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Chapter

How Task Conflict Can Support Creative Problem Solving in Teams by Stimulating Knowledge Sharing, Critical and Creative Thinking and Meta-Cognition

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Abstract

This study explores how task conflict can support creative problem solving in teams and the cognitive processes applied. As multidisciplinary teams can be diverse in nature, they may not always partake competently in the pooling of information, and as a result task conflict may arise due to differences in mental models. Under certain conditions task conflict is considered to be beneficial to creative problem solving because it stimulates knowledge exchange and integration and constructive criticism to reach co-created decisions and solutions. Four case studies were conducted to analyse the discourse of teams carrying out design and innovation projects. Task conflict was found to have a positive impact on creative problem solving in the application of four cognitive processes: knowledge processing, critical and creative thinking and metacognition (team self-reflection). Task conflict was positively related to creativity in the proposal of solution alternatives. The successful application of the cognitive processes was dependent on an awareness of when task conflict is appropriate and high level social skills. The findings have implications for managers of teams solving complex problems. They highlight how the cognitive processes can be constructively used to stimulate and manage conflict to effectively solve problems in teams.

Keywords: creative problem solving, task conflict, knowledge sharing, critical thinking, creative thinking, meta-cognition, cognitive processes

1. Introduction

Institutions and businesses are increasingly reliant on multidisciplinary teams to develop innovative solutions. Creative problem solving can occur in a variety of settings such as entrepreneurship, new venture research and development, and science [1, 2]. Many problems in organisations are complex and ill-defined and therefore orchestrate the need for the methods and processes of multidisciplinary teams which is now common place [3–5]. Team, creative problem solving is considered to be a key contributor to a company's competitiveness [6, 7]. Successful team cognition is when knowledge is distributed, shared and integrated within a team to make informed evaluations, judgements and decisions, during problem solving [8].

Alternative views and opinions when solving complex and ill-defined problems can result in the consideration of a wider array of perspectives and relevant information, which can ultimately result in more informed decision making [8–10]. The sharing and elaboration of diverse perspectives can steer group members to avoid early agreements and snap decisions by encouraging divergent thinking to explore alternative requirements and solutions [2, 11]. However the cognitive processes necessary for creative problem solving have had limited study, in the literature [12]. It has also been shown that the formation of functionally diverse teams does not automatically lead to knowledge sharing and subsequent creative problem solving and disciplinary differences may cause disagreements [13–15]. Alternatively teams may form an early consensus in the form of groupthink, where team members opt for team cohesion at the expense of the further examination of the problem elements [16]. Team creativity and performance has been shown to benefit from task conflict [17–19].

Task conflict is believed to support the exchange and integration of distributed information held by each team member, making for more informed judgements, decisions and solutions [14, 20]. The benefits of task conflict are associated with the constructive challenging of other's opinions and ideas; the encouragement of assertive, independent and unbiased thinking, to balance opposing arguments [21, 22]. These benefits are however subject to strong social, communication and collaboration skills [20, 23]. While conflict can be viewed as communication through dialogue, the components of communication that determine how conflict may support teams has not been significantly addressed [20, 24].

From the perspective of a discourse study around conflict, this study builds on the discussion that views conflicts as episodes of social interaction that are constructed between team members [24, 25]. Therefore, the objective of this study is to explore how through dialogue teams manage task conflict and the cognitive processes applied during creative problem solving.

2. Team cognition in creative problem solving

Previous research on creative problem solving has focused on individual, rather than on team cognition but there is now increased recognition of the importance of understanding team cognition [1]. Team creativity relates to the processes that integrate diverse views to create useful and novel solutions [26]. Studies have found task conflict to relate positively to creativity [27]. Task conflict is considered to promote divergent thinking to explore the problem area and broaden the scope of ideas [2]. The process of creative problem solving involves a number of steps. The first step is the identification of the problem scope and problem elements in order to provide some structure to the problem [28]. Ideation then occurs where one or more ideas are developed. The next step is concept development where selected ideas from the previous stage are further developed, critiqued and evaluated to identify difficulties with the solution. The final step is the refinement of solutions and their implementation [6]. Although numerous forms of team cognition may facilitate team creative problem solving, we focus on four forms of thinking that have a strong influence.

The following cognitive processes are instrumental to creative problem solving [29]. Firstly, as creative problem solving is focused on generating multiple solution options it has mainly been associated with creative thinking. Creative thinking is divergent with the purpose of creating a range of novel ideas [30–32]. It is linked to ideation and brainstorming [33, 34]. In many creative industries such as design and innovation, the solution space can be large in the iteration of multiple ideas which calls for creative thinking [35]. Design and Innovation studies have linked heightened levels of creative thinking to creative performance

[32, 36]. Individuals with advanced creative thinking skills, are deemed to have more originality, and novelty in their outcomes. Tests to determine levels of divergent and creative thinking measure fluency, flexibility and originality [37, 38]. Team creativity concerns the production of novel and useful ideas to produce products, processes and procedures by a team of people working together [39]. Team work is beneficial to creativity as groups are able to produce novel, creative outputs due to quality interactions and diverse cognitive inputs of the team members [40]. The working definition of creative thinking for this study is defined as:

Divergent thinking to explore and generate alternative ideas and options [41].

Secondly, while creative thinking is intrinsic to creative problem solving it is not sufficient in addressing the scope of many complex problems. Creative problems, such as design and innovation problems are ill-defined [42] and un-structured [43]. These problems often have multiple ways to represent the problem, multiple solution paths, emergent sub problems, goals that conflict, requiring distributed knowledge to solve them [42, 43]. Therefore many work place problems require convergent as well as creative and divergent thinking [44], which has not been extensively studied [45]. In creative fields like design, concept generation involves alternating between convergent and divergent thinking [46]. This has been attributed to a co-evolution process where the solution and problem space are explored and constructed in parallel [47, 48]. This entails alternating between the creation of solutions and then the further structuring of the problem as solution generation surfaces a need for further information. Convergent thinking is deductive and logical, involving evaluation, judgement and analysis. Convergent thinking can support the creative process. As alternative options are created through divergent thinking, convergent thinking is applied in a sense making process in order to select the more viable solutions for further development where divergent thinking is applied once again [49, 50]. These alternating cycles are thought to be so frequent that cognitively they occur concurrently in the ideation process [45]. Critical thinking is associated with convergent thinking as it is deductive and logical and includes the skills of analysis, interpretation, inference and evaluation [51, 52]. It involves questioning the reliability of knowledge and sources, and converging on answers and decisions [52, 53]. It involves being able to provide rational arguments to defend a position taken [54, 55]. The working definition of critical thinking for this study is defined as:

Convergent, logical and deductive thinking to interpret, analyse and judge information [41].

Thirdly, Along with the application of critical and creative thinking, functioning communication is essential for teams to create and share information, make decisions and coordinate their efforts [56, 57]. Mol et al. [8] define team cognition as "an emergent state that refers to the manner in which knowledge is mentally organized, represented and distributed within the team" (p. 243). Teams do not always pool distributed knowledge successfully due to difficulties in understanding other team members, the task, and a tendency to agree rather than look for clarifications or elaborations [58]. Therefore, communication and knowledge processing are key aspects of the collaboration process [8, 56]. The presentation of information clearly during creative problem solving can improve creative outcomes [32]. Knowledge processing relates to the collaborative process of the co-construction of knowledge where team members interact with each other to build shared new knowledge [59, 60]. Activities include active discussions such as asking for feedback and clarifications [61]. The working definition of knowledge processing for this study is defined as:

The process of elaborating, explaining, clarifying and exchanging information [41].

Lastly, Reflective thinking or meta-cognition is identified as one of the essential creative problem solving skills to control and monitor the process [51]. The literature has shown that metacognitive skill is synonymous with creativity and open ended problem solving [62, 63]. The ability to switch between divergent and convergent thinking requires metacognitive knowledge about when, how, and why to alternate between these processes [64, 65] Meta-cognitive activities are around planning the management of the problem solving process, monitoring the progress and ability of the team, and evaluating the success of the methods used [62, 66, 67]. The main elements of meta-cognition are: planning, monitoring and evaluating one's problem solving strategies [62, 68, 69]. The working definition of meta-cognition for this study is defined as:

Self-reflection through planning, monitoring and evaluating oneself or the team [41].

While these are the main cognitive processes involved in creative problem solving, multi-disciplinary teams can fail to collaborate and disagreements may occur due to differences in views and opinions [13, 14, 58].

3. Task conflict

Teams engage in discussions and negotiations to integrate diverse perspectives and ideas and this can cause conflict [70, 71]. Task conflict relates to disagreements about the task, including differences in judgements, opinions and alterative directions [72, 73]. Four meta-analyses have been carried out to understand the effect of conflict on team performance, including [17, 70, 74, 75]. The findings from these studies is incomplete but some of the findings show that task conflict can improve creative problem solving when certain conditions prevail. While the findings unanimously found process and relationship conflict to negatively influence team interactions task conflict can enhance team interaction through debate to consider a greater amount of information, opinions and ideas to create an in-depth understanding of the task [19, 76].

Task conflict has been associated with enhanced creativity in inter-organisational teams [77, 78]. Task related disagreements among team members are a key driver for rich collective knowledge structures emerging from knowledge exchange, which has a positive influence on team creativity [40]. Task conflict is considered to aid creative problem solving and group decision making because it defers decision making and triggers critical thinking and constructive criticism to evaluate solutions [17, 79, 80]. During the negotiation of conflict several opinions can be shared and integrated to support solutions and decisions [9, 81] As groups participate in task conflict they acquire a deeper learning and more knowledge of the problem elements. As individuals are willing to hear other perspectives they can then examines their own position and adjust [73] to reach common ground [82]. Task conflict can provide the team with the opportunity for further thinking to broaden the problem and promote novel and creative problem-solving solutions [20]. Micro conflicts for teams solving complex unstructured and ill-defined problems can be beneficial by decreasing uncertainty [14]. The benefits of task conflict are not automatic, Teams must be willing to communication in order to mitigate against the potentially negative influence that task conflict can create [20, 72].

The discussions of the team members during episodes of conflict can determine if conflict has a positive influence on teams. Gheorghe et al. [40] argue that the ability of teams to process information rests on the cognitive processes and individual representations, as well as on the quality of interactions that take place among group members. It can take team members several turns of speech to negotiate and resolve task conflict [25]. Task conflict can instigate collaboration, and social skills are necessary for effective collaboration to resolve conflicts [23]. A collaborative

approach with the application of social skills can reduce task conflict transforming to dysfunctional forms of conflict like relationship conflict. [23, 83]. There are two approaches to resolving conflict, either through degenerative and competitive dialogue or through generative and collaborative dialogue [24, 84]. In degenerative discussions, the focus is not on forming a shared understanding, and the competitive nature of this approach often ends in a win or lose outcome [84]. In a generative dialogue the conflict is used as a vehicle to promote discussion and debate with the ultimate aim of arriving at a shared understanding. Collaboration, means focusing on shared goals, accommodating and integrating the positions of others [24].

While a number of studies have addressed the social skills necessary for collaborative problem solving such as [23, 85] there have been limited studies that have explored the cognitive processes involved in managing task conflict during creative problem solving. Many studies on conflict involve retrospective studies e.g. [70] and researchers have proposed that studies on conflict processes, require observational studies to understand the micro conflicts in the course of discussions [14]. They argue that examining the social-cognitive processes during the back and forth exchanges during conflict in creative problem solving, can provide insights into why task conflict can benefit team performance.

We propose that limited levels of task conflict can have a beneficial impact on creative problem solving by stimulating certain cognitive processes to encourage information exchange and negotiation, to build constructed knowledge within the team. Producing a creative output involves finding connections among seemingly unrelated concepts, requiring a complex knowledge structure facilitating groups to shift between perspectives [40]. In turn this will stimulate iterative episodes of idea exploration and evaluation to arrive at considered solutions. The purpose of this study is to understand how task conflict can support creative problem solving in teams and the cognitive processes used in the process.

4. Method

Case studies were used to investigate design teams working in context at the front end of innovation projects and explores the dialogue of the participants to understand their cognitive processing. The research methodology was chosen to understand the context dependent and complex interconnected processes of creative problem solving. An important part of team creative problem solving is verbal communication and conversation.

5. Data collection

There were four cases in the study. Two of the cases involved two teams within each case, this is summarised in **Table 1**. A case was determined by the context and the project. Therefore, if two teams worked on the same project within the same environment this made up one case. The first case consisted of a bio-medical fellowship program (MedDev1), the second an undergraduate project (Students), the third a professional practice case (Consultants) and the fourth an additional bio-medical case (MedDev2). All data collected was from the front end of the design and innovation process.

Observations were carried out during meetings and work sessions. The raw data was audio recorded and transcribed. Field notes were taken during and shortly after observations episodes to correctly record the activity (Cohen et al. 2007). The research data analysed for each case is summarised in **Table 2**.

Teams	Project	Team Type	Expertise
Med-Dev 1 (2 teams of 4)	Medical device innovation	Interdisciplinary: engineering, medicine, business and law.	Fellows, experienced /post-doctoral level
Undergraduate (2 teams of 7)	Design of a user-centered crew rest for flight attendants.	Interdisciplinary: product design and digital communication	Undergraduate design students, novice
Consultants (1 team of 4)	User experience software interface design.	Interdisciplinary: interaction design, software engineering and business.	Industry consultants, experienced
Med-Dev 2 (1 team of 4)	Medical device innovation	Interdisciplinary: engineering, medicine and design.	Fellows experienced /post-doctoral level

Table 1.
Case study profile.

	MedDev1	Students	Consultants	MedDev2
Analysed data	4 hrs of conversation recorded and analysed	5 hrs of conversation recorded and analysed	1.5 hrs of conversation recorded and analysed	5.5 hrs of conversation recorded and analysed
Meeting durations	*Problem definition:* Team A: 1 hr. 40 min Team B: 1 hr. 52 min	*Problem definition:* Team A: 40 min Team B: 46 min. *Ideation:* Team B: 1 hr. *Concept development:* Team A: 30 min	*Problem definition & Ideation:* 1.5 hrs	*Problem definition:* 3 hrs *Ideation:* 1 hr. 25 min *Concept development:* 1 hr

Table 2.
Details of data collection.

6. Data analysis

The analysis followed protocol and conversation analysis studies in creative research [86, 87]. The turn taking during conversations was analysed during meetings, e.g. [87]. The team dialogue was audio recorded, transcribed and imported to NVIVO and organised per case study. Analysis was both manual, in reviewing the data and digital, in the use of NVivo to theme the codes. The data was first divided into manageable chunks of topic segments. Topic shifts or changes were considered to be a suitable means to define topic segments as, topic shifts and changes start and finish through cooperation and consensus [88]. How a topic shift, or change occurred was assessed to determine if the participants reached agreement or if they changed topic without agreement. Expressions of agreement came in the form of utterances such as: uh, yeah, yes, mm, and Ok (ibid). Content analysis was applied in the deductive analysis of text data from the team discussions, through a systematic classification process of coding and identifying themes or patterns [89]. The four cognitive processes selected from the literature (knowledge processing, critical thinking, creative thinking and meta-cognition) were allocated to the utterances of each participants. **Table 3** shows the cognitive processes explored and descriptors for each [41]. There was some overlap for example where an utterance could overlap two cognitive processes.

Cognitive processes	Primitives
Knowledge processing	The process of elaborating, explaining, clarifying and exchanging information.
Critical thinking	Convergent, logical and deductive thinking to interpret, analyse and judge information.
Creative thinking	Divergent thinking to explore and generate alternative ideas and options.
Meta-cognition	Self-reflection through planning, monitoring and evaluating oneself or the team.

Table 3.
Descriptor of each cognitive process.

Reliability is about the degree to which findings can be repeated in subsequent studies, even by other researchers. An inter-rater reliability study was performed with a second coder, to code a portion of the data according to the descriptions of the themes provided by the researcher. The results showed a Kappa coefficient of: 0.718.

7. Findings

The findings have confirmed that during creative problem solving teams will alternate between the four cognitive process of: critical thinking, knowledge processing, metacognition and creative thinking to different degrees to instigate conflict and use it to support creative problem solving. The level of use across the four cases was:

1. Critical Thinking (40%)

2. Knowledge Processing (34%)

3. Meta-Cognition (27%)

4. Creative Thinking (7%)

Table 4 outlines the number of topics segments per team at each phase with task conflict. While the teams were solution orientated and proposed several solutions to problems they engaged in limited creative thinking. As teams shared knowledge this surfaced a diversity in opinions and views which triggered task conflict. To resolve the conflict and arrive at a united position the teams iteratively alternated through the cognitive processes outlined, in a cycle of information sharing and elaboration, solution generation, solution evaluation and reflection (**Figure 1**).

	Med-Dev1 Team A	Med-Dev1 Team B	Under-graduate Team A	Under-graduate Team B	Consultants	MedDev2
Problem Definition	0 of 40	1 of 56	0 of 13	0 of 11	0 of 44	3 of 40
Ideation	—		—	3 of 34		0 of 37
Concept development	—		3 of 15	—		3 of 34

Table 4.
Number of topic segments per team at each phase with task conflict.

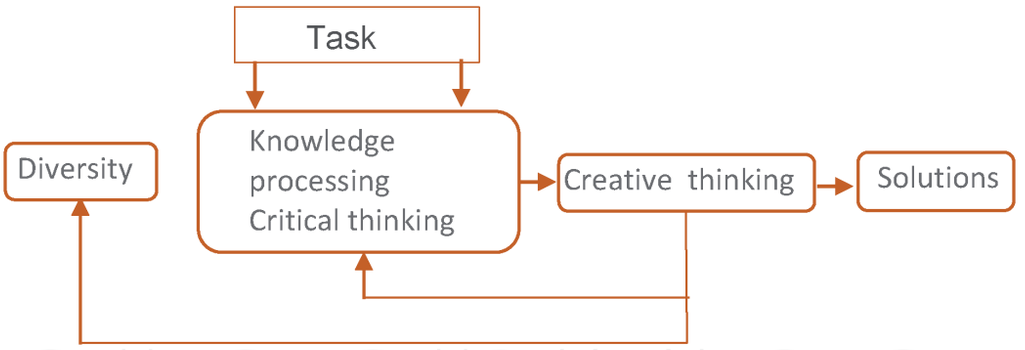

Figure 1.
Team creative problem solving cognitive processes.

Table 5 provides an example of four topic segments from the Med Dev 2 case. The team were at the stage of developing and selecting solution directions for their project. Their aim was to develop an:

"easier way to manage faecal matter from an Ileostomy[1] *in a way that reduces the risks of skin complications and improves security in its management."*

The team were trying to reach a conclusion on the selection of a final solution. Agreement was slow to reach, as solutions were evaluated, critiqued and judged by the team members before reaching a decision. Task conflict prompted the evaluation of solutions put forward by team members and strong negotiations ensued before any common ground was reached. There were a number of options that the team were considering which were around removing the risks of skin complications that can occur when using ileostomy bags. The purpose of the meeting was to discuss the viability of the options. The example in **Table 5** is a proposal put forward by L suggesting that users would cut the proposed solution to their size. He uses knowledge processing to share this information and critical thinking in providing a rational for the proposal. Team member R instigates task conflict by disagreeing with the proposal and uses critical thinking to argue that it allows too much room for error. While L accepts R's argument he counter argues to justify his solution with a material that would stretch to size with an undersized hole. The team members continue to share information and then L picks up the argument again to propose that it is acceptable for users to cut a hole in the product. While this is accepted by K it is not accepted by RS who argues that the solution may not be any better than the original product which leaks. L provides a further argument to justify his proposal over the existing solution. While the team have not reached an agreement the task conflict that has ensued has forced the elaboration of information between the team members and an evaluation of the potential risks associated with the proposed solution.

The discussion continues and a new line of argument is introduced by L in **Table 6** around the requirement for a solution to adhere to manufacturing requirements. He argues against a proposal that had been put forward earlier by R arguing that it complicates the manufacturing process. A number of counter arguments proceed further. There is still no agreement between the team members in reaching a solution path but a further analysis of proposed solutions have been put forward through the exchange of knowledge processing and critical thinking brought about by task conflict.

As consensus did not occur in the previous topic, K shifts the topic to propose a different solution. The response to this is more positive, as *creative thinking* is used to develop the solution instead of critiquing it. K proposes how the idea could work.

[1] An ileostomy is an opening in the abdominal wall that's made during surgery. The end of the ileum (the lowest part of the small intestine) is brought through this opening to form a stoma.

	Cognitive processes
L: You could go with the guideline that if your stoma is an inch in diameter you cut it at ¾ of an inch.	KP, CT
R: I would not have anyone cut anything. Just the cutting thing L. if you allow them to cut it gives someone the room for error.	CT
L: Yeah you are right, but again this is cut and if you look at the difference between this material and that one. There is no real stretch in this one. They cut it and it leaves gaps. Do not worry if it's not disposable then you can pick a size. Whereas if it is that type of material you cut it smaller and you get a seal.	KP, CT
K: If you could get these bags.	KP
R: If they get it, there is a top on it that is completely closed over and they come along with their scissors and cut it.	KP
L: I'm actually speaking about creating the hole in that.	KP
K: Alright (agreement).	
L: Let us say for arguments sake that that is a flat at the moment .	KP
K: It's flat and there is no hole and you get your cutter and cut it to the size of the stoma. That's ideal.	KP, CT
RS: Are you not back to square one then, as the original?	CT
L: There would be two differences one slightly more than the other. One difference is that there is no adhesive. This is touching the skin. Ordinarily there is an adhesive there and that is causing a problem. You do not have any adhesive and you do not have to change it. If you have to change the bag ten times a day this stays on. The second thing is if you cut a hole in that it does not stretch around the stoma. It's just placed around it and there are gaps. Whereas with this one let us say you make a hole in that you have got that element of stretch around it.	KP, CT
KP: knowledge processing, CT: Critical thinking, CRT: Creative thinking, MC: meta-cognition.	

Table 5.
Concept development discussion.

Examples	**Cognitive process**
L: I'm trying to think of it from a manufacturing point of view, as soon as you put this protrusion on it you have a different mode of selection, like what size is your stoma? It's almost like you have to buy these as customised. I'm just thinking production line.	CT
R: It's three different moulds.	CT
L: If it's three different moulds it becomes more expensive very fast.	CT
RS: But if they have to cut it to size would it be accurate enough?	CT
R: I would not allow them cut it at all. I think if we made it flat and this gives you your accommodation that might be enough, we might prove that you need two different sizes within the range.	CT
RS: would it not just stretch on to any size?	CT
K: I would not be worried about manufacturing that, versus a flat in terms of a mould. This stuff is very easy to mould.	KP, CT
L: The question is are you manufacturing ten different sizes or can you customise it?	CT
RS: That looks like it would stretch to any size	CT
KP: knowledge processing, CT: Critical thinking, CRT: Creative thinking, MC: meta-cognition.	

Table 6.
Concept development discussion 2.

Both R and K then build on the idea and establish an agreement on the solution path. Another observation is that when solutions were rejected in the previous topic segments and critiqued in the course of conflict episodes the team members were forced to consider alternatives or adjustments to solutions. This shows a clear relationship between task conflict and creativity (**Table 7**).

The discussion continues with further back and forth exchanges of critical thinking which then results in an agreement on a solution direction and a conclusion of the topic (**Table 8**).

Examples	**Cognitive processes**
K: The way I was thinking, this part could be stiffer and smaller or bigger but if you could get bags with a standard shape cut out that slots into that perfectly every time.	CRT
R: A snap fit.	CRT
K: And your inner flowery type opening always guides the fluid in, they still stick on to each other, then you are sure that there is no contact with the skin. The problem there probably is this hole. Maybe you have to sell exclusively H. bags with a standard hole size.	CRT, CT
R: There is two different options of bags, you can get ones that are cut to size and ones that are pre-cut, so they can sell a pre-cut.	KP
K: So they can do that.	KP
R: So maybe just to further that, if this was to go in you would nearly snap fit it in or that once it's in, there is a rim that goes out this way and it hooks into it. It might be harder to get it in, but once it's in there is a lock on it.	CRT, CT
L: Like vacuum cleaners.	CT
Kev: That's a clever mechanical lock all right but I would still be hoping that the adhesive we currently use in bags and manufacture would suffice to stick the bag onto whatever we have so that there is no leak. But it would be a nice addition.	CT
R: I just thought that if you were getting direct contact between here and here that it is not touching the skin at all is that not it?	CT
K: yeah that's it.	
KP: knowledge processing, CT: Critical thinking, CRT: Creative thinking, MC: meta-cognition.	

Table 7.
Concept development discussion 4.

Examples	**Cognitive processing**
L: Let us say for argument sake that this was your size and it goes into the bag and that's your stoma. There is the risk if you have a smaller stoma that it comes out and leaks back and gets held in here, I mean.	CT
R: Unless this stretches on. Try it on that and see.	CT
L: I'm just saying that in the worst case scenario if that happens you may still be in a much better position than you are if it happens without this ring because as you have seen from the pictures it can spread out whereas it might just be limiting the problem to a few millimetres around it. So you might still be off to a pretty good start.	CT
R: You might get 95% cover.	CT
L: 95% effectiveness. **CONSENSUS**	
R: Yeah that would be great. **CONSENSUS**	CT
KP: knowledge processing, CT: Critical thinking, CRT: Creative thinking, MC: meta-cognition.	

Table 8.
Concept development discussion 4 continued.

A final observation as witnessed in the data presented was that at no stage did the task conflict head towards relationship conflict which has been shown to be a risk and a reason why some researchers do not support the benefits of task conflict [70]. The teams showed an advanced level of social skills in recognising how to benefit from the conflict. For example, in **Table 8** L actively argues against his own solution to ensure that all risk associated with the solution are uncovered. In **Table 7** the teams avoided conflict during episodes of idea generation in order to suspend judgement to let ideas flow.

8. Discussion

Our findings have a number of implications. Firstly, the significant contribution of this paper to the literature on conflict management is in showing how task conflict can stimulate cognitive processes that facilitate teams to partake in creative problem solving. The topic segments depicting conflict as presented here are representative of discursive social interactions, illuminating the cognitive processes and results of the conflicts [24, 90]. They present an understanding of the generative dialogues that are used in instances of task conflict during creative problem solving. The findings highlight that the negotiation of conflict can prompt teams to share diverse information and perspectives, negotiate and elaborate on that information to arriving at co-created solutions as shown in **Figure 1**. Task conflict prevented premature agreement by challenging the status quo and instigating new lines of thinking. As team members shared diverse knowledge and perspectives with knowledge processing this triggered task conflict. To negotiate the conflict and arrive at a united goal, the teams iteratively cycled through episodes of creative thinking in the proposal of ideas, critical thinking to judge and evaluate the ideas and the perspective of others and metacognition to reflect on the suitability of the strategies engaged with by the team.

Secondly, another finding was that task conflict is indirectly and positively connected to team creativity [78]. The findings show however that conflict was not associated with creative thinking and that the topic segments that displayed creative thinking were not topics that had instances of task conflict. Team members appeared to recognise where and when to use conflict and did not critique early ideas. However, there was evidence to show that the task conflict that occurred in preceding topics often forced a rethink in terms of solution directions and it was this, that prompted the teams to use creative thinking to come up with alternative solutions. This required a balance in the management of the conflict in that, while task conflict led to a creative rethink on solution paths, it was important that task conflict did not stifle creative thinking in the flow of alternative ideas. This supports Kiernan et al. [91] who showed that task conflict impacts positively only at certain stages of the creative process, the problem definition and concept development phases. While they recommend moderate levels of conflict at these phases they argue that conflict has the potential to have a damaging impact at the ideation phase by stifling the fluency of ideas. Therefore the focus for teams at the ideation phase should be on producing a breath of ideas which is desirable for creative problem solving [92].

The third contribution points for a need to have advanced social skills [23] and a heightened awareness of when and how to apply these skills. It is about understanding when the introduction and the continuation of task conflict can benefit the progress of the team. It has been shown that enhanced communication, [20] social skills, [23] and generative dialogues [24] are necessary to support the negotiation and beneficial impact of task conflict. This study provides empirical evidence

that the use of the cognitive processes of knowledge processing, critical thinking, creative thinking and meta-cognition were linked to advanced social, communication and collaboration skills that supported the teams to partake in, control and gain from the conflict. Many team members demonstrated this with being able to build strong arguments but also in knowing when not to argue. Team members also regularly built on the arguments of others in order to build on a position being advocated to the group. This concurs with the literature which shows that this is a differentiating factor between experts and novices during episodes of conflict in design problem solving [91].

With respect to the inconclusive findings in the literature with regard to the benefits of task conflict, this research has made a fourth contribution to show that task conflict can benefit creative problem solving and should be encouraged. This study has highlighted the cognitive processes that are verbally uttered and how they are used to both instill and resolve task conflict. These findings have implications for how creative problem solving teams are managed. This study proposes that while task conflict can support creative problem solving it needs to be managed carefully. Advanced social, communication and collaboration skills need to be developed. This can be reached by facilitating the application of the cognitive processes outlined. These cognitive processes can serve as an aid to support teams to start and then negotiate the conflict. The levels of collaboration and social skills applied will determine how well teams function and an experienced facilitator may be necessary to both instigate and manage the negotiation of task conflict to ensure that the level of conflict does not escalate to unmanageable levels. This may be even more necessary when facilitating more novice and inexperienced teams. The level of conflict observed in this research was moderate. Higher levels of conflict could have a counterproductive impact on team interaction resulting in prolonged delays in decision making. This supports the literature which stresses that heightened and prolonged episodes of task conflict could be detrimental to a team's ability to move forward [17, 79].

9. Conclusions

The findings highlight how task conflict can benefit creative problem solving in teams by prompting team members to engage in a social exchange by applying cycles of the cognitive processes of; knowledge processing, critical thinking, creative thinking and meta-cognition. These cognitive processes were instrumental in supporting both divergent and convergent thinking and suspending decision making to process additional information and explore alternative ideas. While conflict was positively related to creativity it was not associated with creative thinking, however previous episodes of conflict often resulted in subsequent topic segments of creative thinking. The ability to apply the cognitive processes appeared to depend on advanced social and collaborative skills pointing to a possible difference between how experts and novices might compare in managing conflict.

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