideas simply need to add value beyond an organisation's boundaries (Randhawa et al., 2016; Saebi & Foss, 2015).

2.3.1 Opening the innovation process

The open innovation process is vastly different from the traditional or closed innovation process. Implementing and gaining ideas through utilising external sources is the primary focus for open innovation (Poot et al., 2009) or by granting external parties access to non-utilised ideas, whereas with traditional innovation the implementation and generation of ideas are supplied only by the organisation's employees (Anderson et al., 2014). The two major differences between these innovation processes are based on the source information and flow of ideas between the boundaries of the organisation, as can be seen in Figure 2 (Randhawa et al., 2016). Several activities can be defined utilising knowledge from external sources within open inbound innovation, including crowdsourcing (Majchrzak & Malhotra, 2013; Scheiner et al., 2017), innovation contests/tournaments (Witt et al., 2011; Wooten & Ulrich, 2017) and joint ventures in R&D (Saebi & Foss, 2015). This research will only cover the enhancement of idea-generation within an organisation or society, and both the inbound and outbound sources must be considered. With the increasing specialisation of information technology-based tools, organisations have started experiences a disproportionate to the computational and selective capacity for the number of internally and externally generated and acquired ideas (van den Ende et al., 2015).

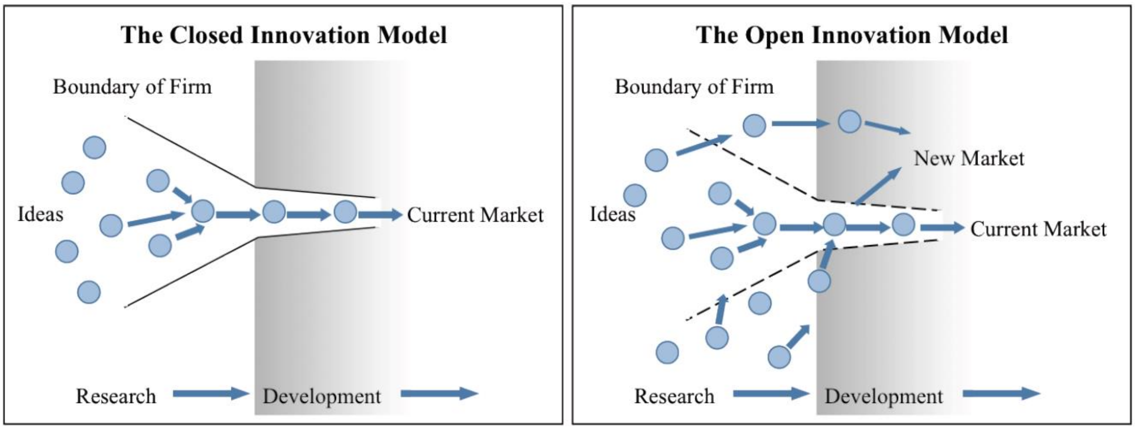

Figure 2. Closed and open innovation models adapted from Chesbrough (2003b)

The emergence of social media and the ease of using these types of systems has accelerated the transition from closed to open innovation models which allow for the creation and exchange of user-generated content in an ever-expanding interconnected world (Kietzmann et al., 2011; Witt, 2017). Social media provides access to unlimited tacit knowledge, supporting cognitive processes as well as collaboration and interaction between virtual teams (Piller & Walcher, 2006).

2.3.2 Open innovation tools

When organisations start adopting an open innovation philosophy into their R&D processes, they can incorporate two different innovators, namely the peripheral inside innovators and the outside innovators (Chesbrough, 2011). The peripheral inside innovators are employees not officially responsible for innovative activities within the organisation, based on their job descriptions (Neyer, Bullinger, & Moeslein, 2009). They willingly contribute their tacit knowledge, which was acquired through their day-to-day work. Outside innovators, on the other hand, are end-users such as suppliers, customers, retailers and partners (Neyer et al., 2009).

Several social media-based tools have already been used by organisations to integrate a broader range of peripheral inside innovators and outside innovators (Kietzmann et al., 2011). This study focuses on tools that include social media design elements to incorporate a broader range of outside innovators and peripheral inside innovators into the predevelopment phase of the innovation process. These tools emphasise the process orientation, and often provide similar functionalities, just with a different graphical presentation. Google moderator is an example of such a social media tool that was freely available from Google as an idea management tool. This specific tool allowed anyone inside or outside the organisation to pose a question and everyone else to rank the questions and answers they liked on a virtual meeting site (Rao & Purkayastha, 2014). Most of the innovation management tools allow the users to suggest, evaluate and discuss solutions to problems that were identified by the organisations and assist in the communication/coordination between departments. Five basic types of social media-based tools can be distinguished, namely: idea management systems, idea competitions, innovation markets, innovation communities and innovation toolkits (Witt, 2017). Of these, the idea management system (Figure 3), is used extensively to increase the innovation potential of peripheral inside innovators and to drive innovative cultures within an organisation (Neyer et al., 2009).

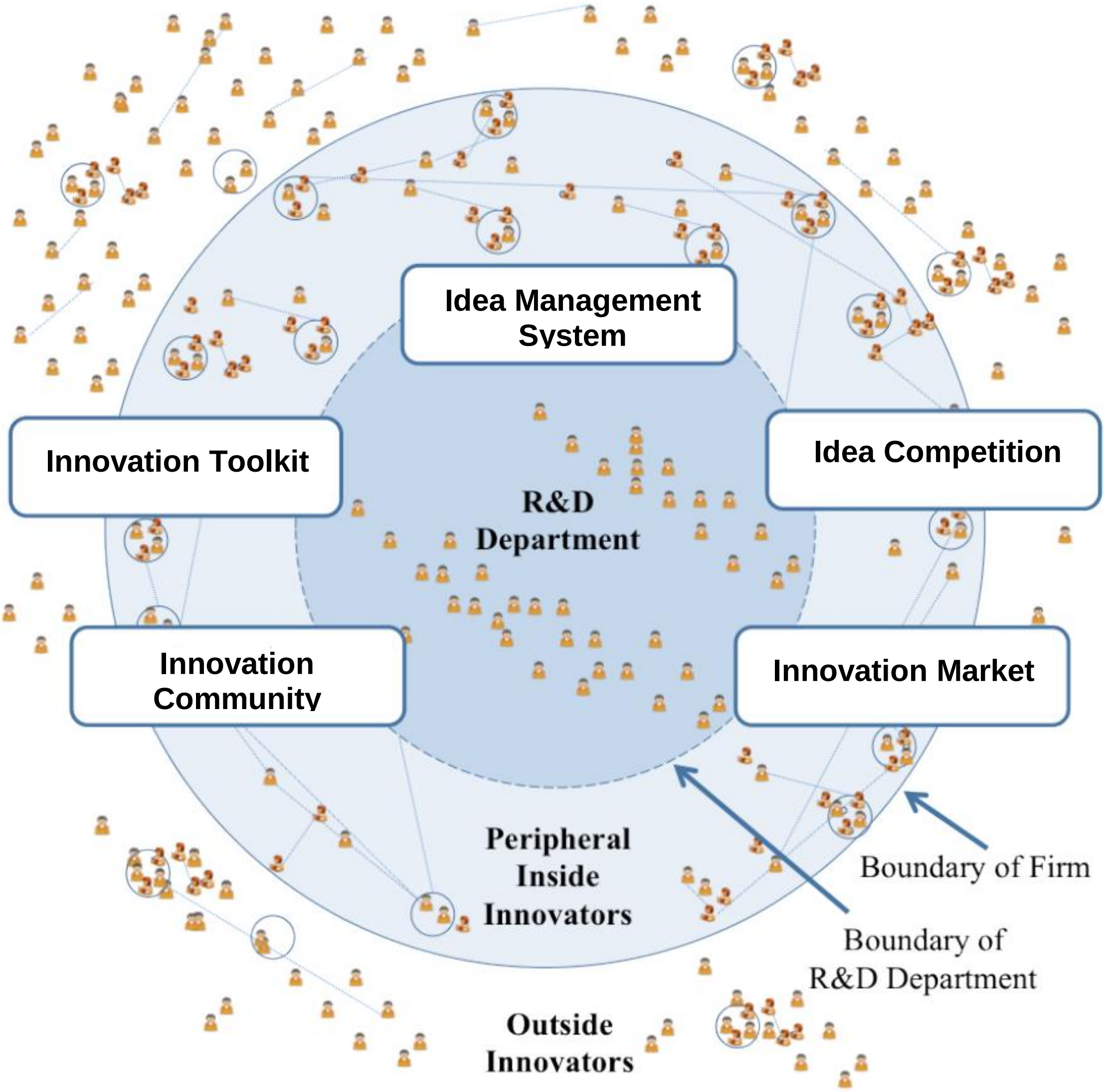

Figure 3. Tools to engage peripheral insiders & outsiders in the innovation process

The other social media-based tools are specifically aimed at fostering the innovation potential of outside innovators through crowdsourcing of creative ideas and innovating solutions.

2.3.3 Idea management systems and idea competition

The idea management system is the next step in the development of employee suggestion boxes (Kietzmann et al., 2011). These suggestion systems are characterised by the organisational features to promote acknowledgement, collection, evaluation and exploitation of ideas from employees (Neyer et al., 2009). The first step in the process requires that employees must be motivated to contribute a novel and useful idea; thereafter, the suggestion system is driven by a standard workflow process. There are some beneficial advantages to such a system, in being a low-cost solution, but outcomes from such a system are inadequate due to the lack of cross-collaboration and limited feedback (Witt et al., 2011).

Idea competitions have proved to be a valuable tool for integrating outsiders and peripheral insiders in the idea-generation, evaluation and implementation activities within an organisations innovation process, and therefore has become a standard recognised tool used for broad stakeholder engagement (Scheiner, 2015; Witt et al., 2011). The success of idea competitions is reliant on the ability of organisers to motivate participants to contribute and then to keep the participants engaged over time. The popularity of idea competitions for problem-solving and customer engagement has created virtual idea communities (Füller, Mühlbacher, Matzler, & Jawecki, 2009; Scheiner et al., 2017), where the organisations are in continuous competition for participants. Financial rewards (Ke & Zhang, 2010; Wang, Schneider, & Valacich, 2012; Zhao & Zhu, 2014) or recognition (Scheiner et al., 2017) are some of the conventional methods used to motivate participants extrinsically. However, research in social psychology and management science indicates that these rewards have a short lifespan in terms of motivating participants and can also negatively affect long-term motivation (Füller et al., 2009; Mekler et al., 2017). These types of extrinsic rewards can reduce people's participation behaviour (Deci & Ryan, 2010; Ryan & Deci, 2000) and can even obstruct the performance of creative and complex tasks (Latham & Locke, 2007). Consequently, it is essential to engage and motivate participants through intrinsic motivation by creating positive experiences (Burgers, Eden, van Engelenburg, & Buningh, 2015; Piller & Walcher, 2006; Scheiner, 2015).

2.4. Idea-generation within electronic brainstorming

Organisations today face serious challenges, amplified by the need to continually innovate (Baumann & Stieglitz, 2014) and generate quality ideas, rather than focusing on the quantity of ideas, which is key to survival and success (van den Ende et al., 2015). When it comes to general idea-generation performance, group-collaboration, in particular, has an extensive history of examination and continues to draw attention from both practitioners and researchers. According to Thayer et al. (2018) the performance potential of a team is influenced by individual user characteristics and attributes such as disposition, skills, knowledge and self-efficacy; group-level attributes such as diversity, size and organisational structure; and environmental level attributes such as reward structures and political uncertainty. These individual and group variables affect the process of engagement and interaction. This leads to process gains and losses within the group's collaborative potential performance which in turn can be used to determine the extent of the actual group performance (Dennis, Minas, & Williams, 2019).

When one looks at the area of idea-generation, early research focused on identifying different techniques for enhancing both the group's and individual's creativity and performance, one of these techniques being brainstorming (Osborn, 1957). However, studies attempting to evaluate the effectiveness of such methods consistently and empirically found that non-interacting individuals whose ideas were pooled, outperformed interacting groups (Dennis et al., 2019). Process losses such as production blocking, evaluation apprehension, social loafing, cognitive interference and communication speed have been identified as the leading causes of poor performance with regard to interacting groups (Dennis et al., 2019). In more recent studies, idea-generation within electronic brainstorming (EBS) has been found to bridge some of these process losses through the benefits of parallel communication, supporting anonymity and group memory (Al-Samarraie & Hurmuzan, 2018; Dennis et al., 2019). Multiple studies on EBS idea-generation groups have shown that they outperform non-supported groups, even with a broad range of group sizes and a variety of tasks (Dennis et al., 2019; Jung et al., 2010; Korde & Paulus, 2017; Scheiner et al., 2017). Through these studies, larger EBS groups were outperformed by similar-sized nominal groups, whereas nominal and EBS groups within small group sizes showed few or no differences (Al-Samarraie & Hurmuzan, 2018; Paulus, Kohn, Arditti, & Korde, 2013). Gallupe et al. (1992) showed that task performance increases substantially with the increase in group size, but that the performance plateaus over 12 participants due to exhausting the ideas and increasing the temptation of free-riding within larger group sizes. They recommended that the minimum size for an EBS group is five participants and no more than 12 per session.

Extensive research has been done by using laboratory (using student subjects) and field studies (using managers) to examine EBS idea-generation (Al-Samarraie & Hurmuzan, 2018) and results are consistent across the different types of participants. One of these studies done by Dennis et al. (2019) tested the effects of anonymity for these different groups of participants (student subjects and members of a chamber of commerce), no significant difference was found between both these different sets of participants. It can therefore be concluded that, in both laboratory and field studies, the EBS groups appear to perform better in larger sized groups, with minimum negative side-effects (Paulus et al., 2013). Another well-researched field studied the optimal amount of time needed to generate the best ideas. Dennis et al. (2005) suggested that EBS groups interaction session be kept to a minimum of 30 minutes for the best results. However, a session of that length may be unnecessary because it is likely that participants will start running out of ideas (Baruah & Paulus, 2016). Johnson and D'Lauro (2018) found that a shorter brainstorming session of 15 minutes is more than sufficient and that the most original ideas were generated within the first five-and-a-half minutes, with top selected ideas generated within two minutes from the start of the session. Another study by Baruah and Paulus (2016) found a reduction in the number of ideas over time, but that the originality of ideas generated increased over time, with the optimum point at ten minutes marking a marginal increase in the quality of ideas.

Besides examining the effects of group-level attributes such as group size, anonymity and time constraints, Korde and Paulus (2017) focused on the individual level attributes, such as efficacy to improve idea-generation performance. In their study, they demonstrated that an individual participant's cognitive ability strongly impacts both the overall group and individual performance. This indicates the importance of addressing individual-level attributes in the context of idea-generation and possibly in other group-collaboration environments. Al-Samarraie and Hurmuzan (2018) stated that a review of all the possible brainstorming techniques indicated that EBS had the most significant effect on performance as well as producing the best quantity and quality ideas, with the least amount of production blocking taking place.

2.4.1. Two main models to understand brainstorming

Paulus and Brown (2003) proposed that group creativity is influenced by various cognitive, social and motivational factors. According to the Associate Memory Model (AMM) of group brainstorming, cognitive stimulation resulting from idea sharing in a group setting is possible. This model postulates that a two-dimensional associative memory matrix can be constructed for each individual in a group, with variable probabilities representing the fluency and accessibility of different semantic categories associated with the brainstorming topic (Paulus & Kenworthy, 2019). Category fluency refers to the probability that a new idea will be generated, while a brainstormer considers a given category and accessibility is the probability of switching to a particular new category. According to this model, the semantic category of the next idea a brainstormer will generate depends on the semantic category of the previous idea and the associated transition (switching) probability of the semantic category. In the group context, the previous idea (that determines where in the semantic network the next idea will come from) can be either the originator's idea or another group member's idea. In this way, the model accounts for cognitive stimulation in group brainstorming: if attention is paid to others' ideas, it can allow team members to switch to a semantic category that would not have been considered within individual brainstorming (Paulus & Brown, 2003).

Nijstad and Stroebe (2006) proposed the other model, which focuses on the retrieval of ideas from long-term memory. This alternative model, called Search of Ideas in Associative Memory (SIAM), tries to explain how synergy happens in group brainstorming (whereas the previous model explains the structure and content of brainstormers' semantic networks and the retrieval of ideas from long-term memory). The focus of SIAM is to account for the search processes and formation of novel ideas in that semantic space (Paulus & Brown, 2003). In other words, SIAM does not assume that creative ideas are always fully formed in an individual's mind. According to this model, idea-generation happens in two stages. The first stage is a controlled process that involves using a search cue to probe the activation of task-relevant concepts in long-term memory. The second step is automatic, and ideas are generated by forming new associations between the features of activated knowledge ("images") and domains of the problem at hand. The SIAM model assumes that category switches require a new search cue and the activation of a new image requires a finite amount of effort and time to process. In group settings, however, features of stimulus ideas that come from other people can be incorporated into the search cues and help reduce response latencies associated with category switches. Both models predict positive effects from group brainstorming and the consideration of a broader array of solutions than would be expected in individual contexts.

Despite these theoretical models that suggest that group brainstorming should lead to cognitive stimulation, limited empirical studies have been able to validate that groups have an advantage over individual performance, and in most cases found that the group settings showed signs of process loss (Mekler et al., 2017; Michinov, 2012; Michinov, Jamet, Métayer, & Le Hénaff, 2015). Most of the research in EBS regarding idea-generation has focused on the various abilities of groups or individuals. Limited studies have however been done on the EBS interface of collaboration environments and how the design plays a role in motivating individuals or groups to contribute their best efforts to the idea-generation process (Paulus & Kenworthy, 2019; Witt, 2017).

2.5. Motivational Affordance – Cognitive motivation model

Witt (2017) suggests that game design principles (gamification) can be used to motivate participants intrinsically; similarly, Burgers et al. (2015) demonstrate that feedback aimed at intrinsic motivation aided in creating a positive experience for the user. Liu, Santhanam, and Webster (2017) further demonstrated that playfulness could be regarded as a precursor when it comes to the perceived ease of use regarding an information system. Extrinsic motivation, in addition to intrinsic motivation, can also influence the intention to use a system (Burgers et al., 2015). Anderson et al. (2014) and Caniëls and Rietzschel (2015) indicated that intrinsic motivation is a critical component in creativity, which influences the quality of ideas being generated and thus the overall performance of idea-generation groups.

One important motivational factor limiting the efficacy of EBS group idea-generation is the decline of cognitive effort from individuals in a group environment towards a meaningful goal (Korde & Paulus, 2017; Thayer et al., 2018). Because group idea-generation is done so inherently, it is sometimes regarded as effortless. Social loafing is seen as an insignificant element contributing to productivity losses in group idea-generation (Al-Samarraie & Hurmuzan, 2018; Dennis et al., 2019; Nijstad & Stroebe, 2006). Zhang (2008a) has advocated the use of motivational needs, arguing that people tend to use and continue to use information systems to fulfil various cognitive and emotional needs. To design a system that is considered to be high in motivational affordance, Zhang (2008b) proposed ten design principles which are related to five different psychological, motivational needs. One of these is the design principles for the cognitive-motivational needs of competence and achievement (Zhang, 2008b). According to Paulus and Kenworthy (2019), increasing accountability and creating a sense of competition could increase the motivation for higher performance from individuals. Providing the indicators of other participants' performance could thereby motivate individuals to increase their own personal efforts (Paulus & Kenworthy, 2019)

2.6. Goal-setting

Goal-setting has been used for several years to explain how to motivate individuals to perform better in work-related tasks – namely, by setting goals and providing feedback on meeting those goals (Landers et al., 2017; Latham & Locke, 2007; Tondello et al., 2018). Goal-setting advocates that individuals' goals or desired outcomes gained from the solution will direct their attention, effort, and action towards achieving the goal-relevant actions at the expense of non-relevant actions (Latham & Locke, 2007). Locke and Latham (1990) identified four primary mechanisms of the relationship between goal and performance. These include goals that direct the attention of the people to relevant and essential tasks, and secondly, goals that regulate the effort which is directly proportionate to the difficulty of the goals. Persistence and goal-attainment strategies are the remaining two of the four mechanisms (Locke & Latham, 1990).

Various studies have consistently supported goal setting as a motivational technique, where the context of performance goals increases individual, group, and organisational performance (Landers et al., 2017; Tondello et al., 2018). The combined effect of performance feedback and goal commitment has shown a significant impact on improving the over task performance of an individual within an EBS designed interface (Jung et al., 2010). Jung et al. (2010) attributed this increase in task performance gains to the fact that the intrinsic need for competence was satisfied. Goals plus feedback have long been a recommended approach, where goals set the performance standards and feedback regulates the expectations of users to ensure that the effort employed is channelled towards completing the task (Langeland, Johnson, & Mawhinney, 1998; Sailer, Hense, Mayr, & Mandl, 2017).

Drawing upon cognitive evaluation theory, Wang, Schneider and Valacich (2012) found that participants performed at their best when provided with a challenging task, but still within an achievable performance target instead of a moderate one. This study claims that this may be due to performance targets satisfying the psychological need for competence. It is, however, unclear whether this was the case, as they did not measure the perceived competence of the participants. In fact, their conclusions contradict those posited by studies in the field of cognitive evaluation theory, as the participants in the control-oriented condition outperformed the autonomy-oriented condition participants (Deci & Ryan, 1985; Ryan & Deci, 2000). Wang, Schneider and Valacich (2015) also examined whether the effects of controlling performance feedback against informational feedback could satisfy the psychological need for competence. Participants within this study reported no significant differences between informational and controlling feedback for moderately challenging performance, and for the challenging condition with controlling feedback, participants reported feeling less competent. Regrettably, most of the published studies in this field (Jung et al., 2010; Wang et al., 2012, 2015) did not actually measure intrinsic motivation, or the effects on intrinsic motivation and how these in turn relate to task performance of generating ideas.

Thus this study will concentrate on the two related design principles of designing for the optimal challenge of explicit goals and providing real-time informational feedback.

2.7. Conclusion

Systems for the early stages of the open innovation process have changed from modest suggestion boxes to complicated social media platforms for the development and adjustment of creative ideas (Kietzmann et al., 2011; Witt, 2017). Accessing these platforms offers an opportunity to gain a competitive advantage in developing new ideas and innovations from stakeholders within and outside the organisation (Chesbrough, 2003b; van den Ende et al., 2015; von Hippel & Katz, 2002; Witt, 2017). While brainstorming has been criticised in a number of ways, it is still widely accepted as an effective way of generating ideas from members of a team or an organisation (Paulus & Kenworthy, 2019). On the other hand, EBS presented the most significant positive effect (performance, quality and quantity) with limited negative side-effects (Al-Samarraie & Hurmuzan, 2018). The two challenges in using these EBS platforms comes down to motivating stakeholders to participate, and secondly, inspiring individuals to generate creative output (Witt, 2017). This study will focus on the design principles, concentrating on the cognitive motivational needs for competence and achievement of users (Zhang, 2008b). Designing for the optimal challenge of explicit goals and providing real-time informational feedback is closely related to the goal-setting requirement for intrinsic motivation.

Figure 4 was created to summarise the concepts which would play a pivotal role in the design of the research experiment.

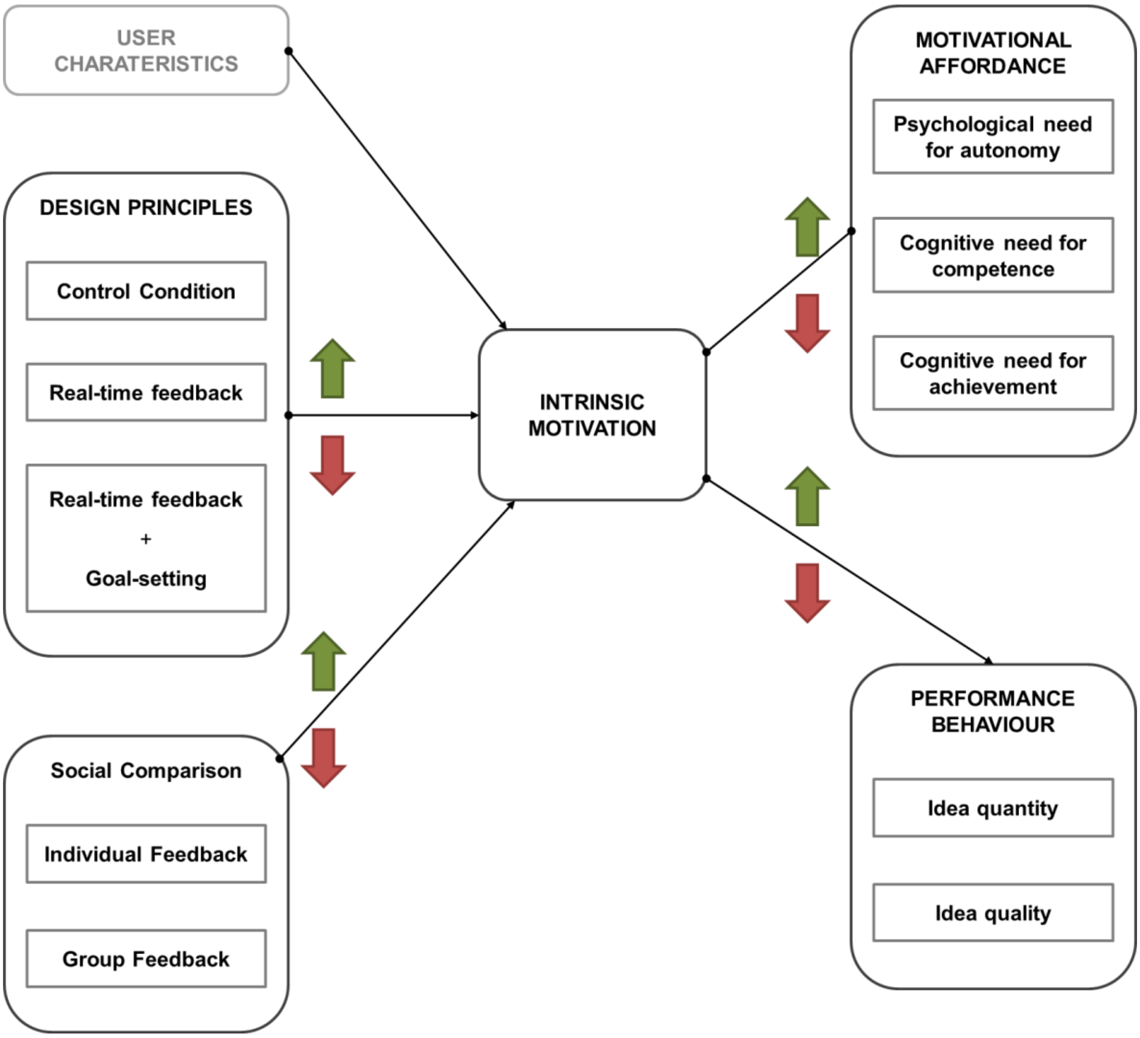

Figure 4. Framework for research design on task performance in EBS.

CHAPTER 3: RESEARCH HYPOTHESES

Osborn (1957) coined the term brainstorming, and since then brainstorming has developed to become the most popular idea-generation method (Rawlinson, 2017). Studies have shown that brainstorming efficiency could be improved by limiting deterrents such as evaluation apprehension, production blocking, and social loafing (Valacich, Dennis, & Connolly, 1994; Ziegler, Diehl, & Zijlstra, 2000). Based on these discoveries, researchers have endeavoured to build electronic open innovation tools that allow users to propose ideas to the group anonymously in parallel to assisting the idea-generation process (Pissarra & Jesuino, 2005). Although these EBS systems have shown great promise in laboratory conditions, they have failed to reach critical success in the field, due to the knowledge gap of how the various design principles affect user motivation and creativity in EBS (Jung et al., 2010; Paulus & Kenworthy, 2019; Witt, 2017).

3.1. Hypothesis development

The design of any information and communication technology (ICT) interface is an essential element of a system's motivational affordance (MA); therefore, design principles must be selectively utilised to enhance the motivation of system operators (Zhang, 2008a, 2008b). Building on the work of Jung et al. (2010), one of the recommendations for further studies, was the need to determine if group cohesiveness, would be a sufficient motivator for individuals to perform tasks at their best, without getting individual performance feedback. This gap in the body of knowledge was highlighted again by Paulus and Kenworthy (2019, p. 291), in that no studies have examined to what extent a system's design enhances group performance relative to individual performance. The other limitation of most EBS studies was the use of various student participants that received extrinsic motivation for participating (Baruah & Paulus, 2016; Gallupe et al., 1992; Johnson & D'Lauro, 2018; Jung et al., 2010; Ziegler et al., 2000), thus limiting positive supporting outcome from the autonomy motivation affordance. Zhao and Zhu (2014) found a significant negative moderating effect of MA if an external motivator (such as course credits and compensation) was used on participants before the brainstorming activity.

The overarching goal of the design principles proposed in this report is to support positively, the user's motivational needs. However, ICT designs are dependent on users, tasks, and the user's context. Thus designing for motivation must revolve around designing whole systems for motivational affordances, not adding elements with presumed-determined motivational effects. Considering the self-determining theory and the psychological need-satisfaction theories (that is, needs for autonomy, competence and relatedness), this report will focus on how the design principles could be used to drive the task performance for generating ideas augmenting the intrinsic motivation (IM) in satisfying the psychological needs of users through autonomy and task competence. Task performance will be measured in terms of the quantity and quality of ideas being generated.

3.2. Support autonomy

Cognitive evaluation theory (Ryan & Deci, 2000), considered a sub-theory of self-determining theory, states that interpersonal events and structures (e.g., rewards, communications and feedback) that provide feelings of competence during action can enhance IM for that action, by supporting psychological and cognitive needs (Deci & Ryan, 1985, 2010). Such competence-enhancing feedback will be effective only when the person has the autonomy to engage in the behaviour (Dysvik & Kuvaas, 2011; Mekler et al., 2017; Zhao & Zhu, 2014). This leads to the following research question: to what degree does the design principle effect informational autonomy need satisfaction with regard to intrinsic motivation and task performance? Ryan and Deci (2000), postulated that autonomy-oriented participants reported having a higher intrinsic motivation compared to control-oriented individuals. Mekler et al. (2017) hypothesised that participants with high perceived autonomy would perform better at a task, but this was only partially proven. The overall findings showed that the specific design principles for the experiment did not have a significant effect on participants' intrinsic motivation. Thus the following hypotheses were developed for testing:

3.2.1 Hypothesis 1:

- **H1**: Participants who experience a higher autonomy satisfaction will perform superior in the task performance of generating ideas.

3.2.2 Hypothesis 2:

- **H2**: Self-reported IM on task meaningfulness has a positive effect on task performance for individuals with a high perceived autonomy satisfaction.

3.3. Providing timely and positive feedback

Individuals and societies have an essential need to complete tasks and to pursue a standard of excellence. Social comparison can take the form of internal competition with self or external competition with others (Latham & Locke, 2007). Encouraging favourable social comparison reduces social loafing and assists lower-performing group members' performance (Ng & Lucianetti, 2016; Witt, 2017; Witt et al., 2011). In a group-collaboration context, the application of design principles such as providing real-time feedback has shown to increase a group's idea-generation task performance. Jung et al. (2010), however, speculated this increase in performance was due to satisfying the cognitive motivation need for competence through applying motivational affordance design principles. Mekler et al. (2017), however, showed no relationship between competence need satisfaction and self-reported intrinsic motivation. Based on this, the following hypotheses were developed:

3.3.1 Hypothesis 3:

- **H3**: Participants provided with real-time individual performance feedback will outperform the control group in the task performance of generating ideas.

3.3.2 Hypothesis 4:

- **H4**: Participants provided with real-time group performance feedback will outperform the control group in the task performance of generating ideas.

3.3.3 Hypothesis 5:

- **H5**: Participants provided with real-time individual performance feedback will outperform the real-time group performance feedback in task performance of generating ideas.

3.3.4 Hypothesis 6:

- **H6**: Self-reported IM on task meaningfulness will positively predict task performance of individuals with a high perceived competence satisfaction.

Providing individuals with performance feedback should increase performance in the following ways: performance feedback serves as a cognitive motivator; it will create social facilitation effect by creating a competitive environment; eliminating any process losses due to group perceptions of productivity; providing negative reinforcement for low performers and positive reinforcement for high performers.

3.4. Design for an optimum challenge

The second design principle was selected to address the psychological need for competence (Sailer et al., 2017; Zhang, 2008a), through using a design for the optimal challenge, and strongly associated with goal-setting and theory that increasing constraints will lead to improved task performance (Caniëls & Rietzschel, 2015; Haught-Tromp, 2017; Johnson & D'Lauro, 2018). Performance goals can provide an environmental condition for encouraging individuals to become competent, and goal-setting can satisfy this need (Latham & Locke, 2007).

The Latham and Locke (2007) model determined that the setting of explicit goals can facilitate task performance because they motivate people to exercise effort, encouraging to persist, guiding attitudes, and directing the behaviour of participants to focus on the task's outcome. Previous studies reported the limited effect on performance if only goal setting is applied within idea-generation (Larey & Paulus, 1995). However, Jung et al. (2010) found that goal-setting significantly increased the performance of the groups when feedback was provided, and explicit goals were set supporting Zhang's (2008b) theory, that individuals need to perceive and evaluate their performance in real-time towards a goal. However, a meta-analysis on the effects of performance and mastery of goals on intrinsic motivation from

Mekler et al. (2017) found that informational feedback alone improved intrinsic motivation for mastery of goals but left the performance goals unaffected.

3.4.1 Hypothesis 7:

- **H7**: Participants provided with explicit individual goals and real-time feedback will outperform groups provided with real-time feedback in task performance.

3.4.2 Hypothesis 8:

- **H8**: Individuals provided with explicit group goals and real-time feedback will outperform groups provided with real-time feedback in task performance.

3.4.3 Hypothesis 9:

- **H9**: Self-reported IM on task meaningfulness will positively predict task performance of individuals with a high perceived achievement satisfaction.

CHAPTER 4: RESEARCH METHODOLOGY

4.1. Choice of methodology

This research is aligned with the positivism philosophy since the method design for the existing growing body of theory development and empirical research on design for idea-generation is already rooted in this field. A quantitative deductive analysis was conducted through a two-step process to test the hypotheses set out in Chapter 3. Field experiments to pilot-test the design and questionnaires were used (Appendix A and B) and subsequently adjusted to refine the research instrument. Following this, the main field-laboratory experiments were performed to test the ecological validity of the dependent variable by manipulating the independent variable. The design for the EBS interface drew on the previously conducted experiments that focus on collaborative group environments (Johnson & D'Lauro, 2018; Jung et al., 2010; Michinov, 2012; Pissarra & Jesuino, 2005; Witt et al., 2011). An explanatory approach using a two-by-two fractional factual design was used to explain the relationship between the various variables (Saunders, Lewis, & Thornhill, 2016). The explanatory study allowed for some manipulation of the independent variable to test the relationship or effect thereof on the dependent variables.

According to Saunders et al. (2016), the following four components are essential for any successful experimental approach:

- Must be able to manipulate the independent variable.
- All other independent variables must be kept constant.
- Observe the effect a manipulation from an independent variable has or does not have on the dependent variable.
- The forecast of possible events that can take place during the experiment.

Four experimental factors were exposed to different conditions of design principles. These are individual real-time feedback; group real-time feedback; individual explicit goals and group explicit goals against a control group. These factors are graphically represented in Figure 5. To assess the creativity of these ideas, Amabile's consensual assessment technique (CAT) was used (Amabile et al., 1996). According to this technique, an idea is creative or novel when a panel of appropriate specialists autonomously agree that it is indeed creative (Amabile et al., 1996). The idea review panel evaluated the ideas generated to give a value to the creativity of these ideas based on the cross-sectional analysis (Piller & Walcher, 2006) in order to provide a measurement for the quality of the ideas generated.

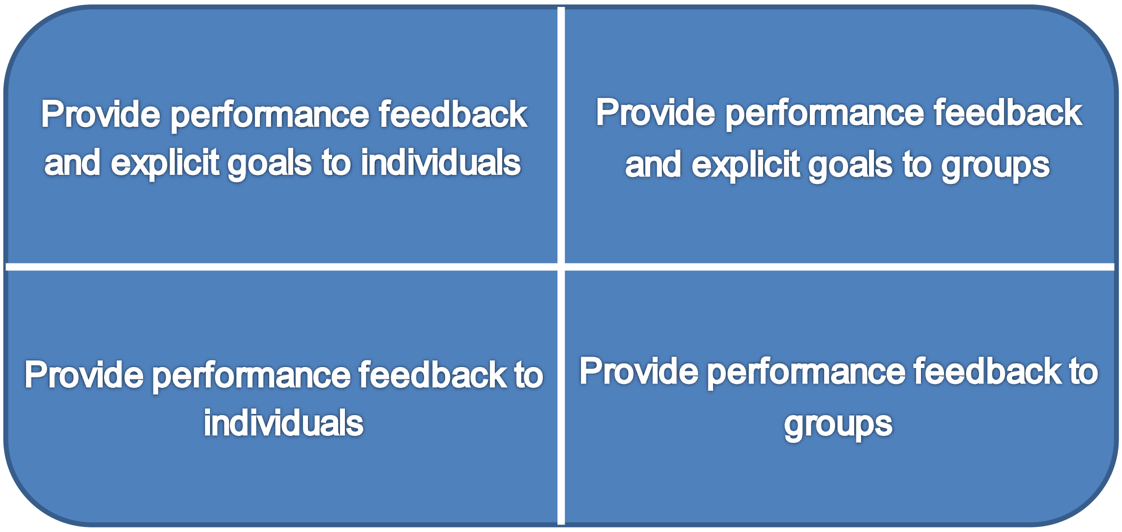

Figure 5. Two-by-two factorial designed matrix for the EBS experiment

The control group was deprived of feedback or explicit set goals during the idea-generation experiment. This provided the study with a baseline in order to determine how effective the manipulation of the independent variable was within the experiment, and for setting the benchmark for explicit goals. This was used to confirm the validity against similar studies previously conducted (Jung et al., 2010; Witt et al., 2011). In the second and third experiments, only real-time feedback was provided to individuals or groups without explicit goals. The fourth and fifth experiments provided both real-time feedback and a set of explicit goals. The main difference between these two experiments was to determine how the feedback would be provided. In the individual setting, participants were able to see their own performance relative to that of the group. In the group setting, the feedback was evident to each individual but not for the group as a whole, and this was compared against the competing groups within the field-laboratory experiment. These experimental conditions measured the effect on task performance of generating new ideas when applying real-time feedback and goal–setting principles within a collaborative group setting. (more detailed explanation in section 4.4.2). The quality of ideas was evaluated by subject matter experts to determine the creativity of the proposed idea per CAT as previously mentioned, and the moderator provided real-time performance feedback during the experimental sessions.

4.2. Population

The target population for this study consisted of individuals who currently use mobile applications and websites on a regular basis. One of the reasons for selecting this population is because these participants require access to the Internet. The EBS is modelled on an electronic chat room with interactive design systems and will necessitate computer- or application-adapted individuals. With regard to the unit of analysis for this study, users of social media applications and individuals who have an interest in generating ideas to solve problems were approached. A consent statement was presented before the start of each of the experiments (Appendix C-1). Participation in these experiments was voluntary, and all participants entering the experiments selected a nickname (Figure 6), which allowed for anonymity throughout the experiment.

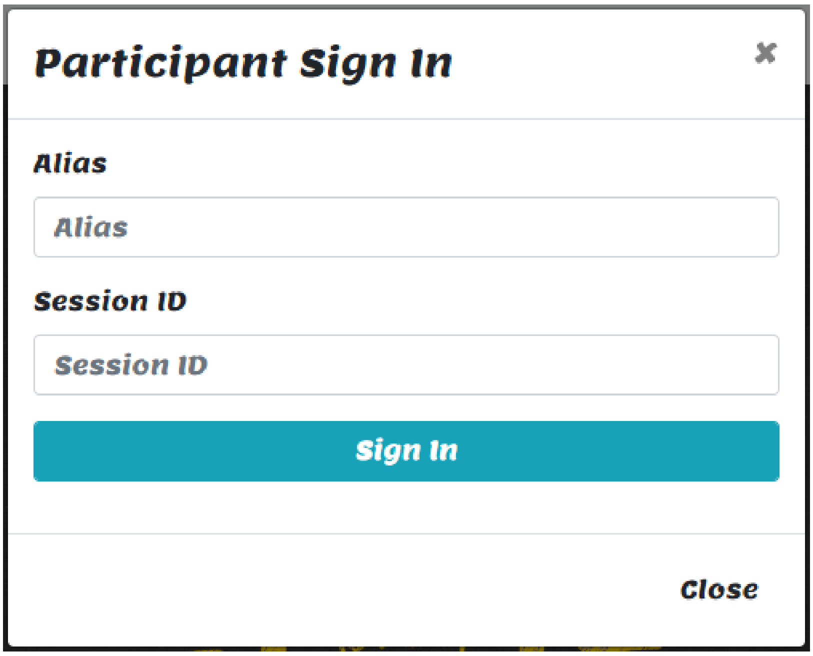

Figure 6. Participant login screen to ensure anonymity.

4.3. Sampling methods and size

Ideosign launched as a pilot project at a large manufacturing production facility in Q1 of 2019 in order to generate new ideas for improving employee engagement, as the idea- and concept-generation platform of the innovation management system. This study followed an experimental sampling method as the population of this study fell within the confines of a specific organisation (Saunders et al., 2016). The sampling was dependent on the problem area that required idea-generation and was context-specific to each environment.

For the pilot study, the local large manufacturing production facility was used to generate ideas on how the company's machine shop could become more competitive and quality orientated. The question compiled for the pilot study was shared as follows: "*Machine shop concessions are at an all-time high. How can this be resolved to make the organisation more competitive and quality orientated?".* Certain experimental parameters had to be taken into account. For instance, all four experiments, as well as the control condition, were conducted at the organisation's training facilities. The production manager, foundry manager and quality manager formed the basis of the committee, which evaluated the novelty and feasibility of the ideas that were generated during the pilot experiment. Before the start of each of the experiments, participants were informed that the group size would be set to five participants per experiment as per Gallupe et al. (1992); with a time allocation of 15 minutes as per Baruah and Paulus (2016) and the same brainstorming rules that Osborn (1957) applied in his research (Appendix C-2).

For the main field-laboratory experiments, post-graduate professional business students were invited via social media to participate and were randomly assigned to each of the five experiments. The question that was addressed revolved around the business simulation that the participants joined in during the course of their MBA studies. Two local instructors assessed the novelty and feasibility of the ideas that were generated. The following is the question posed to the participants of the main study: "*How can the business improve the service offering of the business simulation?*". The groups consisted of five participants per group, and a minimum of four groups per experimental condition in order to avoid the false positive (therefore 20 participants per experimental factor, with a total of 25 groups were required). Osborn (1957), brainstorming rules were shown to these participants as per previous studies in the field of EBS, as these rules promote standardisation and reduced variation within brainstorming (Al-Samarraie & Hurmuzan, 2018).

Participants were invited via a social media platform to partake and requested to log-in to one of five experiments, which took place during multiple contact sessions at the university. These participants were then randomly assigned to one of the five experiments. At the completion of the experiment, participants completed a demographic questionnaire (Appendix A) and a motivation research instrument questionnaire (Appendix B).

4.4. Experiment design and measurements

The EBS interface consisted of a web-based prototype that allowed participants to anonymously register and then interact with a text message chat site interface (Appendix D) in order to exchange ideas. The data from these interactions were stored on a MySQL server for processing once the experiments were completed. A single moderator was assigned to identify when ideas were generated within each of the five experimental conditions. This served a double purpose, as certain ideas that were put forward were highlighted through real-time feedback and points were allocated towards achieving the explicit goal.

4.4.1 Experiment variables

These experiments studied the causal links between the various variables, through a process of observing the change in the dependent variable when the independent variable was manipulated or changed (Saunders et al., 2016). Independent and dependent variables within this experiment were based on the hypotheses that were developed in Chapter 3. The independent variables that were identified within the experimental conditions were the following: No Feedback or Feedback – Individual or Group – No goal and Goal – Self-reported measure of motivation affordance – Self-reported measure of intrinsic motivation for task meaningfulness.

Each of these independent variables aimed to drive the outcome of the dependent variable related to task performance in the number and the quality of ideas that were generated. Liu et al. (2017) stated that intrinsic motivation towards personal accomplishment might be achieved when the design of the information system is aimed at satisfying user experience and engaging, in an attempt towards task mastery. An ICT system must be designed to enhance the number of incidents for the user to be optimally challenged and to offer timely positive informational feedback in order to aid users in achieving task mastery (Jung et al., 2010; Mekler et al., 2017; Sailer et al., 2017).

4.4.2 Detailed experiment measurement and design

The primary objective of the experiment was to collect and measure participants' task performance of generating ideas against the design principles that could affect motivation affordance and intrinsic motivation, as discussed in Chapter 2. Since the Jung et al. (2010) study laid the groundwork for this study, a decision was made to keep the design of the interface (Figure 7 and Figure 8) similar, in order to increase the precision of this study in comparison to other EBS studies (Baruah & Paulus, 2016; Michinov, 2012; Pissarra & Jesuino, 2005; Witt et al., 2011). In this instance, precision refers to how close repeated measurements that are using the same research instrument are to each other, and that ultimately leads to ecological validity.

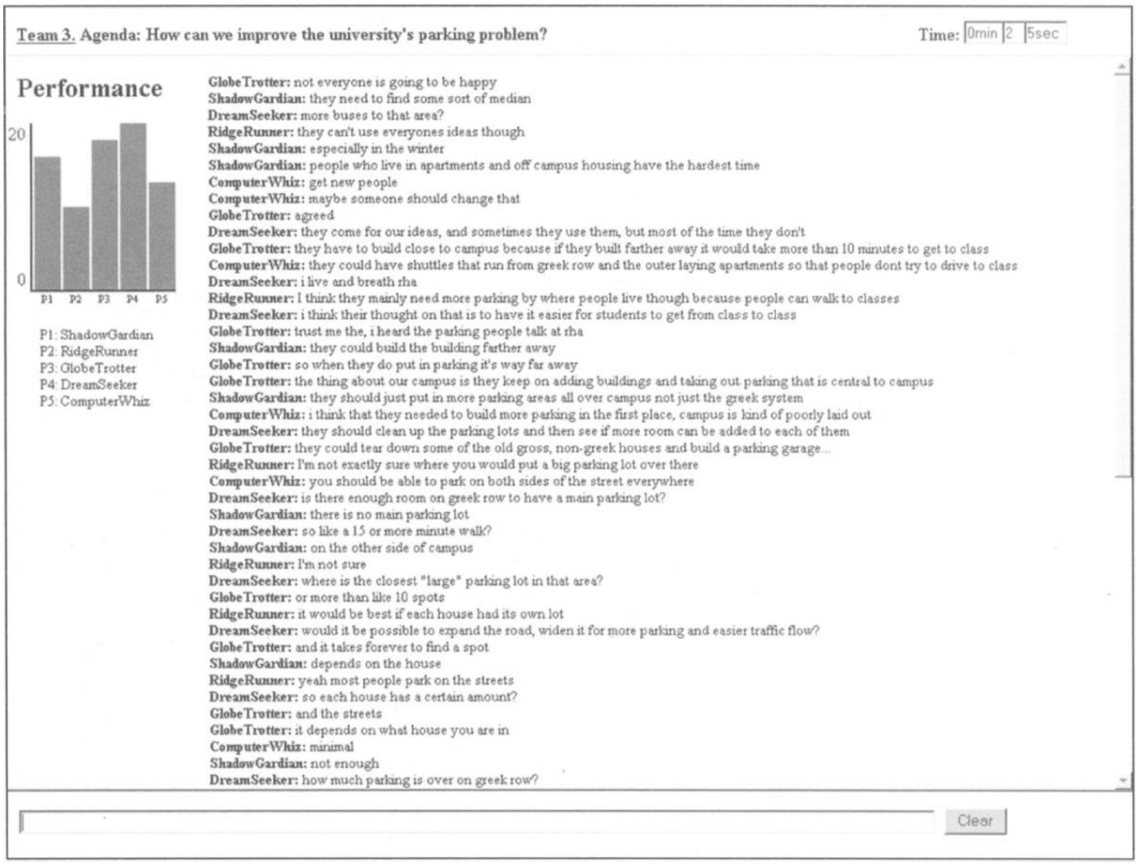

Figure 7. Jung et al. (2010) computer-mediated idea-generation interface.

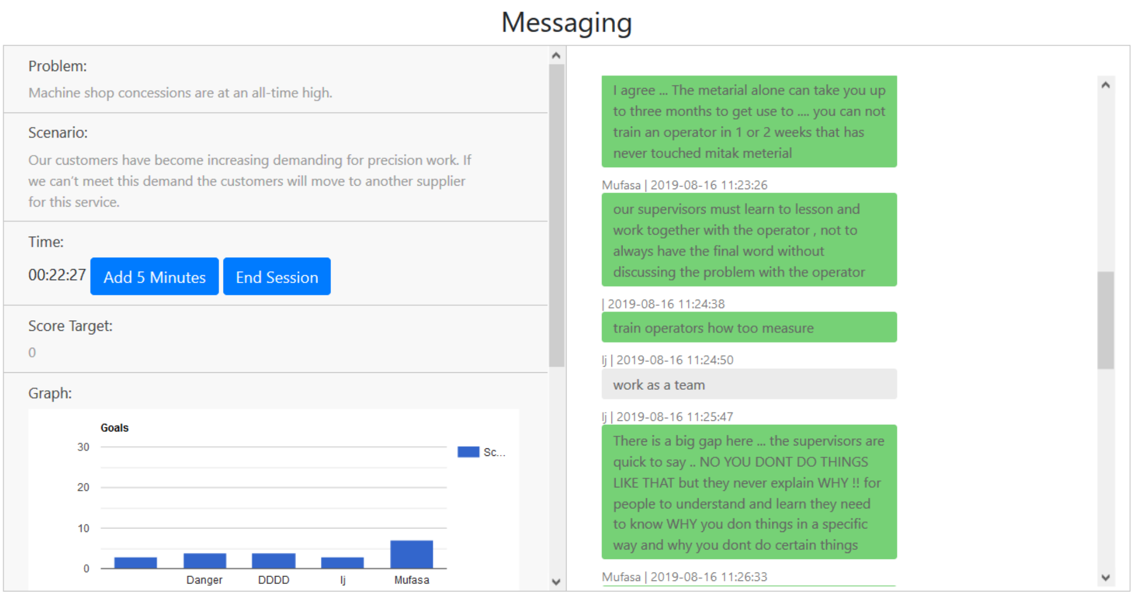

Figure 8. This studies computer-mediated interface (Appendix D-2).

The experiments took the form of an online EBS website, which allowed multiple participants to interact simultaneously (Appendix D-1). Four identical variations of the experiment were created. They differed only in the motivational affordances of real-time feedback, goal-setting compared with individual feedback and group feedback. The control condition had no feedback or explicit goals.

Individual feedback condition: the participants received one point for each idea that was generated and which the moderator assessed to be a valid idea. Participants were able to receive ongoing feedback, as the moderator actively identified the ideas that were deemed valid by highlighting those specific ideas in green (Appendix D-2). This real-time feedback was provided in a relatively short timeframe (less than ten seconds) and was visible to the participants. This method of providing feedback was explained to all the participants at the start of the experiments. Therefore the text lines that were not highlighted were deemed to be invalid ideas. This real-time feedback was consistent for all the other experimental conditions, with the control condition being the exception. A bar graph indicated the number of points for the ideas that each participant contributed within the given time frame.

Group feedback condition: the real-time feedback that was given to participants was still highlighted in green for each individual to view (Appendix D-3). The difference between this and the previous condition was represented in the bar graph. This graph illustrated the number of ideas that were generated by the group as a whole, and not that of the individual participant's number of valid ideas. The aim of this condition is to reduce the social comparison of individuals within a collaborative group environment by obscuring the individual’s cognitive social needs.

Individual feedback and goal-setting condition: the participants received the same feedback and points per validated idea, with each of the individual participants having their own goal, which was represented with a red line in the bar graph (Appendix D-4). This condition could be seen as a leader board incentive for social comparison (Larey & Paulus, 1995).

Group feedback and goal-setting condition: with this condition, the participants also received individual feedback by means of the green highlighted text to identify their ideas that were validated by the moderator. The main difference between this condition and the previous one was that the individual's position and scores were not presented in a bar graph. The group's validated ideas were grouped together, and an explicit goal was set for the group as indicated by the red line on the bar graph (Appendix D-5).

When it comes to the use of graphs in experimental conditions, Sailer et al. (2017) provided some insights as to why specific graphs are more challenging to read than others. Their recommendation is that the image sizes and bar-heights are kept constant to minimise variance.

4.5. Data collection tool

The data consisted of the input that was generated by each participant during the experiments and their respective online surveys. This data collection method was selected to minimise data collection errors through a process of standardising the questionnaires, which allowed each participant's contribution towards the generation of ideas to be assed directly against the independent variables.

4.5.1 Quality control

The following controls were placed on each participant to limit the external variables within the different experimental conditions:

- Each participant created an alias user ID (Figure 6) in order to join the lobby, where after participants were randomly allocated to one of the five experimental conditions.
- The groups consisted of a maximum of five participants per group.
- Participants could only proceed with the experiment after viewing Osborn's (1957) guidelines on effective brainstorming engagement (Appendix C-2) so that all participants understood what to do within the EBS system.
- Only 15 minutes were allocated to each participant to generate as many ideas as possible.

- Participants were redirected to a post-experimental survey (Appendix A and B) at the completion of their experiment for consistency purposes
- The goal for the individual condition was set to 10 ideas per participant, and the goal for the group setting was set to 40 ideas for a group of five participants which was set to 80% of total participants' idea goals.

4.5.2 Questionnaire design

An adaptation for the various measurements items in the motivation affordance and intrinsic motivation questionnaire was taken from validated and well-tested scales in the literature in order to refine the research instrument. In the self-administered questionnaire (Appendix A-2 and B-2), participants' perceived intrinsic motivation inventory (Deci & Ryan, 1985) was used to measure the IM of task meaningfulness. Support for the motivational affordances needs for autonomy (Ke & Zhang, 2010; Ryan & Deci, 2000), competence (Ryan & Deci, 2000; Zhao & Zhu, 2014), and achievement (Landers et al., 2017; Ryan & Deci, 2000) was modelled as influential constructs. The questionnaire was created by adjusting these scales from literature to make them relevant to the context of EBS activities and to measure the constructs in question. The use of one reverse-loaded question (Question 20) was to filter out respondents who made a random selection within the questionnaire.

4.5.3 Reliability of scale item

Reliability was tested by using the Cronbach (1951) alpha coefficient α, which is a standard measure of scale reliability. This Cronbach alpha coefficient is used to reduce the randomness and limited the impact of data splitting, through a process of creating correlation coefficients for every possible split in the data (Cronbach, 1951). Due to the variability of the psychological constructs being measured within these experiments, the α could be expected to be below .700 (Field, 2018).

4.5.4 Requirements for using conceptual assessment technique

Although the method is relatively simple, as previously mentioned in Chapter 2, there are four requirements that need to be fulfilled for an appropriate application of the CAT: These requirements incorporate accomplishing a task, jury members' experiences, independent assessment between jury members, and the utilisation of an inter reliability between jury members, which must be consistent.

Requirements for the accomplishment of a task: that leads to an outcome that can be considered creative should not depend on specialised abilities. The task should be open-ended, to incorporate flexibility in the responses from participants, and must allow a unique outcome that can be observed and differentiated by the jury.

Requirements for the jury members: should have some experience within the task and should be accustomed to the field. The jury can be considered as experts in the field. However, these experts are not required to have identical experiences and must be independent of their own favouritisms in the developed objects (such as ideas) that were assessed for creativity.

Requirements for the independent assessment: procedure entails that experts must assess each object independently from each other, with clear dimensions (within this study, novelty and feasibility were access for the pilot experiments and creativity was access for the main field experiment). Also, the experts must rate the objects relative to one another rather than against an absolute standard.

Requirements for the utilisation: is that each dimension has to be analysed for inter-judge reliability. According to Amabile (1982) this is essential, as the quality of assessment depends on the consensus of evaluations between the jury members. Previous studies suggest using the interclass correlation coefficient to measure the consensus between jury members with a Cronbach alpha above .700 that indicates the high quality of evaluations (Füller et al., 2009; Johnson & D'Lauro, 2018; Jung et al., 2010).

4.6. Data gathering process

The experimental idea-generation data per participant will be aggregated to an experimental conditional level. The total number of ideas highlighted and identified by moderators will constitute the number of verified ideas generated. The panel of subject experts will access all the highlighted ideas per CAT to provide a measure for the quality of the ideas generated. Directly after the time limit is reached, the participants will be re-directed to the demographic and self-administrated survey. The online webpage will capture all the required data and store all relevant data within the MySQL database.

4.7. Data analysis approach

To determine the effect of each of the cognitive design MA constructs on task-performance and intrinsic motivation, the following statistical analysis will be performed on both the pilot and main field experiments:

- Bias and assumptions - test for normality
- Descriptive statistics of demographic questionnaire
- Principle component analysis (PCA) of self-administrated survey
- Correlation (Spearman's correlation coefficient)
- Multivariate analysis of variance (MANOVA)
- Cohen's effect size
- Multiple regression

4.7.1 Test for normality

Requirements for parametric statistical methods (such as the linear regression, correlation and analysis of variance) are that the dependant variable is approximately normally distributed for each category of the independent variable (Field, 2018). For data obtained from both the pilot and main field, experiments were tested for normality using Kolmogorov-Smirnov or/and Shapiro-Wilk tests. If the sigma value exceeds ($p > .050$), then the data can be stated to have non-significance outliners and is approximately normally distributed (Field, 2018), and therefore parametric analytical methods can be used for further statistical analysis.

4.7.2 Descriptive statistics

Descriptive statistics were done to summarise the diversity of the sample population and to determine if the sample is representative of the broader population. These results were summarised into the following categories: age, gender, level of prior education and prior experience in brainstorming activities. A comparison between the pilot and main field experiment will be made to highlight the difference between the two samples. The question with regard to the frequency of brainstorming activities was done to determine if the population that was tested is normally distributed in their experience of brainstorming sessions.

4.7.3 Principle component analysis (PCA)

The majority of psychological questions in the questionnaires measured similar constructs, and this is the reason why a factor analysis was required for this study. The objective of the analysis was to reduce the number of dimensions (factors or components) (Field, 2018) that load on each construct. Reducing the number of dimensions within the questionnaires provides the data sample with higher reliability and validity. The dimensions for each of the constructs were then combined to achieve a single value for motivational affordance and intrinsic motivation. The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) index has to be above .500 for psychological constructs to be adequate for PCA, and Bartlett’s test of sphericity (BTS) sigma value has to be below .050 to show that the items in the questionnaire do correlate significantly. Both conditions are required to ensure that factor analysis is an appropriate tool to reduce the number of dimensions per construct (Field, 2018).

4.7.4 Correlation

Correlation analysis was used to measure the strength of association or relationship between two variables. Spearman's correlation coefficient was used in this study for the PCA correlation matrix because it does not rely on the assumption for parametric testing and the items in the questionnaire were all ordinal (Field, 2018), as where the regression correlation was performed with a Pearson's correlation. The relationships between the variables correlation coefficients can be ranked with the following effects: ± .100 indicates a small effect, ± .300 a medium effect, and ± .500 a significant effect (Cohen, 1992; Field, 2018). This analysis was performed to assess the relations of the individual components of the research instrument.

4.7.5 Multivariate analysis of variance (MANOVA)

Some of the hypotheses require the comparison for the means of groups of entities with multiple outcomes within the datasets. MANOVA will be used to determine the interaction between the dependent variables of idea quantity and idea quality with the experimental conditions of performance feedback and goal-setting. A factorial MANOVA is part of the group of tests which extends the analysis of variance to situations in which more than one outcome variable can be measured (Field, 2018). The MANOVA is a standard test for a variance that is performed to determine the effect of the manipulations within the experimental conditions where there are more than two outcomes that require assessment (Baruah & Paulus, 2016; Gallupe et al., 1992; Jung et al., 2010).

4.7.6 Effect size calculation

In order to determine the magnitude of the relationship between the variables, Cohen's d was done. Cohen's d invokes a standard deviation estimate which averages the outcome variable from the sample standard deviations across both the control group and the experimental condition (Cohen, 1988, 1992). This analysis is regularly used in determining the effect size or the strength of the relationship within the social science field, where the perspective of their power is defined in small, medium and large correlation effect sizes (Field, 2018).

It can be expressed as:

$$d = \frac{(M_e - M_c)}{\sqrt{(SD_e^2 + SD_c^2)/2}}$$

M_e is the post-test sample mean for an experimental group,

M_c is the post-test sample mean for the control group,

SD_e^2 indicates the standard deviation for an outcome for an experimental condition,

SD_c^2 indicates the standard deviation for an outcome for the control group condition.

4.7.7 Regression analysis

Multiple regression was conducted in an attempt to explain the relationship between multiple independent or predictor variables and one dependent or criterion variable. The multiple linear regression analysis aims to shed light on the causal analysis, forecasting an effect, and trend forecasting (Field, 2018). The coefficient (β) was used to determine the power of the relationships between variables. Where β could range from a negative one to a positive one, and the absolute value of one indicating a significant relationship (Field, 2018).

4.8. Limitations

The lack of random assignment potentially results in non-equivalent groups, such as one group possessing a greater mastery of specific content when compared to the other group (Saunders et al., 2016), which could introduce a possible selection bias. It should be noted that Dennis et al. (2019) conducted a laboratory experiment and field-experiments with professional business student participants and members of a local chamber of commerce. Their finding was that both groups' results were identical. However, it could be argued that the pilot experiment's questionnaire would differ between the sample groups because of the factor analysis and population characteristics, e.g. spread of professional business students versus professionals in a particular industry with a vastly different idea-generation challenge could affect the ecological validity of the results. This limitation will form part of the study, forming an assumption that both the pilot study and the main field-laboratory study is comparable even within vastly different environmental contexts.

Due to the use of moderators to assess the quality of ideas, some moderator bias is introduced and will form part of this study. Using a single moderator for validating the ideas during the course of experiments kept the variability of identifying ideas constant between the experimental conditions. However, this can be seen as limitation within the field of idea-generation research (Baruah & Paulus, 2016; Jung et al., 2010), as moderators who assess the validated and quality of the ideas generated within EBS experiments vary greatly in terms of expertise. Another limitation of this study is that different age groups may have an impact on how effectively the design for motivational affordance is perceived by participants (Kappen, Mirza-Babaei, & Nacke, 2017). Environment and the characteristics of participants are critical determinants in interactive brainstorming sessions, and greatly influence user engagement and the overall success of brainstorming initiatives (Al-Samarraie & Hurmuzan, 2018). These effects from the environment and user characteristics will have an impact on users' intrinsic motivation, but will not form part of this study and will be considered to be static throughout all the experiments.

CHAPTER 5: RESULTS

5.1. Introduction

Using the method of experimental prototyping and reverse engineering the EBS software designed by Jung et al. (2010), an EBS web-page named Ideosign.co.za was developed with specific design principles and used to evaluate the various hypotheses presented in Chapter 3. This chapter aims to present the quantitative results from the EBS for the pilot, and the main experiment laid out in Chapter 4. The minimum sample per experiment (20) was required (Simmons, Nelson, & Simonsohn, 2011) to control for the false negatives and to be statistically viable for analyses. This was not achieved due to an insufficient number of usable online questionnaires. However, some test variants have better type I and type II error properties than others, and for most meta-analyses where there are a limited number of studies, the power of these tests are low but can still indicate a significance (Ioannidis, Munafò, Fusar-Poli, Nosek, & David, 2014). The power effects of the experiments are mitigated to a degree due to the specific selection of participants with subject expertise on the problem statement to both the pilot and the main experiments.

Alterations made to the main experiment due to the findings in the pilot study include the following;

- Deleted questions 1,3,6,8 and10 from the main questionnaire survey.
- Changed the coding of the questionnaire not to allow partial completion.
- Instructing participants to use only a laptop or tablet for the main experiment, as the cellphone application did not show the bar graph manipulator.
- Shortening the time allocation for the experiment from 15 minutes in the pilot study to 10 minutes in the main field experiment, due to participants' time constraints and limited idea-generation in the last five minutes of the pilot study.

- Goal-setting for the experiment was set to 10 ideas per individual and 40 ideas for the group setting within the pilot study. This was changed to 15 ideas per individual and 60 ideas per group in the main field experiment, as this target was reached by most of the participants in the pilot study.

5.2. Test for normality

The prerequisite of interval scaling was ensured in the formulation of questions (Appendix A), fulfilling the requirements for parametric statistical methods (such as the linear regression, correlation and analysis of variance) that the dependant variable is approximately normally distributed for each category of the independent variable (Field, 2018). A test for normality for both the pilot and main experiments were tested using the Shapiro-Wilks tests with a 95% confidence interval means. The dependent variable selected was the feedback of quantity verified ideas generated during the experiments and the independent variable of experimental condition.

The following hypothesis was established for normality:

- H_0 – Observed dataset is approximately normally distributed ($p > .050$)
- H_a – Observed dataset is not approximately normally distributed ($p \leq .050$)

5.2.1 Pilot experiments data

A Shapiro-Wilk test ($p > .050$) indicated interval data for the feedback of quantity verified ideas and the motivation affordance (MA) / intrinsic motivation (IM) constructs (Appendix E-1) were approximately normally distributed for all the experimental conditions and constructs, with a skewness and kurtosis z-value between -1.96 and +1.96 for all the experimental conditions (Cramer & Howitt, 2004). Therefore the H_0 was not rejected as the results were not significant.

5.2.2 Main experiments data

A Shapiro-Wilk test ($p > .050$) indicated the idea quantity and quality were approximately normally distributed for all the experimental conditions and that the primary constructs (Appendix E-2), skewness and kurtosis z-value were between -1.96 and +1.96 for all the experimental conditions (Cramer & Howitt, 2004) and that there were no significant outliners within the dataset. Therefore the H_0 was not rejected as the results were not significant.

5.3. Data transformation

Before analysis of the pilot and main experiments, the data were filtered and assessed for usability according to the following criteria:

- Unique answer_ID to ensure there were no duplicates of ideas in the data. In some cases, the submission of ideas within the message board was duplicated due to a delayed response from the online system.
- Questionnaires were discarded in cases where participants had answered all the questions by allocating the same mark across multiple constructs, and especially when failing the reverse question. In the case of both experiments, this was evident as the participants had already spent 10+ minutes on generating ideas and were thereafter expected to complete the questionnaire. The pilot experiment questionnaire design was adjusted halfway through the process to ensure participants completed all the questions before they could submit the survey. For the main experiment, this effect was aggravated due to time constraints - being done in many cases after a full day of class or during lunch breaks. A total of 26 participants were removed from the pilot study because they failed to complete the questionnaire and / or failed the reverse question. For the main experiment, a total of 24 participants were dismissed for failing the reverse question and / or repeating the same scores across multiple items.

The data was coded in SPSS to create a unique identifier per experimental condition to be used as the independent variable. Each question and individual constructs were coded to be used as dependent ordinal variables. The participants' number of messages (Quantity_H0), number of verified ideas (Quantity_H1) and quality of ideas assessed per assessor (Quality_Ass*) were left in numeric values. Identified ideas evaluated with CAT is high and consequently reliable when there is a high consensus between the individual ideas assessed per assessor (Amabile et al., 1996). The consistency for the quality of ideas was confirmed by the inter-reliability (Cronbach's α) value between assessors. The Cronbach value indicates a high degree of consensus when values are above .700 for experimental conditions (Field, 2018). The results were as follows:

- Pilot study; each assessor evaluated all 254 ideas, based on novelty (α = .802) and feasibility (α = .742), indicating that the assessor ratings were highly consistent between different ideas. The mean of the two ratings were (α = .854) used as an index value for the total quality of ideas. (See Appendix E-3).

- Main study; each assessor evaluated all 463 ideas, based on creativity (α = .865); a high interrater correlation indicates that the assessor ratings were highly consistent. This one measurement was selected due to the high number of ideas that required accessing and still falls within the requirements for CAT (Amabile et al., 1996). The index value for the total quality of ideas was based on the total points allocated per participant. (See Appendix E-4).

5.4. Sample descriptive statistics

Both the pilot and main experiments consisted of five experiments with a minimum of three sessions per experiment, involving a maximum of five participants per session. After the participants had completed the brainstorming activity, they were directed to two online surveys. A total number of 49 usable responses were obtained for the pilot study and 51 for the main experiment, as depicted in Figure 9 and Figure 10, respectively. Almost 130 participants for the EBS were asked to participate in the pilot experiments at the local large manufacturing production facility. From these, only 75 participated in the experimental sessions, and 49 of those questionnaires could be used for the analysis. Figure 9's blue bars graphs represent 37.7% of the total participants of the EBS pilot experiment that could have contributed. Feedback from those who declined to participate highlighted some concerns about negative repercussions of participation, even when full anonymity was provided.

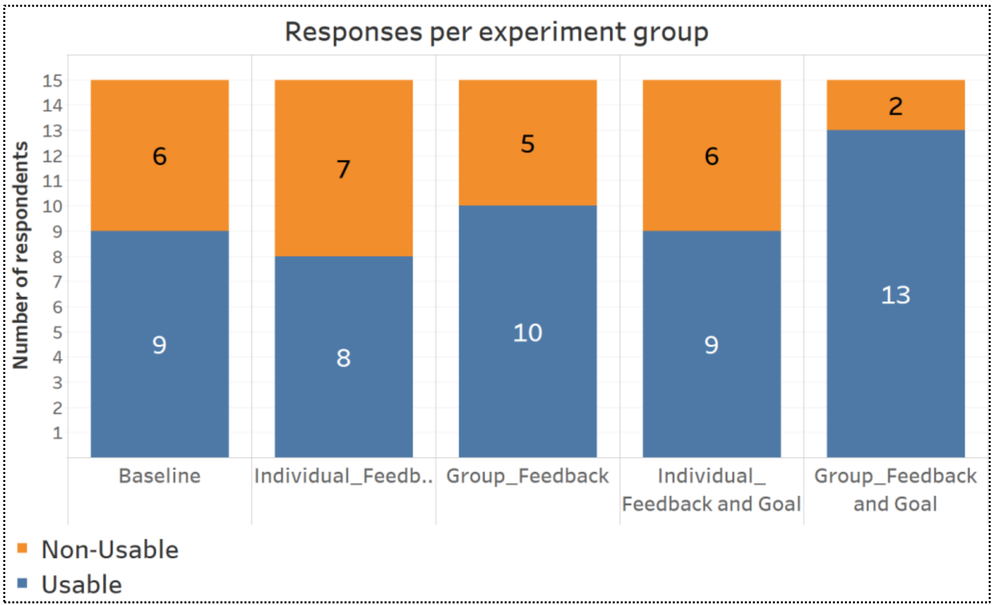

Figure 9. Pilot experiment respondents.

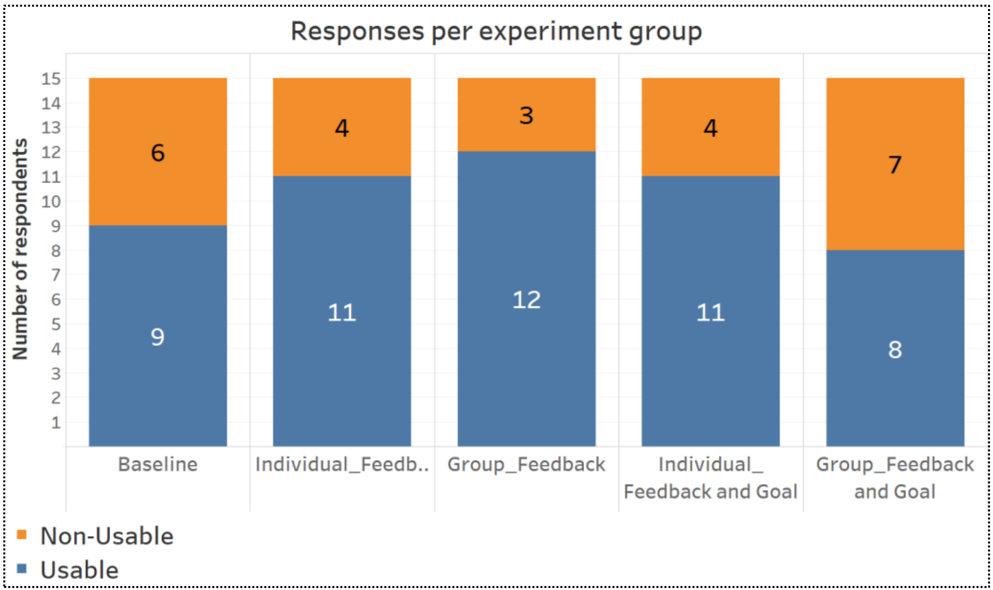

Figure 10. Main experiment respondents.

5.4.1 Pilot experiments demographics

The demographics for the pilot experiment were presented in Figure 11 (Age distribution), Figure 12 (Gender distribution), and Figure 13 (Education distribution). Participants were redirected to the demographic questionnaire directly after the time limit of the experiment was reached. The majority of participants for the pilot experiment (Appendix E-5) were male (84%), aged 35-44 (35%), with a certificate (39%). While the gender distribution for the pilot experiment may not be representative of the total population, the results are in line with the 2018 South African national employment averages for gender in large manufacturing facilities (Statistics SA, 2018).

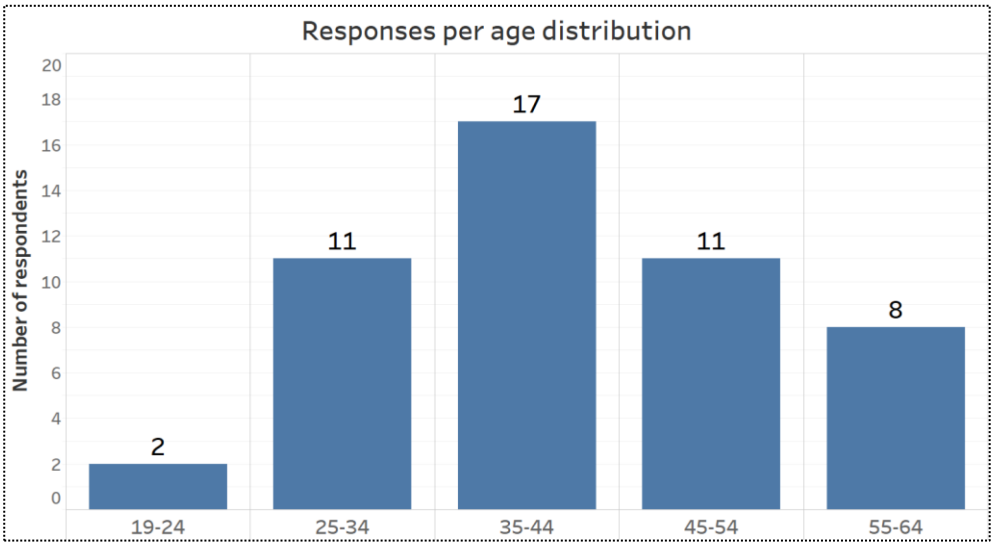

Figure 11. Pilot respondents – age distribution.

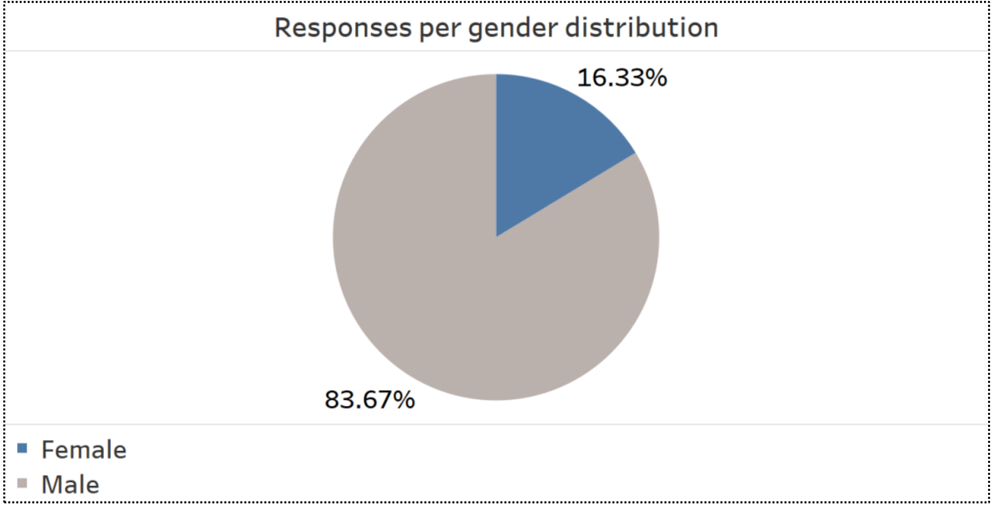

Figure 12. Pilot respondents – gender distribution.

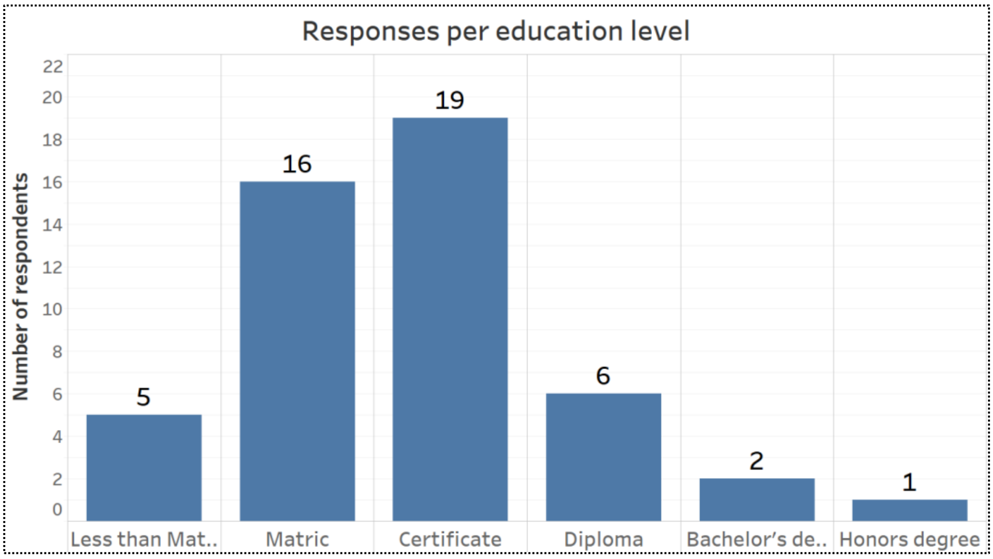

Figure 13. Pilot respondents – education levels.

5.4.2 Main experiment demographics

The demographics for the main field experiment was presented in Figure 14 (Age distribution), Figure 15 (Gender distribution), and Figure 16 (Education distribution). Participants were redirected (as in the pilot study) to the demographic questionnaire directly after the time limit of the experiment was reached. The majority of participants for the main experiment (Appendix E-6) were male (78%), between the age of 35-44 (51%), with an honours degree (67%).

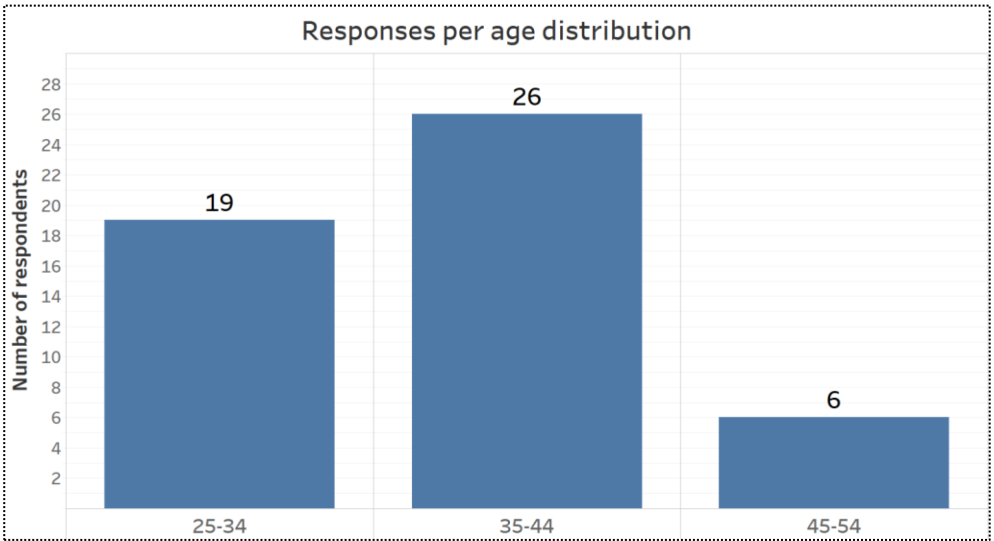

Figure 14. Main experiments – respondents' age distribution.

While the gender distribution for the main experiment is not representative of the total student population of the group, the sample selection method was biased due to course selection of participants. Before any further analysis was conducted, the data were tested for age and gender effects, but these variables made no significant differences.

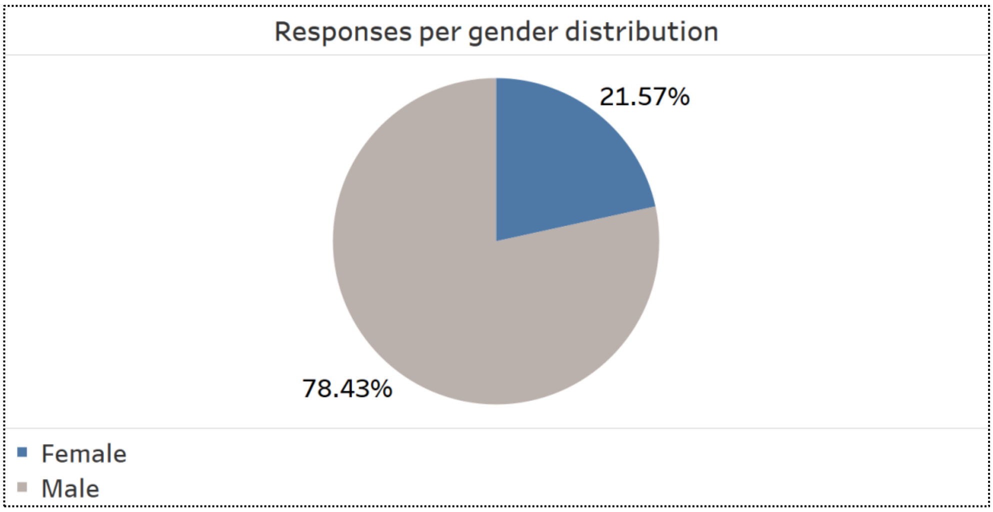

Figure 15. Main experiments – respondents' gender distribution**.**

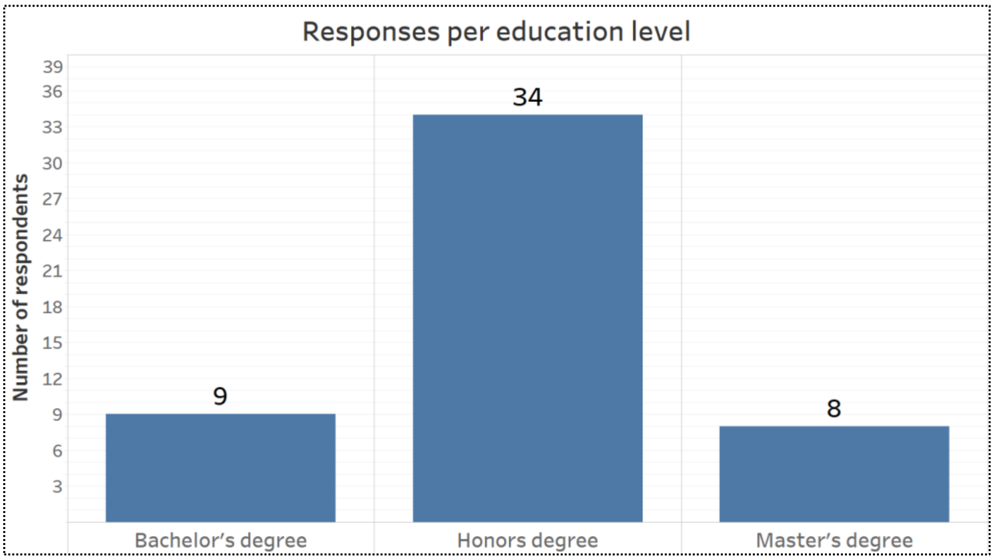

Figure 16. Main experiments – respondents' education levels.

5.4.3 Pilot experiment's exposure to brainstorming

For the pilot experiment, the self-reporting frequency of participation in brainstorming activities can be seen in Figure 17. This was included to ensure that participants with various levels of brainstorming exposure were included in the experiments.

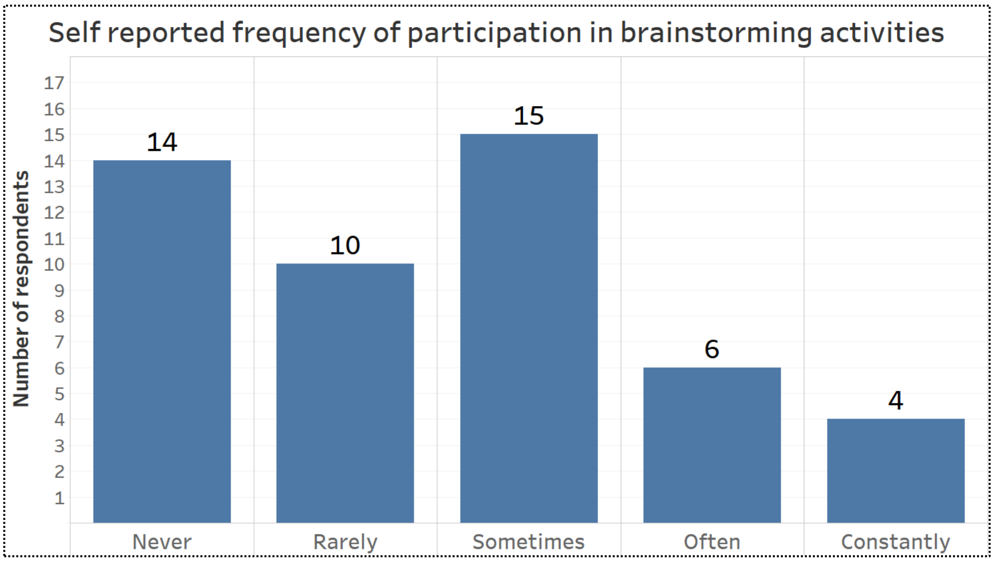

Figure 17. Pilot respondents' frequency of brainstorming activities.

5.4.4 Main experiment's exposure to brainstorming

For the main experiment, the self-reporting frequency of participation in brainstorming can be seen in Figure 18. This was higher and more evenly distributed than the pilot experiment's results.

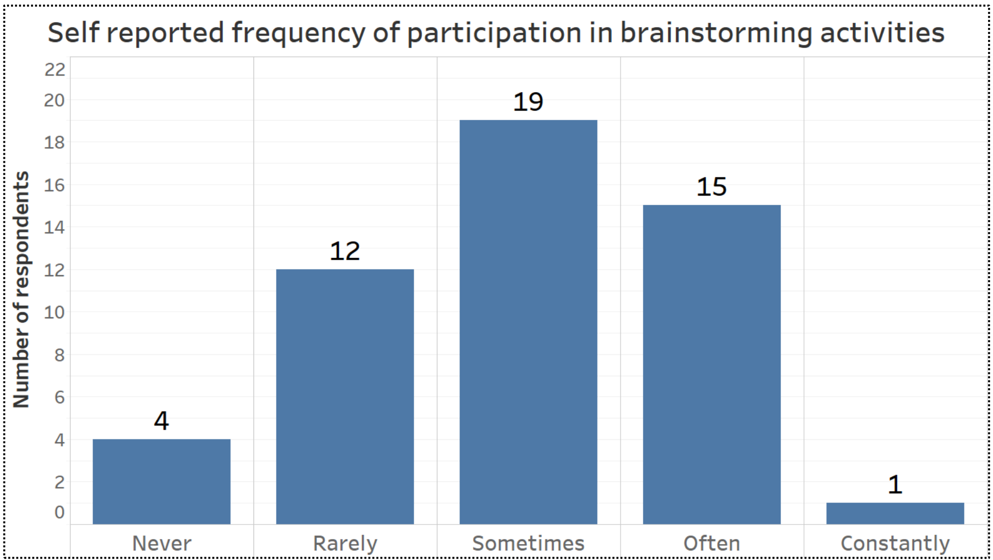

Figure 18. Main experiments respondents' frequency of brainstorming activities.

5.5. Factor analysis, validity, scale reliability and refinement

5.5.1 Linear components of the research instrument

After completing the demographic list of questions, participants had to rank 20 individual components. Each of the four constructs was tested by conducting principal components analysis (PCA), with orthogonal rotation (assumption is that the factors are independent of each other) method of varimax to reduce the number of components per construct. The KMO test of sampling adequacy provided a .844, which was above the recommended .500 and fell in-between the range of marvellous and middling, indicating the sample size was adequate to continue with PCA (Field, 2018). BTS in Table X recorded a significance of .000 ($p \leq .050$), confirming that PCA was an appropriate method for analysis (Field, 2018).

Table 1. Pilot experiments KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.844**
Bartlett's Test of Sphericity	Approx. Chi-Square	610.109
	df	190
	Sig.	.000

The PCA total variance explained table (Appendix E-7), indicated there were two points of inflexion at both three and five factors; the recommendation for Kaiser's criterion is that all components with an eigenvalue more significant than one must be retained (Field, 2018). The first four components all had values above one, where component 1 accounted for 47.09% of the variance, component 2 for 7.68%, component 3 for 6.52% and component 4 for 6.07%. These four components explain 67.35% of the total variance for the sample.

To determine which variable loaded highest on each of the four components, a rotated component matrix was done (Table 2). The most significant factor loading was bolded and enlarged to demonstrate which of the questions loaded to each of the four components. Coefficients below .300 were suppressed to reduce the amount of noise within the table. The reverse scale question was represented with negative values, as shown by QU_20.

Table 2. Pilot experiments rotated component matrix[a].

	Component			
	MA – Autonomy	MA – Competence	MA – Achievement	IM – Task Meaning
QU_01: I can pretty much be myself when working in an electronic brainstorming activity.		.322	**.693**	.342
QU_02: I had pretty much freedom to do what I wanted on this brainstorming activity.		**.688**		
QU_03: I had a lot of opportunities for independent thought and action.				**.609**
QU_04: This brainstorming activity afforded me the opportunity to use my own initiative/judgement.	**.726**	.321	.315	
QU_05: I was deeply immersed in the brainstorming activity.	**.687**	.369		
QU_06: I felt very competent when participating in this brainstorming activity.	.478		**.579**	.312
QU_07: I often feel confident when using brainstorming activities to solve problems.	**.526**		.451	
QU_08: I get many chances to show my talents in brainstorming activities.	.373	**.616**		
QU_09: After working at this task, I started feeling competent.		**.692**		
QU_10: The feedback received during the activity, made me feel more competent.	.364		**.593**	
QU_11: I gave my best effort in this brainstorming activity in order to achieve the objective.	.401		**.653**	
QU_12: I gave my best hoping other participants would acknowledge my solutions and ideas.	.319		**.693**	.334
QU_13: I gained a sense of accomplishment from this brainstorming activity.	.314	**.594**	.485	
QU_14: I tried to be the best or better than other participants in this brainstorming activity.			**.784**	
QU_15: The felt the goal that was set could easily be achieved and provided a sense of satisfaction.	.537		**.631**	
QU_16: I found this brainstorming activity important and motivating in itself.	.473			**.602**
QU_17: This brainstorming activity was meaningful.	.401			**.705**
QU_18: I put a lot of effort into this brainstorming activity.	.311		.501	**.593**
QU_19: The goal that was set during the brainstorming activity forced me to exert myself.	.373		**.720**	
QU_20: I didn't put in a lot of effort into this brainstorming activity. (R)		-.323		**-.798**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 24 iterations.

From the rotated component matrix (Table 2), Table 3 was created to compare the original construct questions with the variables that loaded on specific constructs during the PCA. Table 3 demonstrates that the measurable items were well suited in measuring the intended fundamental constructs. Nine of the 20 questions loaded with constructs differing from what was expected, with at least two of the original questions loading on the designed theoretical construct.

Table 3. Construct questions and reloading of questions.

Construct	Original questions	Loaded questions
1. MA - Autonomy	1, 2, 3, 4, 5	4, 5, **7**
2. MA - Competence	6, 7, 8, 9, 10	**2**, 8, 9, **13,**
3. MA - Achievement	11, 12, 13, 14, 15	**1, 6, 10**, 11, 12, 14, 15, **19**
4. IM – Task Meaning	16, 17, 18, 19, 20	**3**, 16, 17, 18, 20(R)

(R) – Reverse-scale questions

MA – Autonomy: This construct lost three of the original questions, showing that what was measured is too closely correlated to the existing constructs, and not sufficiently diverse between the dormant constructs.

MA – Competence: Two of the original questions loaded directly to MA - Achievement, which also supports the close relationship between the Achievement construct (Mekler et al., 2017; Zhang, 2008b). Question 10, “The feedback received during the activity, made me feel more competent.” could be perceived as invalid because the feedback was received during the experiment but not by the control group.

MA – Achievement: The majority of the original questions loaded to this construct, with an additional four variables loading to the Achievement construct. Some of the re-loaded variables were directed to questioning motivational affordance - Autonomy “I can pretty much be myself when working in an electronic brainstorming activity” loading to achievement. Question 19 loaded strongly on MA – Achievement, which indicated a close relationship between the constructs.

IM – Task Meaningfulness: This construct lost two of the variables to Achievement and Autonomy, but gained question 3, "I had a lot of opportunities for independent thought and action." which did not express the intended primary construct.

For the enhancement of the main experiment survey instrument, the following individual measurement items were removed: questions 1, 3, 6 and 10 due to over-analysis of the same construct and not measuring the dormant construct. Each construct must contain a minimum of two variables to fulfil the requirements for explanatory factor analysis and three variables for confirmatory factor analysis (Field, 2018). Table 3 was accordingly adjusted to Table 4, which was used for the main experiment survey instrument.

Table 4. Construct questions and reloading of questions.

Construct	Adjusted questions
1. MA - Autonomy	4, 5, 7,
2. MA - Competence	2, 8 (Removed), 9, 13
3. MA - Achievement	11, 12, 14, 15, 19
4. IM – Task Meaning	16, 17, 18, 20(R)

(R) – Reverse-scale questions

A total of four questions were removed from the original instrument. Field (2018) recommends that when any one of the variables are removed, the factor analysis has to be reassessed to ensure the variables still load correctly to each factor. After initially repeating the analysis question, question 8 again shifted from one construct to another. As there were already three variables measuring the competence construct, a decision was taken to remove the question and repeat the analysis.

The KMO test of sampling adequacy provided an .849, which was still well above the recommended .500 and fell in-between the range of marvellous and middling (Field, 2018). A significance of .000 (p ≤ .050) was obtained with the BTS in Table 5, which indicated that PCA was still an appropriate method for analysis (Field, 2018).

Table 5. Pilot experiments adjusted KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.849**
Bartlett's Test of Sphericity	Approx. Chi-Square	417.365
	df	105
	Sig.	.000

With the repeat of the adjusted PCA, each of the factors loaded relatively high to their respective components (Table 6), which confirmed the factor structure.

Table 6. Pilot experiments adjusted rotated component matrix[a].

	Component			
	MA – Autonomy	MA – Competence	MA – Achievement	IM – Task Meaning
QU_04: This brainstorming activity afforded me the opportunity to use my own initiative/judgement.	**0.617**		0.474	0.369
QU_05: I was deeply immersed in the brainstorming activity.	**0.824**			
QU_07: I often feel confident when using brainstorming activities to solve problems.	**0.626**		0.482	0.332
QU_02: I had pretty much freedom to do what I wanted on this brainstorming activity.		**0.723**		
QU_09: After working at this task, I started feeling competent.	0.553	**0.663**		
QU_13: I gained a sense of accomplishment from this brainstorming activity.	0.358	**0.592**	0.484	
QU_11: I gave my best effort in this brainstorming activity in order to achieve the objective.		0.314	**0.669**	
QU_12: I gave my best hoping other participants would acknowledge my solutions and ideas.			**0.685**	0.354
QU_14: I tried to be the best or better than other participants in this brainstorming activity.		0.572	**0.643**	
QU_15: The felt the goal that was set could easily be achieved and provided me with a sense of satisfaction.			**0.771**	
QU_19: The goal that was set during the brainstorming activity forced me to exert myself.	0.354		**0.742**	
QU_16: I found this brainstorming activity important and motivating in itself.	0.386			**0.752**
QU_17: This brainstorming activity was meaningful.			0.549	**0.691**
QU_18: I put a lot of effort into this brainstorming activity.		0.426	0.497	**0.553**
QU_20: I didn't put in a lot of effort into this brainstorming activity. (R)		-0.466		**-0.728**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 12 iterations.

5.5.2 Validity testing of the research instrument

Due to the small sample size and the survey data being ordinal, a bivariate nonparametric Spearman's correlation analysis was performed on the dataset to determine the degree of content relationship between the individual variables' measurement items. The required assumptions for the Spearman's correlation of ordinal scale data and that a monotonic relationship between the variables exists were both obtained. The results of correlation (Table 7) indicate that the two-tailed correlation effect among the items represented in the green text was strong between questions and statistically significant at a .010 level. These results indicated that the probability of getting a correlation coefficient between the constructs is relatively high.

Table 7. Pilot experiments – Spearman's correlation matrix.

N=49	QU_04	QU_05	QU_07	QU_02	QU_09	QU_13	QU_11	QU_12	QU_14	QU_19	QU_15	QU_16	QU_17	QU_18	QU_20
QU_04	1														
QU_05	.597**	1													
QU_07	.535**	.312*	1												
QU_02	.418**	.232	.366**	1											
QU_09	.580**	.543**	.440**	.420**	1										
QU_13	.574**	.403**	.503**	.483**	.711**	1									
QU_11	.589**	.308*	.559**	.459**	.437**	.553**	1								
QU_12	.436**	.287*	.546**	.456**	.384**	.558**	.486**	1							
QU_14	.381**	.222	.422**	.444**	.426**	.571**	.486**	.394**	1						
QU_19	.499**	.415**	.467**	.120	.394**	.488**	.472**	.424**	.565**	1					
QU_15	.489**	.241	.393**	.194	.280	.489**	.547**	.501**	.449**	.425**	1				
QU_16	.502**	.395**	.465**	.222	.459**	.564**	.308*	.550**	.208	.233	.365**	1			
QU_17	.553**	.357*	.501**	.409**	.408**	.506**	.496**	.702**	.368**	.381**	.564**	.758**	1		
QU_18	.516**	.291*	.549**	.515**	.539**	.607**	.476**	.595**	.496**	.325*	.448**	.459**	.598**	1	
QU_20	.407**	.254	.216	.397**	.448**	.311*	.282	.346*	.249	.037	.106	.386**	.363*	.539**	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Most of the correlation coefficients were +/-.500, indicating that the effect of the relationship was moderate to large (Field, 2018). The items highlighted in orange did not have a significant correlation, and the items highlighted in blue correlated to .050 significance. Question 5 had a medium correlation to most of the other variables with some values not being significant, and question 20 (being a reverse question) had a negative correlation to all the other variables and the broadest portion of insignificant correlation.

5.5.3 Scale reliability of the research instrument

Separate reliability analyses for each distinct constructs were tested using the scale inter-reliability of questions on the factor loaded constructs: These results are presented in Appendix E-7 and this analysis must have a value higher than .600 to be considered inter reliable for psychological construct (Field, 2018).

MA – Autonomy:

The autonomy construct had a Cronbach's Alpha of .776, illustrating that this scale is reliable, and well above the .600 requirement.

MA – Competence:

The competence construct had a Cronbach's Alpha of .770, illustrating that this scale is reliable, and well above the .600 requirement.

MA – Achievement:

The achievement construct had a Cronbach's Alpha of .853, illustrating that this scale is very reliable, and well above the .600 requirement.

IM – Task Meaningfulness:

The intrinsic motivation - task meaningfulness construct had a Cronbach's Alpha of .820, illustrating that this scale is very reliable, and well above the .600 requirement.

5.5.4 The re-test of the research instrument for the main experiment

The re-test of the research instrument was performed to ensure that the validity and scale of the reduced questionnaire still loaded correctly to each component. Principal components analysis (PCA), with an orthogonal rotation method of varimax, was performed. The KMO test of sampling adequacy provided a .794, which was still above the recommended .500 and fell in-between the range of marvellous and middling, indicating that the sample size for the main experiment was adequate to continue with PCA (Field, 2018). BTS in Table X recorded a significance of .000 ($p \leq .050$), confirming that PCA was an appropriate method for analysis (Field, 2018).

Table 8. Main experiments KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.794**
Bartlett's Test of Sphericity	Approx. Chi-Square	281.457
	df	105
	Sig.	.000

The total variance explained table (Appendix E-8) shows that, once again, four components with an eigenvalue over 1 was obtained. The first four components all had values above 1, where component 1 accounted for 35.35% of the variance, component 2 for 11.84%, component 3 for 8.49% and component 4 for 7.89%. These four components explain 63.58% of the total variance for the sample.

A rotated component matrix was performed to determine if the variables still loaded correctly to each of the four components (Table 9). The most significant factor loading was bolded and enlarged to demonstrate which of the questions loaded to each of the four components. Coefficients below .300 were suppressed to reduce the amount of noise within the table. The reverse-scale question was inverted to load correctly. Only question 17 (“This brainstorming activity was meaningful”) loaded to a different component and in this context did not make sense to load to MA of Autonomy. The majority of variables loaded to the correct components, which indicates that the research instrument is consistent between the pilot and the main experimental conditions.

Table 9. Main experiments adjusted rotated component matrix[a].

	Component			
	MA – Autonomy	MA – Competence	MA – Achievement	IM – Task Meaning
QU_04: This brainstorming activity afforded me the opportunity to use my own initiative/judgement.	**0.729**			
QU_05: I was deeply immersed in the brainstorming activity.	**0.612**	0.432		0.307
QU_07: I often feel confident when using brainstorming activities to solve problems.	**0.863**			
QU_02: I had pretty much freedom to do what I wanted on this brainstorming activity.		**0.787**		
QU_09: After working at this task, I started feeling competent.		**0.665**		0.381
QU_13: I gained a sense of accomplishment from this brainstorming activity.	0.337	**0.560**	0.558	
QU_11: I gave my best effort in this brainstorming activity in order to achieve the objective.	0.329	0.355	**0.568**	
QU_12: I gave my best hoping other participants would acknowledge my solutions and ideas.			**0.795**	
QU_14: I tried to be the best or better than other participants in this brainstorming activity.			**0.663**	
QU_15: The felt the goal that was set could easily be achieved and provided me with a sense of satisfaction.			**0.687**	
QU_19: The goal that was set during the brainstorming activity forced me to exert myself.		0.416	**0.493**	0.449
QU_16: I found this brainstorming activity important and motivating in itself.			0.372	**0.628**
QU_17: This brainstorming activity was meaningful.	**0.630**		0.318	0.489
QU_18: I put a lot of effort into this brainstorming activity.	0.403	0.499		**0.509**
QU_20: I didn't put in a lot of effort into this brainstorming activity. (Inversed)				**0.776**

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

5.5.5 Scale reliability of the research instrument for the main experiment

Separate reliability analyses for each distinct construct were re-tested using the scale inter-reliability of questions on the factor loaded constructs: These results are presented in Appendix E-8, and this analysis must have a value higher than .600 to be considered inter reliable for psychological construct (Field, 2018).

MA – Autonomy:

The Autonomy construct had a Cronbach's Alpha of .596, illustrating that this scale is relatively reliable in terms of the consistency, and is close to the .600 requirement for psychological constructs.

MA – Competence:

The Competence construct had a Cronbach's Alpha of .600, illustrating that this scale is reliable, just meeting the required .600 requirements for reasonable reliability.

MA – Achievement:

The Achievement construct had a Cronbach's Alpha of .708, illustrating that this scale is still very reliable, and well above the .600 requirements.

IM – Task Meaningfulness:

The Intrinsic Motivation - Task Meaningfulness construct had a Cronbach's Alpha of .667, illustrating that this scale is relatively reliable, and above the .600 requirement.

Each of the individual constructs for this research instrument was still reasonably reliable for the main experiment.

5.6. Results relating to research hypotheses

5.6.1 Intrinsic Motivation (IM) from the control group

IM – Task Meaningfulness construct was based on four items from the questionnaire, which comprised the score per participant's intrinsic motivation. Each item was answered using a five-point Likert scale, with the total values obtained being the multiplier between individual items. For the control group (Appendix E-8) the mean was 13.56 out of a possible 20, which indicated that the task of generating ideas was intrinsically motivated (68%) regardless of motivational affordance design principles.

5.6.2 High or low perceived MA construct from the control group

The majority of items within the research instrument control group's condition consisted of 11 motivational affordances (MA - Total), and the sub-constructs of MA – Autonomy, Competence and Achievement composed of three, three and five questions respectfully. Each item was answered using a five-point Likert scale; thus, the total variables obtainable for these constructs was calculated as follows.

- MA - Total: 11*5 = 55
- MA - Autonomy: 3*5 = 15
- MA - Competence: 3*5 = 15
- MA - Achievement: 5*5 = 25

Table 10. The motivational affordance of control groups.

Main Experiment				
	MA - Total	MA - Autonomy	MA - Competence	MA - Achievement
Mean	37.67	11.00	9.78	16.89
Median	38.00	12.00	10.00	17.00

The mean score for MA in the main experiment (Table 10) indicated that the participants overall had a high perceived Motivational Affordance (68% - 73%) and that the subcategory Autonomy (73%), Competence (65%) and Achievement (68%) was still relatively high without applying any manipulation. All the participants for the main experiment were then split into a high and a low MA constructs groups based on the mean. (For example, low MA - Autonomy ≤ 11.00 and high MA - Autonomy > 11.00) for the control group and this constituted the independent variable for the difference between participants.

5.6.3 Supporting task performance through autonomy

The first two hypotheses sought to determine whether participants who had a higher perceived autonomy satisfaction would perform better in their task performance of generating ideas. To determine if an effect exists a factorial MANOVA was conducted, using high and low perceived autonomy (independent) on dependent variables of task performance (verified idea quantity and idea quality) and IM on task meaningfulness. The descriptive analysis in Table 11 showed limited variance between the means for task performance, and an increase in the high autonomy group when comparing IM task meaningfulness.

Table 11. Descriptive statics of low and high perceived autonomy.

High or low Autonomy		Mean	Std. Deviation	N
Idea quantity	Low Autonomy	8.21	5.365	24
	High Autonomy	7.15	5.454	27
	Total	7.65	5.385	51
Idea quality	Low Autonomy	33.8125	27.28107	24
	High Autonomy	33.2407	35.65200	27
	Total	33.5098	31.67641	51
IM_Task mean	Low Autonomy	12.7917	2.68618	24
	High Autonomy	15.4074	2.24052	27
	Total	14.1765	2.76916	51

The assumption of homogeneity of variance results are shown in Table 12 and was found tenable using Levene's Test; $F(1,49) = .34$, $p = .56$ for idea quantity, $F(1,49) = .03$, $p = .86$ for idea quality, and $F(1,49) = .58$, $p = .45$ for the self-reported IM. Levene's test results are not significant ($p > .050$), between low and high autonomy groups for all the dependent variables, and therefore the null hypothesis cannot be rejected.

Table 12. Levene's test of equality of error variances[a] for autonomy.

		Levene Statistic	df1	df2	Sig.
Idea quantity	Based on Mean	.340	1	49	.562
Idea quality	Based on Mean	.029	1	49	.864
IM_Task mean	Based on Mean	.576	1	49	.451

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Autonomy_HL

There was a significant difference (Table 13) between the low and high autonomy groups when considered jointly on the variables task performance and IM, Pillai's Trace $V = .230$, $F(3,47) = 4.69$, $p = .006$, partial $\eta^2 = .23$.

Table 13. Multivariate tests[a] for autonomy.

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.979	715.551[b]	3.000	47.000	.000
	Wilks' Lambda	.021	715.551[b]	3.000	47.000	.000
	Hotelling's Trace	45.673	715.551[b]	3.000	47.000	.000
	Roy's Largest Root	45.673	715.551[b]	3.000	47.000	.000
Autonomy_HL	Pillai's Trace	.230	4.689[b]	3.000	47.000	.006[c]
	Wilks' Lambda	.770	4.689[b]	3.000	47.000	.006
	Hotelling's Trace	.299	4.689[b]	3.000	47.000	.006
	Roy's Largest Root	.299	4.689[b]	3.000	47.000	.006

a. Design: Intercept + AutonomyHL

b. Exact statistic

c. R Squared = .230 (Adjusted R Squared = .214)

It is unclear from Table 13, which of the variables in question had a significant effect. A separate ANOVA analysis was performed between each of the variables, with each ANOVA evaluated at a significance of $p \leq .050$ (Table 14). There was no significant difference between low and high autonomy participants with regard to their verified generated ideas, $F(1,49) = .488$, $p = .488$, partial $\eta^2 = .010$, or total quality of ideas, $F(1,49) = .004$, $p = .949$, partial $\eta^2 = .000$. There was, however, a significant difference between the groups on intrinsic motivational, $F(1,49) = 14.37$, $p = .000$, partial $\eta^2 = .227$ and combined with multivariate tests indicated that the combined effect has a significant effect on task performance between the low and high autonomy groups. Thus hypothesis one was unsupported, and hypothesis two was supported.

Using Cohen's rule of thumb; η^2 of .02 indicates small effect size, .13 a medium effect size and .26 a large effect size (Cohen, 1992). For this linear compensate model, the Partial Eta squared of .23 was obtained; thus, the effect size can be classified as medium to large.

Table 14. ANOVA tests of between-subjects effects for autonomy.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Idea quantity	14.281[a]	1	14.281	.488	.488	.010
	Idea quality	4.154[b]	1	4.154	.004	.949	.000
	IM_Task mean	86.935[c]	1	86.935	14.368	.000	.227
Intercept	Idea quantity	2996.321	1	2996.321	102.287	.000	.676
	Idea quality	57127.389	1	57127.389	55.800	.000	.532
	IM_Task mean	10103.562	1	10103.562	1669.859	.000	.971
Autonomy _HL	Idea quantity	14.281	1	14.281	.488	.488	.010
	Idea quality	4.154	1	4.154	.004	.949	.000
	IM_Task mean	86.935	1	86.935	14.368	.000	.227
Error	Idea quantity	1435.366	49	29.293			
	Idea quality	50165.591	49	1023.788			
	IM_Task mean	296.477	49	6.051			
Total	Idea quantity	4432.000	51				
	Idea quality	107438.000	51				
	IM_Task mean	10633.000	51				
Corrected Total	Idea quantity	1449.647	50				
	Idea quality	50169.745	50				
	IM_Task mean	383.412	50				

a. R Squared = .010 (Adjusted R Squared = -.010)

b. R Squared = .000 (Adjusted R Squared = -.020)

c. R Squared = .227 (Adjusted R Squared = .211)

5.6.4 Effect of real-time feedback on task performance

The third, fourth and fifth hypotheses sought to determine if there is an effect on task performance of the participants with regard to the various group levels of real-time feedback, in comparison to the control group which did not receive any feedback. In order to determine if there is a cause-effect, a MANOVA was performed using the feedback conditions as the independent variables against task performance (verified idea quantity and idea quality) as the dependent variable. The descriptive analysis in Table 15 shows the significant variance between the non-feedback and real-time feedback groups task performance for generating ideas, with a slight decrease in performance for the level of feedback from the individual to group conditions.

Table 15. Descriptive statics of real-time feedback and level of feedback.

	Real-time feedback	Level of feedback	Mean	Std Deviation	N
Idea quantity	No Feedback	Individual	4.11	3.444	9
	No Feedback	Group	4.11	3.444	9
	Feedback	Individual	8.78	5.946	23
	Feedback	Group	7.42	4.388	19
	Total	Individual	7.47	5.719	32
	Total	Group	6.36	4.339	28
Idea quality	No Feedback	Individual	18.78	18.30	9
	No Feedback	Group	18.78	18.30	9
	Feedback	Individual	34.21	29.52	23
	Feedback	Group	35.95	26.89	19
	Total	Individual	29.88	27.47	32
	Total	Group	30.43	25.46	28

The assumption of homogeneity of variance results are shown in Table 16 and was found tenable using Levene's Test; $F(3,56) = 1.74$, $p = .17$ for idea quantity, and $F(3,56) = .723$, $p = .54$ for idea quality. Levene's test results were not significant ($p > .050$), between feedback groups for task performance, and therefore the null hypothesis cannot be rejected. These findings provide extra confidence in the reliability and robustness of the multivariate analysis, which is to follow.

Table 16. Levene's test of equality of error variances[a] for real-time feedback.

		Levene Statistic	df1	df2	Sig.
Idea quantity	Based on Mean	1.742	3	56	.169
Idea quality	Based on Mean	.723	3	56	.542

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Factor0 + Factor1 + Factor0 * Factor1

Table 17. Multivariate tests[a] for feedback.

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	.604	41.909	2.000	55.000	.000
	Wilks' Lambda	.396	41.909	2.000	55.000	.000
	Hotelling's Trace	1.524	41.909	2.000	55.000	.000
	Roy's Largest Root	1.524	41.909	2.000	55.000	.000
Factor0	Pillai's Trace	.152	4.931	2.000	55.000	.011[c]
	Wilks' Lambda	.848	4.931	2.000	55.000	.011
	Hotelling's Trace	.179	4.931	2.000	55.000	.011
	Roy's Largest Root	.179	4.931	2.000	55.000	.011
Factor1	Pillai's Trace	.044	1.259	2.000	55.000	.292
	Wilks' Lambda	.956	1.259	2.000	55.000	.292
	Hotelling's Trace	.046	1.259	2.000	55.000	.292
	Roy's Largest Root	.046	1.259	2.000	55.000	.292
Factor0*Factor1	Pillai's Trace	.044	1.259	2.000	55.000	.292
	Wilks' Lambda	.956	1.259	2.000	55.000	.292
	Hotelling's Trace	.046	1.259	2.000	55.000	.292
	Roy's Largest Root	.046	1.259	2.000	55.000	.292

a. Design: Intercept + Factor0 + Factor1 + Factor0 * Factor1
b. Exact statistic
c. R Squared = .152 (Adjusted R Squared = .108)

Hypothesis three, which stated that an individual provided with real-time feedback would outperform the control group in terms of task performance, was supported and is indicated in Table 17 (Factor0 being control group vs real-time feedback). Pillai's Trace $V = .152$, $F(2,55) = 4.93$, $p = .011$, partial $\eta^2 = .15$. Both the level of feedback (Factor1 being individual versus group) and combined interaction effect showed no significance (p > .050).

Table 18. ANOVA tests of between-subjects effects for feedback conditions.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Idea quantity	226.528[a]	3	75.509	3.217	.030	.147
	Idea quality	3346.962[b]	3	1115.654	1.664	.185	.082
Intercept	Idea quantity	1874.218	1	1874.218	79.856	.000	.588
	Idea quality	36451.453	1	36451.453	54.357	.000	.493
Factor0	Idea quantity	200.116	1	200.116	8.526	.005	.132
	Idea quality	3340.412	1	3340.412	4.981	.030	.082
Factor1	Idea quantity	5.824	1	5.824	.248	.620	.004
	Idea quality	9.402	1	9.402	.014	.906	.000
Factor0 * Factor1	Idea quantity	5.824	1	5.824	.248	.620	.004
	Idea quality	9.402	1	9.402	.014	.906	.000
Error	Idea quantity	1314.322	56	23.470			
	Idea quality	37552.972	56	670.589			
Total	Idea quantity	4439.000	60				
	Idea quality	95381.000	60				
Corrected Total	Idea quantity	1540.850	59				
	Idea quality	40899.933	59				

a. R Squared = .147 (Adjusted R Squared = .101)[a]

b. R Squared = .082 (Adjusted R Squared = .033)[b]

The ANOVA analysis (Table 18) indicated a significant effect (p ≤ .050) of real-time feedback on task performance where idea quantity (F(1,56) = 8.53, p = .005, partial η^2 = .132) and idea quality (F(1,56) = 4.98, p = .030, partial η^2 = .082) both had a positive effect, thus supporting hypotheses three and four.

This linear compensate model attained a Partial Eta squared of .132; indicating a medium Cohen's d effect size for idea quantity and small to medium Cohen's d effect size for idea quality. Hypothesis five was unsupported as there was no significant effect between the level of feedback to participants in supporting task performance.

5.6.5 Relationship IM task meaningfulness on MA competence

Hypothesis six attempts to see whether intrinsic motivation could positively predict the task performance for individuals with a high competence satisfaction. A multiple linear regression analysis was performed to determine if a relationship exists, using task performance (verified idea quantity for model 1 and idea quality for model 2) as the dependent variable, and the predictor variables MA high/low competence satisfaction, IM task meaningfulness, real-time feedback and level of feedback.

Table 19. Regression: Idea quantity and Idea quality.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.475[a]	.225	.169	4.658
2	.463[a]	.214	.157	1.269

a. Predictors: (Constant), Individual or Group, Feedback or No feedback, High or Low Competence, IM_Task mean

Table 19, R Square indicates that 22.5% of the variance for idea quantity is explained by model 1, and 21.4% for the idea quality in model 2. Acceptable Pearson's product-moment correlation r-value for psychological studies can range from .10 for small, .30 for medium, and .50 for large effect sizes (Cohen, 1992), which is represented with the R-value in Table 19. This indicates the combined task performance for the two models has a large effect size (r combined = $\sqrt{.225 + .214}$ = .66).

Table 20 represents the regression, ANOVA analysis with regard to task performance. Both models showed significant values (p ≤ .05).

Table 20. Regression: Idea quantity, ANOVA[a] and Idea quality, ANOVA[b].

Model		Sum of Squares	df	Mean Square	F	Sig.
1[a]	Regression	347.266	4	86.816	4.000	.006[c]
	Residual	1193.584	55	21.702		
	Total	1540.850	59			
2[b]	Regression	24.127	4	6.032	3.745	.009[c]
	Residual	88.595	55	1.611		
	Total	112.722	59			

a. Dependent Variable: Idea quantity

b. Dependent Variable: Idea quality

c. Predictors: (Constant), Individual or Group, Feedback or No feedback, High or Low Competence, IM_Task mean

Table 21. Regression: Idea quantity, Coefficients[a] and Idea quality, Coefficients[b].

Model		Non-standardised Coefficients		Standardised Coefficients	t	Sig.
		B	Std. Error	Beta		
1[a]	(Constant)	5.317	3.779		1.407	.165
	High or Low Competence	3.037	1.538	.298	1.975	.053
	IM_Task mean	-.641	.284	-.348	-2.260	.028
	Feedback or No feedback	3.594	1.374	.325	2.616	.011
	Individual or Group	-.105	1.291	-.010	-.081	.936
2[b]	(Constant)	2.409	1.030		2.340	.023
	High or Low Competence	.049	.419	.018	.117	.908
	IM_Task mean	-.119	.077	-.239	-1.540	.129
	Feedback or No feedback	1.260	.374	.421	3.366	.001
	Individual or Group	.596	.352	.217	1.694	.096

a. Dependent Variable: Idea quantity
b. Dependent Variable: Idea quality

From Table 21, it can be seen those independent predictor variables; IM task meaningfulness and real-time feedback, are significant in predicting task performance as a measure of idea quantity. IM task meaningfulness has the most significant coefficient with an absolute β value of .348, presenting the most influential predictor in explaining the idea quantity. The level of competence is only significant for a one-tailed test, due to directionality of the hypothesis, the significance could be considered at .027. The "feedback and no feedback" variable was significant, only for the idea quality and non-significant for idea quantity. Thus hypothesis six is partially supported where participants with a high perceived competence task performance for idea quantity can be predicted with IM.

5.6.6 Effect of explicit goals and real-time feedback on task performance

The seventh and eight hypotheses sought to determine if there is an effect on task performance of the participants with regard to the explicit goals and real-time feedback for the two levels of feedback. In order to determine if there is an effect, a MANOVA was performed using the explicit goals and feedback conditions as the independent variables against task performance (verified idea quantity and idea quality) as the dependent variable.

The ANOVA summary table for the dependent variables is shown in Appendix E-8. The only row that showed up as significant was the real-time feedback condition. The values of p indicate that there was a non-significant difference between the other experimental conditions ($p > .05$ in each case). Thus both hypotheses seven and eight were unsupported.

5.6.7 Relationship IM task meaningfulness on MA achievement

The last hypothesis sought to determine whether IM on task meaningfulness could positively predict task performance of individuals with a high perceived achievement satisfaction. Multiple regression was performed (Appendix E-8), to determine if such a relationship existed. The coefficient between both the idea quantity and quality was non-significant ($p > .05$ in each case) for the MA achievement constructs. Thus this hypothesis was unsupported within the context of this study.

5.7. Results summary

Summary of the results from this chapter for the hypotheses present in Chapter 3 is presented in Table 22.

Table 22. Summary of the hypothesis results.

H1	A high perceived autonomy satisfaction has an effect on individuals' task performance of generating ideas.	Not supported
H2	Individuals with high perceived autonomy satisfaction and intrinsic motivation have a positive effect on task performance.	Supported with a medium effect size
H3	Participants who receive individual real-time feedback will outperform the control group (no feedback) in task performance.	Supported with a medium effect size
H4	Participants who receive group real-time feedback will outperform the control group (no feedback) in task performance.	Supported with a medium effect size
H5	Participants who receive real-time individual feedback will outperform the real-time group feedback in task performance.	Not supported
H6	Self-reported IM on task meaningfulness will positively predict task performance of individuals with a high perceived competence satisfaction.	Partially supported for idea quantity with a small effect
H7	Participants provided with explicit individual goals and real-time feedback will outperform groups provided with real-time feedback in task performance.	Not supported
H8	Individuals provided with explicit group goals and real-time feedback will outperform groups provided with real-time feedback in task performance.	Not supported
H9	Self-reported IM on task meaningfulness will positively predict task performance of individuals with a high perceived achievement satisfaction.	Not supported

CHAPTER 6: DISCUSSION OF RESULTS

This chapter considers the results attained through statistical analysis outlined in Chapter 5 and relates the results to the literature reviewed in Chapter 2. Each of the nine hypotheses that were formulated in Chapter 3 has been interpreted, based on the results obtained. Through this process, the ecological validity of the hypotheses will be confirmed, and further insight will be gained towards understanding the research question of how design principles can influence task performance for generating ideas. This chapter consists of the following overarching sections: experimental interface design, research hypotheses discussion, and a summary of the results.

6.1. Experimental interface design for task performance

IT-based idea management systems have assisted organisations in evaluating and selecting the most promising ideas from a wide selection of peripheral insiders and outsider innovators (Scheiner et al., 2017). In order to obtain these benefits, organisations have to be aware of the reasons and motives of why people participate in brainstorming activities and have to address these motives by creating a positive and satisfactory experience (Witt, 2017). Before positive and satisfactory experience can be obtained the developers and decision-makers of such systems must be aware that affordance (actionable properties between the object and the actor), more specifically the motivational affordance has to be constructed in such a manner that design principle contribute to the creation of an enjoyable experience (Sailer et al., 2017).

Figure 4 in Chapter 2 was constructed based on the broad range of literature within the field of idea management systems. This figure assisted the outline for this study, and was used to aid in answering the primary research question, how can motivational affordance design principles be used to drive task performance in an innovation management system (EBS being the subsystem for idea management) by means of enhancing intrinsic motivation through meeting user’s psychological needs?

Following cognitive evaluation theory (Sub theory of self-determination theory) the cognitive needs for competence and achievement would not improve intrinsic motivation unless the users experience a sense of autonomy (Ryan & Deci, 2000), combined with Zhang (2008a) design principles for motivation affordance indicated that the positive outcomes from supporting autonomy in ICT social contexts tend to develop self-determined motivation. Previous studies (Gallupe et al., 1992; Jung et al., 2010; Landers et al., 2017; Wang et al., 2015) in the field of EBS have classically used participants who have received extrinsic motivation (course credits) for their participation however, extrinsic motivation has been shown to displace intrinsic motivation (Ke & Zhang, 2010; Ryan & Deci, 2000; Zhao & Zhu, 2014) which could be explained by the lower sense of autonomy. Thus the design for EBS interface had to intrinsically motivated participants through supporting the motivational affordance design principles for autonomy, competence and achievement (Zhang, 2008a).

From section 5.6.1 it can be seen that the IM scores in the control group for the main experiment was 68%, indicating that the task of generating ideas within the EBS was intrinsically motivating to the participant, regardless of the motivation affordance design principles incorporated.

6.2. Research hypotheses

6.2.1. Hypothesis 1 and 2 – Autonomy

The objective of the first two hypotheses was to determine to which degree does the design principle affect autonomy need satisfaction in regard to intrinsic motivation and task performance.

The literature highlighted that perceived autonomy had a positive moderation relationship with intrinsic motivation (Dysvik & Kuvaas, 2011), however as the design for the interface was aimed at optimising the task performance of individuals through addressing their cognitive needs, and that cognitive, motivational affordance cannot increase intrinsic motivation unless the individual experience autonomy (Ryan & Deci, 2000), thus autonomy was a condition needed to determine the success of the experiment. Furthermore, Mekler et al. (2017) found that intrinsic motivation was positively correlated with autonomy and that the individuals with higher autonomy satisfaction performed better at their task.

- **H1**: A high perceived autonomy satisfaction has an effect on individuals' task performance of generating ideas.

- **H2**: Individuals with high perceived autonomy satisfaction and intrinsic motivation have a positive effect on task performance.

The results for the multivariance analysis performed in section 5.6.3 showed that the participants with a higher perceived autonomy did not improve in task performance unless the intrinsic motivation of the participants was also taken into consideration. The multivariate analysis for Pillai's Trace $V = .230$, $F(3,47) = 4.69$, $p = .006$, partial $\eta^2 = .23$, showed a significant medium effect with regard to perceived grouping of low- and high-autonomy individuals. (That is, where the significant effect was represented by the self-reported intrinsic motivation of participants). Therefore, in the latter case, the null hypothesis could be rejected in favour of the proposed hypothesis.

These results support the current literature in that there is a strong effect between the perceived autonomy level of participants and their self-reported intrinsic motivation. However, the perceived autonomy does not lead to better task performance, but that the individuals with a higher intrinsic motivation will perform better at the task of generating ideas. This would explain why many EBS studies have not taken autonomy into account as a significant moderating effect. For example, the use by Jung et al. (2010) of extrinsically motivated individuals' level of autonomy may have been affected due to them providing course credits for their participation. However, the task of generating ideas on solving a parking issue, which gave the students direct ownership of the topic, was more intrinsically motivated and was perhaps one of the reasons why such a significant effect on the task performance was observed.

6.2.2. Hypothesis 3, 4, 5 and 6 – Real-time feedback

These hypotheses sought to test how the cognitive need for competence could be addressed by applying a common social element with the design principles of timely and positive feedback to individuals or groups. If the affordances are focused on the informational aspect of feedback and perceived to be non-controlling, they usually lead to an increased sense of competence which increases intrinsic motivation (Mekler et al., 2017; Zhang, 2008b). Some of the other mechanisms which could increase the sense of users' competence include perceived competition and optimum challenges – here internal competition with self or external competition with others is done through social comparison (Latham & Locke, 2007). This level of competition was incorporated into the experiment by providing the users with different levels of feedback to facilitate social comparison. Michinov et al. (2015) showed that this social comparison could lead to an increase in the task performance of creative individuals due to cognitive need for competence. The question was, would such a simple social comparison as a bar graph and highlighting of text, be sufficient to increase task performance between individual and group feedback?

- **H3**: Participants who receive individual real-time feedback will outperform the control group (no feedback) in task performance.

- **H4**: Participants who receive group real-time feedback will outperform the control group (no feedback) in task performance.

The results from the MANOVA conducted in section 5.6.4 revealed that both the individual and group level of feedback outperformed the control group in terms of task performance of generating ideas ($F(1,56) = 8.53$, $p = .005$, partial $\eta^2 = .132$) and the quality of the ideas ($F(1,56) = 4.98$, $p = .030$, partial $\eta^2 = .082$). Therefore, the null hypothesis could be rejected for both H3 and H4. These results are in line with the literature on improving task performance within EBS through the use of providing real-time feedback (Al-Samarraie & Hurmuzan, 2018; Jung et al., 2010; Wang et al., 2015).

It must also be noted that this principle of providing timely and positive feedback was perceived as information and not as control, which did not lead to a reduction in the intrinsic motivation of the participants (Mekler et al., 2017).

- **H5**: Participants who receive real-time individual feedback will outperform the real-time group feedback in task performance.

The modifications in the real-time level of feedback from the individual to the group were to reduce the social cues in the individual-feedback condition. Adding this additional mechanism did not appear to change the pattern of the results among the conditions. Whether the participants in the real-time group condition worked in full view of each other (and could easily count their own scores in comparison to the group) did not seem to change the performance of the real-time individual condition relative to the control condition.

The MANOVA results in section 5.6.4 showed that the social comparison was neither an enabler nor disabler in terms of task performance of generating ideas ($F(1,56) = 5.82$, $p = .620$, partial $\eta^2 = .004$) and the quality of the ideas ($F(1,56) = 940$, $p = .030$, partial $\eta^2 = .000$). Therefore, the null hypothesis could not be rejected, and thus the hypothesis was unsupported. This finding is supported by Nijstad and Stroebe (2006) which labelled the term "*the illusion of group productivity*", showing that group brainstorming is not superior to individual brainstorming. They hypothesised that group members' perception on idea sharing is stimulating because communication reduces the subjective experience number of failures in a group setting. Thus the explanation from Jung et al. (2010), on the increase in task performance due to upward social comparison between the experimental conditions, was not supported within this study.

- **H6**: Self-reported IM on task meaningfulness will positively predict task performance of individuals with a high perceived competence satisfaction.

This hypothesis sought to conclude this section of the real-time feedback principle by positively predicting the task performance for the experiments through participants perceived competence and ultimately intrinsic motivation.

The results of the regression analysis completed in section 5.6.4 showed that intrinsic motivation, level of competence, and real-time feedback were all significant in predicting the number of ideas that would be generated. However, for the quality of ideas, only the feedback condition had a significant relationship. Therefore this hypothesis was only partially supported due to the requirement that both indicators for task performance have to show a significant relationship.

This could to some extent, be explained that perhaps the participants found the electronic brainstorming system engaging because of its novelty or the question that required addressing, and therefore may have worked harder on producing more ideas. Or it could be argued that the question posed to professional students was limiting in itself and that the time allocated per experiment was insufficient to generate higher quality ideas (Johnson & D'Lauro, 2018).

6.2.3. Hypothesis 7, 8 and 9 – Goal-setting

The second design principle was selected to address the social-cognitive need for achievement which is strongly related to competence (Sailer et al., 2017; Zhang, 2008a), as everyone wants to do well relative to a standard of excellence. Using the design principle for an optimal challenge, which is strongly associated with goal-setting, and increasing constraints should lead to improved task performance (Caniëls & Rietzschel, 2015; Haught-Tromp, 2017; Johnson & D'Lauro, 2018).

- **H7**: Participants provided with explicit individual goals and real-time feedback will outperform groups provided with real-time feedback in task performance.

- **H8**: Individuals provided with explicit group goals and real-time feedback will outperform groups provided with real-time feedback in task performance.

The results in section 5.6.6 indicate that there was no significant effect from the goal-setting on task performance. The last hypothesis was set around designing for the optimal-challenge principle, in order to determine whether the self-reported achievement and, ultimately, intrinsic motivation could positively predict the task performance of participants.

- **H9**: Self-reported IM on task meaningfulness will positively predict task performance of individuals with a high perceived achievement satisfaction.

The results in section 5.6.7 did not support this hypothesis, and therefore all three hypotheses were rejected in favour of the null hypothesis.

Interestingly, this goal-setting condition did not show a significant increase in task performance from the participants (Appendix E-2), which was the case from the Jung et al. (2010) study. In contradiction, the group condition with explicit goals performed worse than the group condition, which received real-time feedback and had no explicit goals. It could be that the experimental design interface was unsuccessful in motivating the participants towards the explicit goal. What was also interesting was that, in the control condition, only one participant had more than 10 verified ideas thus reaching the set explicit goal; in the individual feedback / group feedback / individual feedback and explicit goal, each condition had five participants who reached this explicit goal of 10 or more verified ideas. But with the goal feedback and explicit goal, only one participant had 10 verified ideas. One possibility from the literature on goal-setting that explains this, speaks to two types of goals – performance goals and mastery goals (Tondello et al., 2018). Performance goals are driven by social comparison to outperform others, but this was proven to have a limited effect. Orientating the participants to compare their competence to others aimed to promote performance goals, which leads to a reduction in performance due to lowering the lower intrinsic motivation of those participants (Landers et al., 2017).

6.3. Summary

The findings from this study offer first-hand insight into the effect of motivation affordance to design principles of real-time feedback and goal-setting within a web-based mediated idea-generation platform. However, it must be borne in mind that this study faced several limitations. With only 51 usable questionnaires, the sample is relatively small and did not fulfil the requirements of representativeness of the sample population. In addition, only one specific question was analysed. Within the EBS, only two MA principles were manipulated (real-time feedback and explicit goals) the other (autonomy) was only measured. During the building of the EBS application, the definition and architecture of the idea management systems were aimed to optimise the task performance of users in generating ideas and was not focused on the intrinsic motivation need of users.

The results of the study indicate that certain design principles address specific psychological needs and that these principles could lead to a positive effect on the task performance for generating ideas. This is consistent with theoretical considerations about the potential design principles to act as informational feedback elements and to satisfy users' need for competence, which can lead to increased performance from users of such systems (Sailer et al., 2017). However, adverse effects were also observed in the condition of setting explicit goals for groups, and creating an environment of competition between individuals had no beneficial effect on the task performance as was hypothesised by Paulus and Kenworthy (2019) Thus the selection of design principles to use within a setting should be considered by the context of the users' affordance of such systems.

CHAPTER 7: CONCLUSION

This chapter will summarise the objectives of the research and also provide insight into the effect that real-time feedback and goal setting has within an electronic brainstorming on task performance.

7.1. Principal findings for interface design

Electronic brainstorming is one of the most widely studied topics in the fields of information communication technology and computer-mediated communication, but the question remains, what is the ideal virtual environment for generating ideas? Using Zhang's (2008a) framework, motivation affordance related to social and cognitive aspects of the user interface was investigated. This study was the author's first attempt in an explanatory approach to gain experience in MA design principles; as such, the design principles were consequently basic in their functionality with the aim to measure sophisticated constructs. Combined with the previous question, could these basic additions of functionality in open innovation tools influence the affordance of users? The present study provides insights with respect to motivation and creativity, and how incorporating these design principles into open innovation tools could lead to intrinsic motivation which ultimately leads to user satisfaction and increased task performance.

Designing for user competence provides a natural source of motivation for users seeking out and putting forth the effort necessary to master optimal challenges. When we engage in a task with a level of difficulty and complexity that is precisely right for our current skills, we start feeling engaged (Tondello et al., 2018). One prime condition for competence need is an optimal challenge, and feedback is what satisfies our competence need (Burgers et al., 2015). The use of individual design principle can lead to an increase in task performance but should also be carefully considered independently due to the difference in the environmental context of users. Each user will have different levels of skills, and will thus require different levels of challenges. If these open innovation tools are to support all possible targeted users, identifying and setting different levels of feedback and challenges will have to centre around the design.

The level of participants' intrinsic motivation for the control condition found that the task of generating ideas in itself was intrinsically motivating, but was this due to sampling a population of professional business students already being highly intrinsically motivated individuals? From the literature review, it was vital that the users experienced autonomy within the designed interface due to the competence relationship that exists and which could influence the intrinsic motivation of users.

7.2. Summary of findings for theoretical interpretation

The design framework (Figure 4) presented at the end of Chapter 2 was adjusted (Figure 19) with the primary findings for this research report.

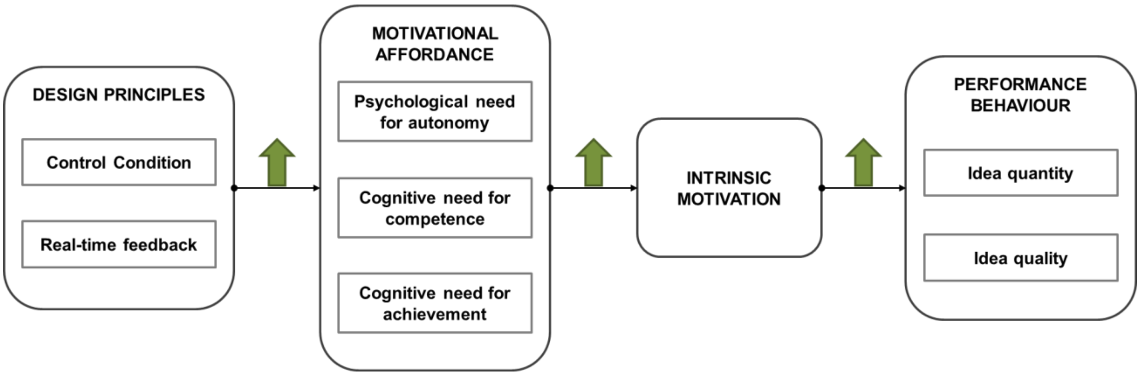

Figure 19. Research findings for this study.

Based on the literature and the results of the statistical analysis conducted in this study, the following points were concluded on the overall findings:

- Literature recommended that design for electronic brainstorming interfaces incorporate a level of optimum challenge and real-time feedback, which should lead to an increase in task performance, under the condition of autonomy, which leads to an increased in intrinsic motivation. The task of generating ideas used in this experiment proved to have a certain level of intrinsic motivation on the participants.
- Intrinsic motivation had a direct positive effect on the task performance for both the quantity and quality of ideas that were generated.
- The real-time feedback condition led to a significant increase in task performance when compared to the control condition.

- The goal-setting with real-time feedback condition led to no significant effect in task performance in comparison to the real-time feedback condition. However, for the group level feedback, a non-significant negative effect was obtained. This is not in line with the literature with regard to constraints and optimum challenge, increasing the generation of creative ideas.
- Individual versus group-level feedback had a non-significant effect on task performance.

These findings were summarised in Table 22 at the end of Chapter 5.

7.3. Implications for business

Promoting individuals' capability to generate novel and quality ideas in order to solve complex issues is considered a valuable asset in any organisation. EBS offers an alternative way for organisations to engage their employees and customers in interactive discussions which encourage creative problem-solving of these complex issues. The process for constructing ideas in the EBS environment requires less cognitive and social resources which decreases the production blocking that may occur when the group participates in traditional brainstorming.

The findings of this work present definitive support for recommendations of design principles in innovation management systems. Synthesising the insights gained from this research study, a set of key lessons was generated. These key lessons can not only assist innovation managers who strive to improve their innovation management process through the application of the design principles but are a necessity for long term user engagement.

The key lessons relate to the planning design phase and the commissioning of an EBS system for the initial idea-generation phase of the innovation management system:

Follow a structured approach for the design phase by clearly defining what goals the system must accomplish. Whether using an EBS system or any other type of idea management system, the innovation manager must have a clear understanding of how many ideas are needed and when/who is to evaluate those ideas for commercialisation. Secondly, the innovation manager has to determine all possible activities from each of the design principles and rank them, that is from their perspective critical for effective ideation within the system. Thirdly, measure each addition of design principle with regard to the user's motivation factors to ensure the design contributes positively to the experience of ideation. Lastly, align the principle around what motivates the users within that organisation accordingly, and engagement will follow. For in this study, real-time feedback was the fundamental principle for the increase in task performance, but the design of the system would have looked different for the same professional student participants if a different question had been asked.

Commissioning of an idea-management system must be an iterative process of testing the effects of each of the design principles. The behavioural patterns and option of users responding to mechanics within these systems are often difficult to foresee and specific to each organisation context. While testing and evaluating, designers can encounter problems such as a need to improve the design of feedback systems, the allocation of points for harder-to-reach goals, and social points for peer-to-peer evaluation of ideas and leader boards that can be implemented over longer-running brainstorming sessions for refinement of the ideation phase.

7.4. Implications for academia

Extrinsic incentives undermine intrinsic motivation, and when it comes to stimulating cognitive tasks like ideation, due to the undermining effect. Cognitive evaluation theory states that how someone perceives the extrinsic rewards will mediate the undermining effect (Ryan & Deci, 2000). If they perceive the reward to be controlling, the intrinsic motivation will decrease; however, if the reward is perceived as informative, non- controlling, and a boost to perceived competence, then only will it increase intrinsic motivation, through a sense of competence (Thayer et al., 2018).

For this study, the real-time feedback provided by highlighting ideas can be seen as an extrinsic social reward, whereby the approval of the users' idea is done by the moderator. Thus controlling the participants' extrinsic reward for cognitive and social motivation. The results indicate that real-time feedback did increase the intrinsic motivation of the participants. But was this due to a bias in the experiment design or was this intrinsically motivating because of the task meaningfulness or because the participants did not perceive the feedback provided as controlling?

This study also contributed to the empirical finding within the field of EBS platform design for ideation, in that there is virtually no significant effect if the feedback provided is given at an individual or group level – as long as the feedback is provided. This may be different if the EBS activity is done over an extended period, but for a single EBS activity, the motivational aspect for social comparison between the users is negligible. The other finding was that goal-setting did not provide a significant effect on intrinsically motivating the participants; this could be because the goal was not set correctly or that setting goals must be done by the participant to achieve a motivation effect. The setting of explicit goals for others could have been perceived to be controlling and thus reduced the intrinsic motivation of the users.

The other interesting finding was that the performance of specific individuals within an experimental condition indicated that the cognitive uniformity effect (Ziegler et al., 2000) had a dynamic influence on the overall group's performance in comparison to the same inter experimental condition. People within these groups influenced each other, and that process of mutual influence largely determined which ideas were being generated and how creative these ideas were. The SIAM model explained some of the observation, in that the activation of knowledge was a controlled and effortful process for the participants, and SIAM does not assume that creative ideas are always fully formed in the individual’s mind, but that they are re-formed during the social interaction of participants.

7.5. Limitations and future research

The nature of the tasks for this online EBS experiment were specific in context because the task required participants to be creative. The participant's prior experience with regard to prior brainstorming activities may have impacted the results and also their state of mind. For instance, if a previous business simulation (that the participants had to complete during the course of their studies) had been a negative experience, the participant could have had a negative attitude towards the task of generating ideas, which may have subsequently impacted their motivation affordance. Witt (2017) recommends identifying challenges which already exist in the users' pursuit of their goals, and that these should be used within the system, by structuring them around the motivational affordance of the users' needs. As such, this experiment was not applied to a specific or a pre-existing challenge, and therefore the results could change if applied in such a manner. It is therefore recommended that further studies be conducted using actual everyday examples of user challenges.

There are numerous other aspects of a group brainstorming session that could potentially affect intrinsic motivation and task performance (Al-Samarraie & Hurmuzan, 2018; Paulus & Kenworthy, 2019). For example, reading the ideas of others could assist individuals' idea-generation only after exhausting personal ideas or after a prolonged interval where no ideas were expressed. An alternative possibility is that the cognitive uniformity effect for these types of experiments could stimulate an individuals' ideation process especially when the ideas being generated fall within a category not already used by this individual. Thus, future research could focus on the specific intrapersonal and interpersonal aspects of the ideation process within EBS groups.

There is also a call to redo the Jung et al. (2010) study with a clear focus on determining which mechanisms within their design lead to a significant increase in task performance. The interaction of those mechanisms on the intrinsic motivation of the participants was not investigated in their study, and the results from this study (even though the experimental conditions were very similar) did not align with the same outcomes.

Feedback from those participants who declined to participate within the pilot study highlighted some concern of negative repercussions of participation, even when full anonymity was provided. With EBS having such a fundamental requirement for anonymity, future research will have to investigate the social comparison within dynamic group interaction when no anonymity is provided. This could in theory completely change any findings that are specific to autonomy systems.

The present findings support the cognitive social motivational model of group ideation (Paulus & Kenworthy, 2019), which postulates that attention is one of the crucial variables influencing cognitive tasks such as idea-generation. Future research could investigate whether the upward comparison with a more-creative individual could increase the performance of the less-creative individuals in terms of both the quantity and quality of ideas.

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APPENDICES

APPENDIX A: Online demographic questionnaire

Appendix A-1: Pilot experiment

Nm	Questions				
01.	Age	Under 18	19-24	25-34	35-44
		45-54	55-64	65-74	Older than 75
02.	Gender	Female	Male	Other	
03.	Highest qualification	Less than Matric	Matric	Certificate	Diploma
		Bachelor's degree	Honours degree	Master's degree	Doctorate
04.	How frequently do you participate in brainstorming activities	Never	Rarely	Sometimes	Often
		Constantly			

Appendix A-2: Main experiment

Nm	Questions				
01.	Age	Under 18	19-24	25-34	35-44
		45-54	55-64	65-74	Older than 75
02.	Gender	Female	Male	Other	
03.	Highest qualification	Less than Matric	Matric	Certificate	Diploma
		Bachelor's degree	Honours degree	Master's degree	Doctorate
04.	How frequently do you participate in brainstorming activities	Never	Rarely	Sometimes	Often
		Constantly			

APPENDIX B: Online questionnaire for MA and IM

Appendix B-1: Pilot experiment research instrument

Nm	Questions	1	2	3	4	5
	MA - Autonomy					
01.	I can pretty much be myself when working in an electronic brainstorming activity.	o	o	o	o	o
02.	I had pretty much freedom to do what I wanted on this brainstorming activity.	o	o	o	o	o
03.	I had a lot of opportunities for independent thought and action.	o	o	o	o	o
04.	This brainstorming activity afforded me the opportunity to use my own initiative/judgement.	o	o	o	o	o
05.	I was deeply immersed in the brainstorming activity.	o	o	o	o	o
	MA - Competence					
06.	I felt very competent when participating in this brainstorming activity.	o	o	o	o	o
07.	I often feel confident when using brainstorming activities to solve problems.	o	o	o	o	o
08.	I get many chances to show my talents in brainstorming activities.	o	o	o	o	o
09.	After working at this task, I started feeling competent.	o	o	o	o	o
10.	The feedback received during the activity, made me feel more competent.	o	o	o	o	o
	MA - Achievement					
11.	I gave my best effort in this brainstorming activity in order to achieve the objective.	o	o	o	o	o
12.	I gave my best hoping other participants would acknowledge my solutions and ideas.	o	o	o	o	o
13.	I gained a sense of accomplishment from this brainstorming activity.	o	o	o	o	o
14.	I tried to be the best or better than other participants in this brainstorming activity.	o	o	o	o	o
15.	The felt the goal that was set could easily be achieved and provided me with a sense of satisfaction.	o	o	o	o	o
	IM - Task meaningfulness					
16.	I found this brainstorming activity important and motivating in itself.	o	o	o	o	o
17.	This brainstorming activity was meaningful	o	o	o	o	o
18.	I put a lot of effort into this brainstorming activity	o	o	o	o	o
19.	The goal that was set during the brainstorming activity forced me to exert myself.	o	o	o	o	o
20.	I didn't put in a lot of effort into this brainstorming activity. (R)	o	o	o	o	o

Appendix B-2: Main experiment research instrument

Nm	Questions	1	2	3	4	5
04.	This brainstorming activity afforded me the opportunity to use my own initiative/judgement.	o	o	o	o	o
05.	I was deeply immersed in the brainstorming activity.	o	o	o	o	o
07.	I often feel confident when using brainstorming activities to solve problems.	o	o	o	o	o
02.	I had pretty much freedom to do what I wanted on this brainstorming activity.	o	o	o	o	o
09.	After working at this task, I started feeling competent.	o	o	o	o	o
13.	I gained a sense of accomplishment from this brainstorming activity.	o	o	o	o	o
11.	I gave my best effort in this brainstorming activity in order to achieve the objective.	o	o	o	o	o
12.	I gave my best hoping other participants would acknowledge my solutions and ideas.	o	o	o	o	o
14.	I tried to be the best or better than other participants in this brainstorming activity.	o	o	o	o	o
15.	The felt the goal that was set could easily be achieved and provided me with a sense of satisfaction.	o	o	o	o	o
19.	The goal that was set during the brainstorming activity forced me to exert myself.	o	o	o	o	o
16.	I found this brainstorming activity important and motivating in itself.	o	o	o	o	o
17.	This brainstorming activity was meaningful.	o	o	o	o	o
18.	I put a lot of effort into this brainstorming activity.	o	o	o	o	o
20.	I didn't put in a lot of effort into this brainstorming activity. (R)	o	o	o	o	o

Questions followed a Likert scale of 1-5

APPENDIX C: Experimental setup for pilot and main

Appendix C-1: Consent statement for participants

Welcome to this research experiment within the domains of idea generation and innovation management.

Informed Consent:

Dear Reader,

I am currently a student at the University of Pretoria's Gordon Institute of Business Science (GIBS) and completing my research in partial fulfilment of an Masters' of Business Administration (MBA).

I am conducting research on the role that design principles plays in human interface interaction in generating ideas and stimulating creativity within an electronic brainstorming platform. To that end, you are asked to participate in the short online idea generation experiment and then complete a short online questionnaire. This will assists the research team to better understand how the design interface for electronic brainstorming platform could be optimised for idea generation.

Your participation is voluntary and you are allowed to withdraw at any time without penalty. Your participation is anonymous and only aggregated information will be reported. By completing the experiment and questionnaire, you have indicated that you voluntarily participate in this research.

If you have any concerns, please contact myself or my supervisor.

Our details are provide below:

Researcher: Werner van der Merwe
Email: 18378511@mygibs.co.za
Phone: 076 486 2622

Research Supervisor: Prof. Gavin Price
Email: Priceg@gibs.co.za
Phone: (011) 771 4000

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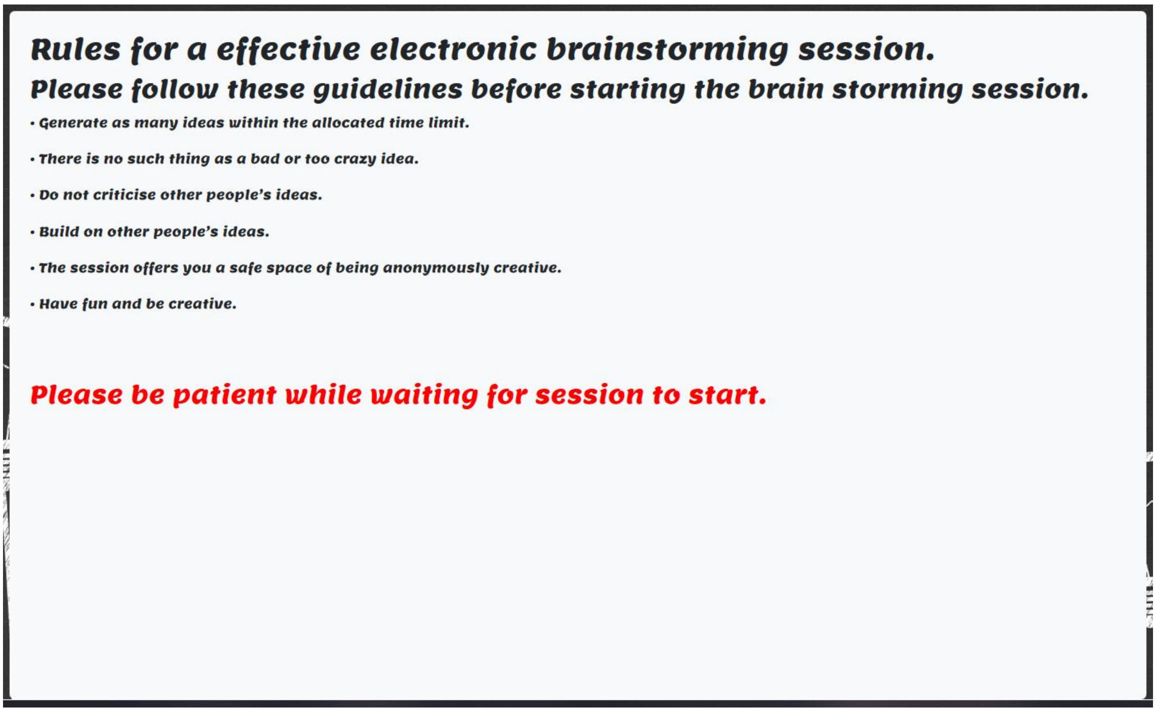
Appendix C-2: Rules and guidelines for participants to follow



Rules for a effective electronic brainstorming session.

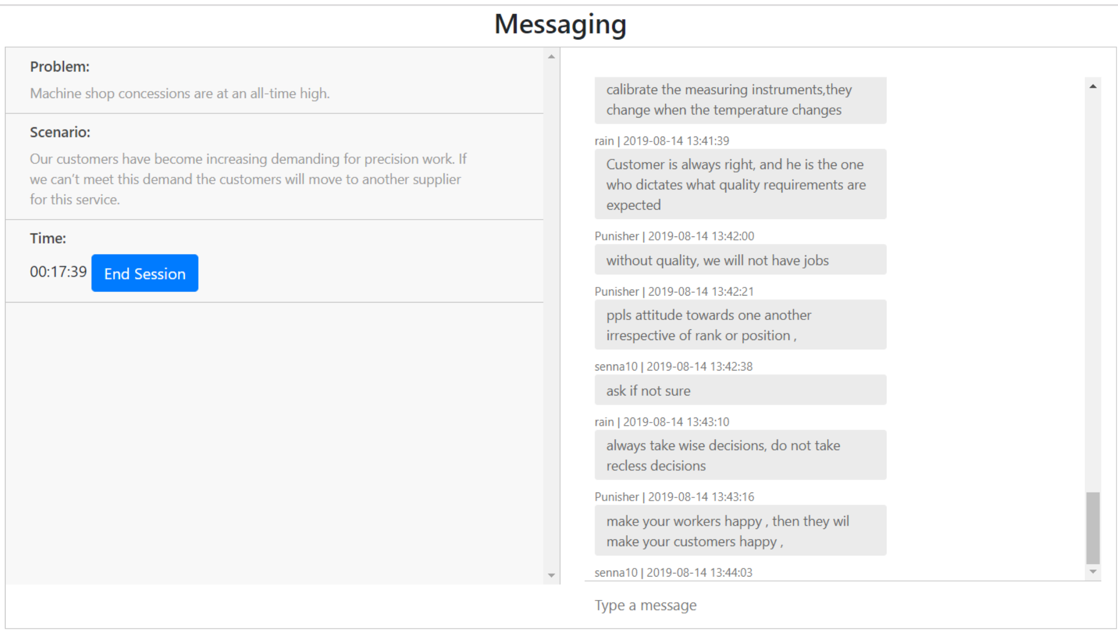
Please follow these guidelines before starting the brain storming session.

- Generate as many ideas within the allocated time limit.
- There is no such thing as a bad or too crazy idea.
- Do not criticise other people's ideas.
- Build on other people's ideas.
- The session offers you a safe space of being anonymously creative.
- Have fun and be creative.

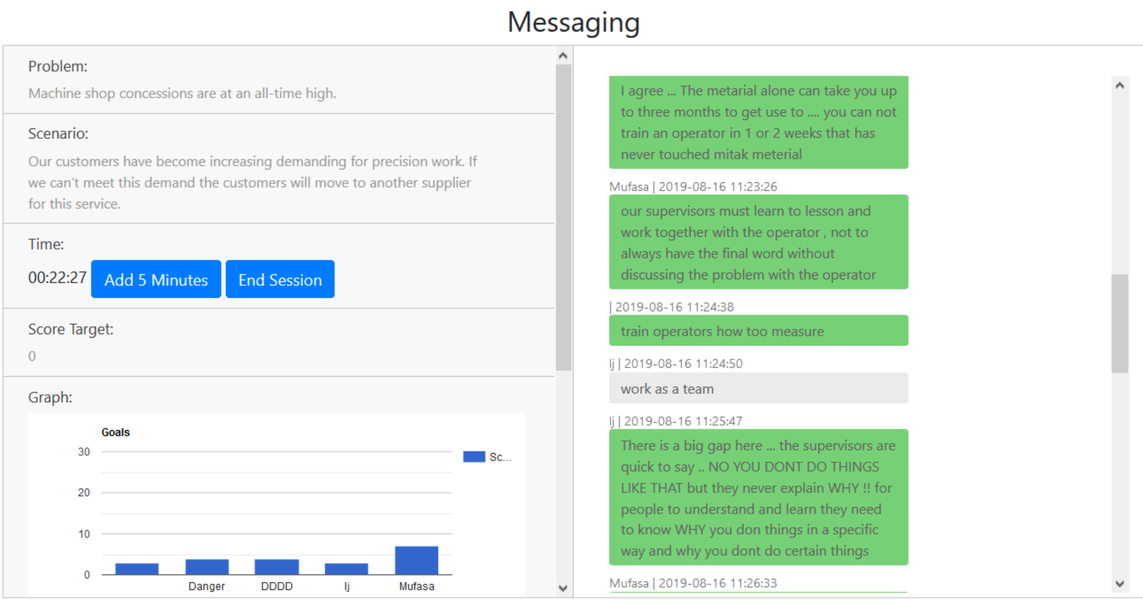
Please be patient while waiting for session to start.

APPENDIX D: EBS experimental conditions for pilot and main

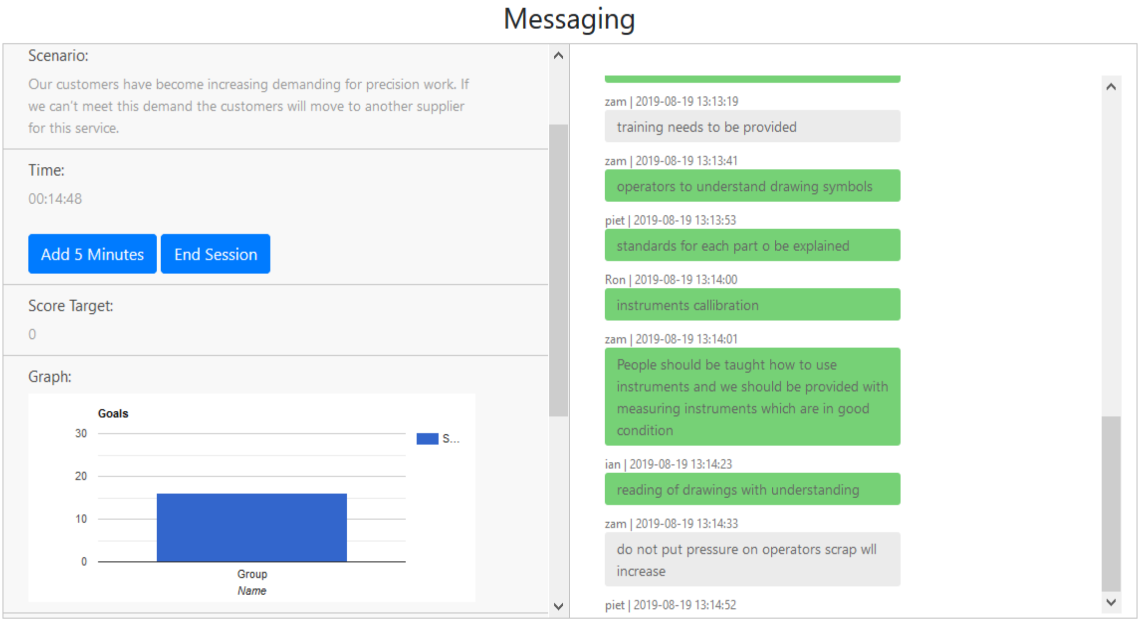
Appendix D-1: Control Condition



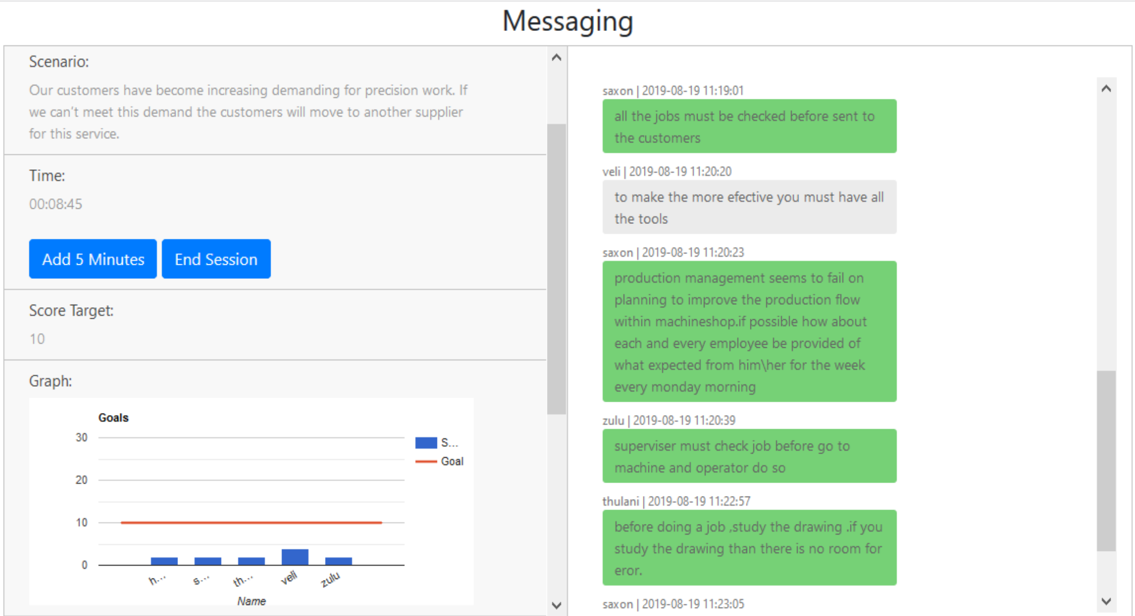
Appendix D-2: Individual feedback



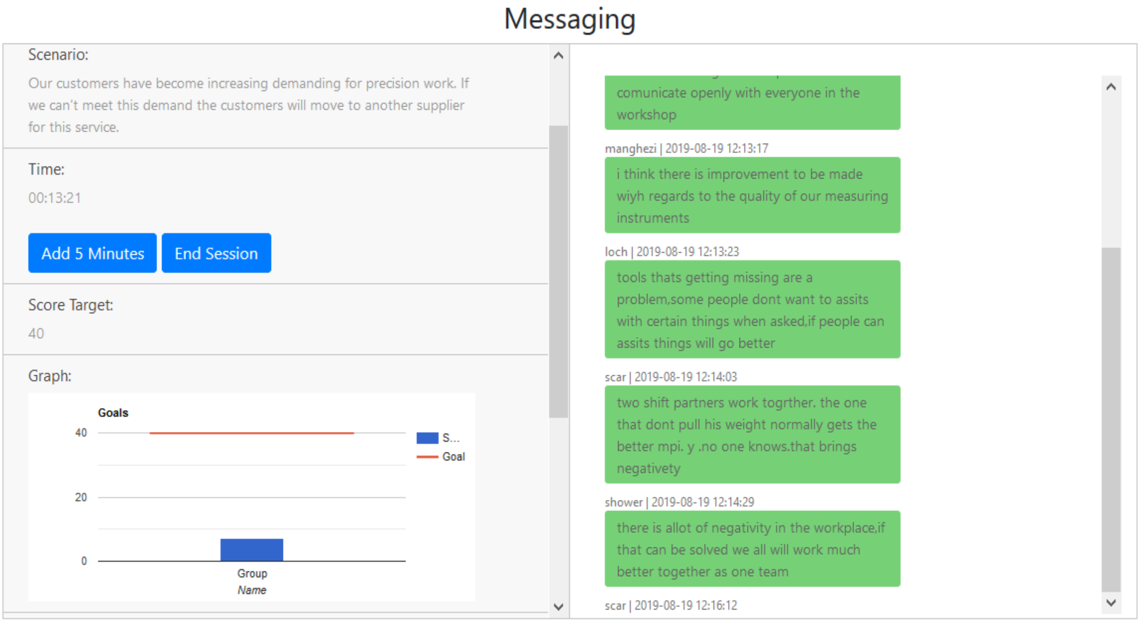
Appendix D-3: Group feedback



Appendix D-4: Individual feedback and goal setting



Appendix D-5: Group feedback and goal setting



APPENDIX E: Results from analytical techniques

Appendix E-1: Pilot experiment: Test for normality

Test of Normality

	Experimental Condition	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Quantity_H1	Control_Group	.279	9	.042	.859	9	.094
	Individual_Feedback	.182	8	.200*	.935	8	.561
	Group_Feedback	.179	10	.200*	.955	10	.724
	Individual_Feedback and Goal	.175	9	.200*	.960	9	.794
	Group_Feedback and Goal	.192	13	.200*	.902	13	.141

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Test of Normality

	Constructs	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Constructs	MA_Total	.115	49	.107	.956	49	.068
	IM_Total	.133	49	.031	.957	49	.069

Descriptives

	Experimental Condition		Statistic	Std. Error
Quantity_H1	Control_Group	Mean	5.1111	1.29577
		Skewness	.565	.717
		Kurtosis	-1.437	1.400
	Individual_Feedback	Mean	2.8750	.78916
		Skewness	.618	.752
		Kurtosis	.429	1.481
	Group_Feedback	Mean	7.3000	1.15518
		Skewness	-.728	.687
		Kurtosis	.238	1.334
	Individual_Feedback and Goal	Mean	6.0000	1.28019
		Skewness	.204	.717
		Kurtosis	-.408	1.400
	Group_Feedback and Goal	Mean	3.4615	.76473
		Skewness	.303	.616
		Kurtosis	-.688	1.191

Quantity of verified ideas (dependent) per experimental condition (independent).

Appendix E-2: Main experiment: Test for normality

Tests of normality for dependent variables per experimental condition

	Experimental condition	Kolmogorov-Smirnov[a] Statistic	df	Sig.	Shapiro-Wilk Statistic	df	Sig.
Idea quantity	Control_Group	.175	9	.200*	.938	9	.558
	Individual_Feedback	.181	11	.200*	.925	11	.361
	Group_Feedback	.150	12	.200*	.962	12	.807
	Individual_Feedback and Goal	.213	11	.175	.895	11	.162
	Group_Feedback and Goal	.234	8	.200*	.860	8	.120
Idea quality	Control_Group	.176	9	.200*	.909	9	.308
	Individual_Feedback	.225	11	.126	.857	11	.053
	Group_Feedback	.164	12	.200*	.954	12	.701
	Individual_Feedback and Goal	.158	11	.200*	.927	11	.380
	Group_Feedback and Goal	.151	8	.200*	.939	8	.599

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Descriptives for dependent variables per experimental condition

	Experimental condition	Statistic Mean	Statistic Skewness	Statistic Kurtosis	Std. Error Mean	Std. Error Skewness	Std. Error Kurtosis
Idea quantity	Control_Group	4.11	.375	-.852	1.15	.717	1.400
	Individual_Feedback	8.82	.646	-.643	1.41	.661	1.279
	Group_Feedback	7.92	.455	-.706	1.59	.637	1.232
	Individual_Feedback and Goal	8.55	-.224	-1.235	1.49	.661	1.279
	Group_Feedback and Goal	5.88	1.180	.666	1.13	.752	1.481
Idea quality	Control_Group	18.78	.887	.040	6.10	.717	1.400
	Individual_Feedback	30.18	1.421	1.627	6.32	.661	1.279
	Group_Feedback	31.33	.403	-.959	6.37	.637	1.232
	Individual_Feedback and Goal	37.64	.213	-1.117	7.02	.661	1.279
	Group_Feedback and Goal	27.38	.909	.642	6.24	.752	1.481

Tests of normality for construct totals

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
MA_Autonomy	.151	51	.005	.955	51	.054
MA_Total	.096	51	.200*	.984	51	.708
IM_Total	.137	51	.018	.958	51	.070

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Descriptives for construct totals

	Statistic			Std. Error		
	Mean	Skewness	Kurtosis	Mean	Skewness	Kurtosis
MA_Autonomy	11.47	-.243	-.118	.278	.333	.656
MA_Total	40.57	-.190	-.240	.868	.333	.656
IM_Total	14.18	-.026	-.567	.388	.333	.656

Appendix E-3: Pilot experiment: Assessor reliability

Creativity - Novelty

Reliability Statistic

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.802	.826	2

Creativity - Feasibility

Reliability Statistic

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.742	.743	2

Creativity - The combined mean of novelty and feasibility

Reliability Statistic

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.854	.887	2

Creativity index means, standard deviation and population

Item Statistics

	Mean	Std. Deviation	N
Pilot_Quality_Ass1	5.11	1.797	254
Pilot_Quality_Ass2	4.46	1.239	254

Appendix E-4: Main experiment: Assessor reliability

Creativity

Reliability Statistic

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
.865	.869	2

Creativity index means, standard deviation and population

Item Statistics

	Mean	Std. Deviation	N
Main_Quality_Ass1	4.17	1.316	463
Main_Quality_Ass2	4.27	1.502	463

Appendix E-5: Pilot experiment: Descriptive statistics

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	19-24	2	4.1	4.1	4.1
	25-34	11	22.4	22.4	26.5
	35-44	17	34.7	34.7	61.2
	45-54	11	22.4	22.4	83.7
	55-64	8	16.3	16.3	100.0
	Total	49	100.0	100.0	

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	8	16.3	16.3	16.3
	Male	41	83.7	83.7	100.0
	Total	49	100.0	100.0	

Qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than Matri	5	10.2	10.2	10.2
	Matric	16	32.7	32.7	42.9
	Certificate	19	38.8	38.8	81.6
	Diploma	6	12.2	12.2	93.9
	Bachelor's degree	2	4.1	4.1	98.0
	Honours degree	1	2.0	2.0	100.0
	Total	49	100.0	100.0	

Brainstorming frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	14	28.6	28.6	28.6
	Rarely	10	20.4	20.4	49.0
	Sometimes	15	30.6	30.6	79.6
	Often	6	12.2	12.2	91.8
	Constantly	4	8.2	8.2	100.0
	Total	49	100.0	100.0	

Experimental condition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Control_Group	9	18.4	18.4	18.4
	Individual_Feedback	8	16.3	16.3	34.7
	Group_Feedback	10	20.4	20.4	55.1
	Individual_Feedback and Goal	9	18.4	18.4	73.5
	Group_Feedback and Goal	13	26.5	26.5	100.0
	Total	49	100.0	100.0	

Appendix E-6: Main experiment: Descriptive statistics

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	25-34	19	37.3	37.3	37.3
	35-44	26	51.0	51.0	88.2
	45-54	6	11.8	11.8	100.0
	Total	19	37.3	37.3	37.3

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	11	21.6	21.6	21.6
	Male	40	78.4	78.4	100.0
	Total	51	100.0	100.0	

Qualification

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor's degr	9	17.6	17.6	17.6
	Honours degree	34	66.7	66.7	84.3
	Master's degree	8	15.7	15.7	100.0
	Total	51	100.0	100.0	

Brainstorming frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Never	4	7.8	7.8	7.8
	Rarely	12	23.5	23.5	31.4
	Sometimes	19	37.3	37.3	68.6
	Often	15	29.4	29.4	98.0
	Constantly	1	2.0	2.0	100.0
	Total	51	100.0	100.0	

Experimental condition

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Control_Group	9	17.6	17.6	17.6
	Individual_Feedback	11	21.6	21.6	39.2
	Group_Feedback	12	23.5	23.5	62.7
	Individual_Feedback and Goal	11	21.6	21.6	84.3
	Group_Feedback and Goal	8	15.7	15.7	100.0
	Total	51	100.0	100.0	

Appendix E-7: Pilot experiment measuring instrument analysis

Principal Component analysis - Eigenvalues

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	9.417	47.087	47.087	9.417	47.087	47.087	4.866	24.332	24.332
2	1.536	7.678	54.765	1.536	7.678	54.765	3.726	18.631	42.963
3	1.304	6.518	61.283	1.304	6.518	61.283	2.483	12.417	55.380
4	1.214	6.070	67.352	1.214	6.070	67.352	2.394	11.972	67.352
5	.958	4.788	72.140						
6	.859	4.296	76.437						
7	.713	3.566	80.002						
8	.644	3.219	83.221						
9	.532	2.661	85.882						
10	.459	2.294	88.176						
11	.448	2.242	90.418						
12	.365	1.826	92.244						
13	.341	1.704	93.948						
14	.289	1.445	95.393						
15	.231	1.156	96.549						
16	.216	1.078	97.627						
17	.160	.799	98.426						
18	.136	.680	99.107						
19	.104	.519	99.626						
20	.075	.374	100.000						

Extraction Method: Principal Component Analysis.

Individual constructs: Cronbach's Alphas

Scale reliability	Questions	Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
MA – Autonomy	QU_4/5/7	.776	.782	3
MA – Competence	QU_2/9/13	.770	.767	3
MA – Achievement	QU_11/12/14/15/19	.853	.858	5
IM – Task Meaningfulness	QU_16/17/18	.820	.823	3

Appendix E-8: Main experiment measuring instrument analysis

Principal Component analysis - Eigenvalues

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.303	35.352	35.352	5.303	35.352	35.352	2.496	16.640	16.640
2	1.776	11.841	47.193	1.776	11.841	47.193	2.481	16.542	33.182
3	1.273	8.488	55.681	1.273	8.488	55.681	2.439	16.262	49.444
4	1.185	7.899	63.580	1.185	7.899	63.580	2.120	14.135	63.580
5	.982	6.546	70.126						
6	.873	5.818	75.943						
7	.667	4.445	80.389						
8	.581	3.877	84.265						
9	.550	3.666	87.931						
10	.415	2.769	90.701						
11	.344	2.295	92.996						
12	.300	1.999	94.995						
13	.289	1.925	96.919						
14	.247	1.644	98.564						
15	.215	1.436	100.000						

Extraction Method: Principal Component Analysis.

Individual constructs: Cronbach's Alphas

Scale reliability	Questions	Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
MA – Autonomy	QU_4/5/7	.597	.600	3
MA – Competence	QU_2/9/13	.600	.597	3
MA – Achievement	QU_11/12/14/15/19	.708	.713	5
IM – Task Meaningfulness	QU_16/17/18/20	.667	.665	4

Intrinsic motivation: Descriptive statistics for experimental conditions

IM per experimental condition			Statistic	Std. Error
IM_Task mean	Control_Group	Mean	13.5556	0.46538
		Median	13.0000	
		Variance	7.797	
		Std. Deviation	2.79228	
		Skewness	-0.246	0.393
		Kurtosis	-1.226	0.768
	Individual_Feedback	Mean	13.3636	0.66432
		Median	13.0000	
		Variance	4.855	
		Std. Deviation	2.20330	
		Skewness	0.326	0.661
		Kurtosis	-0.761	1.279
	Group_Feedback	Mean	12.8333	0.80560
		Median	12.5000	
		Variance	7.788	
		Std. Deviation	2.79068	
		Skewness	0.205	0.637
		Kurtosis	-0.908	1.232
	Individual_Feedback and Goal	Mean	15.1818	0.74855
		Median	15.0000	
		Variance	6.164	
		Std. Deviation	2.48267	
		Skewness	0.226	0.661
		Kurtosis	0.028	1.279
	Group_Feedback and Goal	Mean	16.6250	0.70553
		Median	16.0000	
		Variance	3.982	
		Std. Deviation	1.99553	
		Skewness	0.690	0.752
		Kurtosis	-0.219	1.481

Multivariate test of between-subjects effects for all experimental conditions

Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	Idea quantity	389.962[a]	7	55.709	2.685	.016	.212
	Idea quality	5850.632[b]	7	835.805	1.387	.225	.122
Intercept	Idea quantity	2819.457	1	2819.457	135.900	.000	.660
	Idea quality	54896.021	1	54896.021	91.073	.000	.565
Factor0	Idea quantity	292.336	1	292.336	14.091	.000	.168
	Idea quality	4880.884	1	4880.884	8.097	.006	.104
Factor1	Idea quantity	12.450	1	12.450	.600	.441	.009
	Idea quality	2.848	1	2.848	.005	.945	.000
Factor2	Idea quantity	24.059	1	24.059	1.160	.285	.016
	Idea quality	326.955	1	326.955	.542	.464	.008
Factor0 * Factor1	Idea quantity	12.450	1	12.450	.600	.441	.009
	Idea quality	2.848	1	2.848	.005	.945	.000
Factor0 * Factor2	Idea quantity	24.059	1	24.059	1.160	.285	.016
	Idea quality	326.955	1	326.955	.542	.464	.008
Factor1 * Factor2	Idea quantity	.886	1	.886	.043	.837	.001
	Idea quality	23.816	1	23.816	.040	.843	.001
Factor0 * Factor1 * Factor2	Idea quantity	.886	1	.886	.043	.837	.001
	Idea quality	23.816	1	23.816	.040	.843	.001
Error	Idea quantity	1452.256	70	20.747			
	Idea quality	42193.855	70	602.769			
Total	Idea quantity	4933.000	78				
	Idea quality	107087.000	78				
Corrected Total	Idea quantity	1842.218	77				
	Idea quality	48044.487	77				

a. R Squared = .212 (Adjusted R Squared = .133)

b. R Squared = .122 (Adjusted R Squared = .034)

Regression: Idea quantity, Coefficients[a] and Idea quality, Coefficients[b]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1[a]	(Constant)	8.824	3.401		2.595	.012
	IM_Task mean	-.681	.248	-.387	-2.744	.008
	Feedback or No feedback	3.430	1.075	.352	3.190	.002
	Individual or Group	-.078	1.019	-.008	-.077	.939
	No Goal or Goal	-1.412	.990	-.145	-1.427	.158
	High or Low Autonomy	-.911	1.248	-.093	-.730	.468
	High or Low Competence	3.157	1.326	.325	2.381	.020
	High or Low Achievement	.400	1.222	.041	.327	.744
2[b]	(Constant)	2.731	1.013		2.696	.009
	IM_Task mean	-.252	.074	-.465	-3.401	.001
	Feedback or No feedback	1.446	.320	.483	4.514	.000
	Individual or Group	.546	.303	.183	1.799	.076
	No Goal or Goal	-.167	.295	-.056	-.565	.574
	High or Low Autonomy	1.226	.372	.409	3.297	.002
	High or Low Competence	.035	.395	.012	.088	.930
	High or Low Achievement	-.207	.364	-.069	-.567	.572

a. Dependent Variable: Idea quantity

b. Dependent Variable: Idea quality

APPENDIX F: Ethical clearance

Gordon Institute of Business Science
University of Pretoria

22 August 2019

Van der Merwe Werner

Dear Werner

Please be advised that your application for Ethical Clearance has been approved.

You are therefore allowed to continue collecting your data.

Please note that approval is granted based on the methodology and research instruments provided in the application. If there is any deviation change or addition to the research method or tools, a supplementary application for approval must be obtained

We wish you everything of the best for the rest of the project.

Kind Regards

GIBS MBA Research Ethical Clearance Committee

Gordon Institute of Business Science
University of Pretoria

APPENDIX G: Turnitin report

Final Edited Version

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