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Towards the Creative University: Developing a Conceptual Framework for Transdisciplinary Teamwork

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Abstract

The paper emphasizes the importance of creating opportunities at universities for developing transdisciplinary teams since many today's complex issues or highly innovative products can no longer be effectively solved or created from a singular perspective, but require different and broader viewpoints and a collaboration of different expertise, approaches and methodologies. Indeed, recent research indicates that disciplinary boundaries can be fluid; therefore, creative transdisciplinary teams are capable to transfer useful ideas, concepts and knowledge between different disciplinary domains. The objective of this paper is to develop a conceptual framework for student transdisciplinary teamwork by reconciling different streams of literature on teamwork, creativity and transdisciplinarity, and to test the appropriateness of this framework in practice by observing three transdisciplinary teams, which were assembled for a new product development ideation. The framework was constructed as a network of interlinked concepts (uncertainty management, effort synchronization management, and synthesis management) that together provide a comprehensive understanding of the necessary capabilities for transdisciplinary teamwork and the need for their management. This exploratory paper relevance is assessed in terms of research contribution towards answering the question on how to make transdisciplinary teamwork more effective by providing a synergy-driven approach for more effective transdisciplinary teamwork capability development and their management.

Keywords: creativity, teamwork, transdisciplinarity, transdisciplinary teamwork, creative university.

Introduction

Creativity is the prerequisite of innovation, which is the main engine of long-term economic growth, society development and human evolution. There is no doubt that creativity is the most important human resource of all, since without creativity, there would be no progress, and we would be forever repeating the same patterns (de Bono, 1995). Creativity is a multidimensional phenomenon that manifests itself in many fields, domains and contexts, from arts to business, design, science or entrepreneurship. Different dimensions of creativity have been a subject of academic debates for decades and have been discussed in a range of contexts, including psychology, business, management, sociology, cognitive science, artificial intelligence, arts, philosophy and other disciplines. There is no single, authoritative definition of creativity. Creativity refers to our human capacity to produce new insights, ideas, concepts, inventions or artistic objects, which infer social, economic, spiritual, esthetic, technological or any other value.

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Creativity, according to Ackermann et al. (2009), can be divided into three different kinds: combinatorial, exploratory and transformational. Combinatorial creativity refers to generating new, surprising and valuable ideas and artifacts through combining existing ideas and artifacts. Exploratory creativity entails generating new, surprising and valuable ideas and artifacts that expand our understanding of an area or creative domain; whereas, transformational creativity is about generating new, surprising and valuable ideas and artifacts that transform the way we see the world. Despite many definitions of creativity, the concept of creativity is still developing and has not reached the maturity stage. In the past, creativity research was focused on eminently creative people as creative geniuses. For many decades much of the creativity research was focused on unambiguous examples of creative breakthroughs and productivity (Runco, 2004). In addition, a shift has occurred from the individual to the collective as teamwork may bring additional synergies to support creative outcomes (Barlow, 2000; Kasl, Marskcik, & Dechant, 1997; Hargadon & Beckhy, 2006).

Collective or team creativity infers that specialists with knowledge, skills, and abilities in a variety of fields, domains and specializations may maximize the creative problem solving process and produce outstanding creative outputs that range from incremental improvements to radical creative ideas for breakthrough products or processes. Indeed, collective intelligence and creative problem solving has high potential to drive creativity since creativity comes from the ability to synthesize and combine data and information, and make new combinations of existing ideas. According to Mark Runco (2004), it is now more of an interdisciplinary effort than ever before, and new techniques, topics, and applications are apparent in the creativity-driven research. There are real world problems, issues or creative needs that are broader than any single discipline, and can be fruitfully examined, solved or created in a multiple disciplinary framework. Disciplines are the result of artificial fragmentation of knowledge. Complex world problems are rarely limited to the artificial boundaries of academic disciplines; therefore; many real-world problems have become too complex to solve for a single expert out of one discipline.

Contemporary higher education is primarily characterized by receiving knowledge out of one single department, nevertheless; complex problem solving or innovative product creation requires transdisciplinary approaches. In turn, universities should focus on fostering and supporting new learning opportunities based on transdisciplinary collaboration that are aimed at having students practice meaningful collaboration with other disciplines and developing valuable creative solutions. There is an ever increasing call for transdisciplinary approaches to tackle fundamental societal challenges. In Germany, for instance, transdisciplinary research is considered to be key for the fundamental sustainable energy transition enacted by the Federal Parliament of Germany in Summer 2011 (Lang et al., 2012). Nowadays, universities are at the forefront of supporting creativity potential among students. This paper emphasizes the importance of creating opportunities at universities for developing transdisciplinary teams since

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many today's complex issues or highly innovative products can no longer be effectively solved or created from a singular perspective, but require different and broader viewpoints and a collaboration of different expertise, approaches and methodologies. Indeed, recent research indicates that disciplinary boundaries can be fluid; therefore, creative transdisciplinary teams are capable to transfer useful ideas, concepts and knowledge between different disciplinary domains. Some researchers have suggested that such transdisciplinary skills are broad-spectrum creative thinking skills that are used by successful people across disciplines (Root-Bernstein, 1999; 2003, Mishra, et al., 2011). Transdisciplinary teamwork may give access to gain new perspectives, share learning between disciplines and create new outcomes.

The objective of this paper is to develop a conceptual framework for student transdisciplinary teamwork by reconciling different streams of literature on teamwork, creativity and transdisciplinarity, and to test the appropriateness of this framework in practice by observing three transdisciplinary teams, which were assembled for a new product development ideation. Team members included specialists of business, marketing, computer science, sociology and different arts. The framework was constructed as a network of interlinked concepts (uncertainty management, effort synchronization management, and synthesis management) that together provide a comprehensive understanding of the necessary capabilities for transdisciplinary teamwork and the need for their management. This exploratory paper relevance is assessed in terms of research contribution towards answering the question on how to make transdisciplinary teamwork more effective by providing a synergy-driven approach for more effective transdisciplinary teamwork capability development and their management. Today the growth in teamwork (Lawler & Mohrman, 2003) highlights the importance of understanding what helps teams to function effectively; therefore, team education is a potential avenue in overcoming barriers to successful collaboration in diverse teams (Northcraft et al., 1995). Student ability to function well in a transdisciplinary team has become an expectation of modern society, especially for those who aim at developing creative business or societal solutions. This analysis was conducted at the Faculty of Business Management at Vilniaus Kolegija / University of Applied Sciences in Lithuania under the framework of a European Union funded project for creativity development, which gave birth to a multinational triple-university degree study program in "Creativity and Business Innovations". The program incorporates different innovative thinking and creativity-driven approaches into the curriculum and advances creativity application to different transdisciplinary business contexts. This conceptual study is an attempt to develop further visions for creativity development at the university by modelling student transdisciplinary competencies and mindsets, necessary for transdisciplinary teamwork.

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Assessment of teamwork dynamics: implications of multidisciplinarity, interdisciplinarity and transdisciplinarity

In the context of transdisciplinary teamwork, transdisciplinary creativity is a relatively new framework for creativity (RootBernstein, 2003; Mishra, et al. 2011). Creativity relates to the historical notion of polymathy, where individuals develop expertise in different domains or disciplines that might even be distant from each other and encourage fluid creativity. In turn, fluid creativity is an ability of an individual to cross-pollinate ideas, concepts, knowledge and information. Indeed, creative people are capable to recombine multiple knowledge and domain areas in different and unique ways from one discipline into another. Transdisciplinarity refers to bringing together individuals of different backgrounds and specializations provides a possibility for cross-fertilization of knowledge, concepts and ideas that could spark innovation and higher creativity potential (Milliken and Martins, 1996). However, in a university setting, discipline-based departments usually have a tradition of autonomy and tend to operate within the context of their domain specificity. The aim of this paper is to identify the factors that influence transdisciplinary teamwork, which could potentially integrate diverse inputs, knowledge and expertise into a coherent whole and give birth to new concepts, theories and creative outcomes.

The analysis of transdisciplinary teamwork requires a deeper insight into the theoretical background of teamwork dynamics. What makes a team? The literature review suggests that one of the essential elements of a team is its focus toward a common goal or a clear purpose (Fisher et al., 1997; Johnson & Johnson, 1995, 1999; Parker, 1990; Harris & Harris, 1996). Academic research points out that definition of a team refers to the team's way of interacting adaptively, interdependently, and dynamically toward a common valued goal (Salas, Sims, & Burke, 2005). Team interaction stimulates others and results in increased productivity, efficiency and creativity (Levi, 2001; Hargadon & Bechky, 2006). As teamwork relies on working together in a cooperative environment to achieve common goals through sharing knowledge, ideas and skills, it infers a dynamic that emerges between individuals working cooperatively to accomplish a goal that is beyond their individual capabilities (Marks, Mathieu, & Zaccaro, 2001; Osborn & Moran, 2000). Furthermore, effective teamwork implies synergism between all team members that are willing to combine and recombine their expertise in order to achieve a common goal. In this respect, teams are effective at generating innovation because they bring together far more concepts and bodies of knowledge than any one individual can, while a diversity of skills and experience promotes such collaborative relationships that add significant value to innovation outcomes (Leonard & Swap, 1999). In this respect, complex problems require transdisciplinary teams to envision possible futures and promote collective to drive forward innovation and the solving of highly complex issues or tasks. The literature review suggests that variety of skills or knowledge-based dimensions like educational background, occupational or industry experience ought to result in a greater variety of perspectives that increase the likelihood of creative and

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innovative solutions to problems (Nonaka, 1994). Nevertheless, the contextualization of transdisciplinary teams requires to view such teams in the contexts of multidisciplinary, interdisciplinary and transdisciplinary concepts, which are often ambiguously defined and interchangeably used in the literature.

By assessing the teamwork dynamics based on multidisciplinarity, such teamwork approach infers knowledge generation from different disciplines by staying within their boundaries. In multidisciplinarity-based teamwork, team members represent a variety of disciplines and collaborate without integration of concepts, methodologies or epistemologies. Multidisciplinary infers the lowest level of involvement as team members representing different disciplines are working without challenging their disciplinary boundaries. The literature review suggests that multidisciplinarity is a process for providing a juxtaposition of disciplines that is additive, not integrative, where disciplinary perspectives are not changed, only contrasted (Klein, 1990). For instance, in a multidisciplinary team dealing with ideation for new product development, team members function as independent specialists rather than interactive team members since they juxtaposes two or more disciplines focused on a problem. Despite that such juxtaposition promotes wider knowledge and possibilities, disciplines remain separate and teamwork outcomes tend to result in separate insights rather than synthesized. Multidisciplinarity is an approach when experts from different fields work together on a common subject within the boundaries of their own disciplines, but if they keep thinking within those boundaries, they tend to inhibit their further progress. In contrast to multidisciplinary teamwork, interdisciplinary teamwork is viewed as a collaboration of several disciplines, but in this case concepts, methodologies or epistemologies are exchanged and integrated. According to Klein (1990), interdisciplinarity integrates information, data, methods, tools, concepts, and/or theories from two or more disciplines focused on a complex question, problem or topic.

Transdisciplinary teamwork approach is much more ambitious than multidisciplinary or interdisciplinary teamwork. By assessing the teamwork dynamics based on transdisciplinarity, transdisciplinary teamwork approach integrates different disciplines in order to transcend their traditional boundaries. Variety of perspectives, knowledge and expertise and its integration is a fundamental aspect of transdisciplinarity, since it infers the goal to achieve the unity of all knowledge and ideas regardless of disciplines. As the prefix “trans” suggests, it aims at going beyond the narrow disciplinary divisions. According to Klein (1990), a transdisciplinary approach often leads to new perspectives, as it concerns what is between the disciplines, across the different disciplines, and beyond all disciplines. Transdisciplinarity is supported by disciplinary research; however, disciplinary research is clarified and optimized by transdisciplinary knowledge in unique new ways (Nicolescu, 2002). By contrasting the implications of multidisciplinarity, interdisciplinarity and transdisciplinarity, the literature review suggests that multidisciplinary teams work from the perspective of their disciplinary base and stays within their boundaries, interdisciplinary teams work

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more jointly but still from a discipline-specific base to address a common problem, while transdisciplinary teams work using a shared conceptual framework, drawing together discipline-specific theories, approaches and concepts to achieve a common goal and unity of knowledge (Rosenfield, 1992). In this respect, transdisciplinary teamwork support effective integrations of knowledge, new knowledge creation, eureka moments and even serendipitous discoveries.

Uncertainty management: towards overcoming ambiguity and perplexity in transdisciplinary teamwork

Transdisciplinary teamwork entails many complex issues associated with uncertainty, ambiguity and perplexity, since transdisciplinary team members of different domains and disciplines must find a common ground both for the effective communication of their knowledge and ideas, and the language and terminology that each team member would understand. In this respect, conflict and deep uncertainty of collaborative communication is unescapable and underpins the complex dynamic of transdisciplinary teamwork. The literature review suggests that despite the teamwork cohesiveness, empathy, and flexibility; conflict still arises from differences (Al-Rawi, 2008). The diversity of viewpoints and misunderstandings related to domain-specific terminology are highly characteristic to transdisciplinary teams. Academic research points out that diverse teams have inherently a higher conflict potential than homogenous teams and despite that conflict is an integral part of teamwork dynamics, it may suppress all creativity and productivity in group work (Nemeth, 1997). This situation implies the need for exploring the possibilities to prepare transdisciplinary team members for uncertainty management, which could help them to overcome ambiguity and perplexity related to teamwork. In this paper uncertainty management refers to the development and management of team's capability to manage ambiguity and uncertainty. The literature review suggests that transdisciplinary outputs are often criticized for digressing to the edges of everything; therefore, uncertainty management entails the importance to tolerate ambiguity, uncertainty and seeming lack of structure (Harris & Harris, 1996). Based on the observations under this investigation, the following problematic implications could be indicated as related to the need of better uncertainty management for transdisciplinary teamwork:

- Some team members could not understand the terminology and "jargon" of different disciplines (for instance, students of the arts could not understand some terms used by business or IT students);
- Some team members felt "superior" as if implying that their discipline has the best answers to achieve their common goal (for instance, business students tend to show that they have best answers and expertise related to new product development);
- Some team members had difficulties expressing their ideas since other team members did not have any knowledge and expertise related to their discipline

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(for instance, students of IT introduced innovative IT-related possibilities, which other team members found far too difficult to understand);

- Some team members felt "inferior" and even became passive in teamwork (for instance, some students of the arts felt passive in the teamwork since team discussions basically revolved around technological business innovations).

In the context of uncertainty management, transdisciplinary teamwork should be encouraged to discuss issues openly with team members, be honest, trustworthy, supportive, and show respect and commitment to the team and to its individuals. Actively listening to the concerns and needs of team members and valuing their contribution and expressing this helps to create an effective work environment. Transdisciplinary teamwork entails creation of a team atmosphere that is informal, relaxed, comfortable and non-judgemental (Harris & Harris, 1996; Levi 2001). Supportive climates, in particular, encompass diverse ideas and expressions of both agreement and disagreement. This kind of communication climate affects the willingness of team members to participate, offering members the sense of affiliation, commitment, pride, and trust in their teams. In addition, supportive communication behaviors include problem orientation, spontaneity, equality, and provisionalism, whereas, defensive behaviors include evaluation, control, neutrality, superiority, and certainty (Levi, 2001). Team members should be willing to give and receive constructive criticism and provide authentic feedback and show consideration for each other (Kets De Vries, 1999).

Another key aspect of building a collaborative transdisciplinary team is to develop a ''common language'' or "jargon" among all team members. When transdisciplinary teams work on tasks involving more ambiguity and uncertainty, the possibility for divergent and misleading interpretations is a real progress-suppressing issue. Without a "common language", the probability for misinterpretation is far higher. Creating a common language has a potential to build team capacity to prevent misunderstandings and stagnation for collaboration and further progress. Developing the "common language" of a particular transdisciplinary teamwork implies the need for prior team preparation and efforts to establish ground rules and terminology or "jargon" that each team member could understand and efficiently operate in the teamwork. Furthermore, team members should be encouraged to develop their "common language" throughout the whole duration of teamwork process in order to support coherent, continuous and active understanding of joint discussions and sharing of ideas and knowledge.

Academic research points out that some degree of conflict may be beneficial to teamwork and its outcomes, since constructive conflict may push individuals to higher standards and clarify individual perspectives (Eisenhardt & Zbaracki, 1992). Cognitive or task-based conflict can open thought processes and become essential for effective team performance (Forbes & Milliken, 1999). In order to make conflict beneficial, team members need to challenge one another and welcome differences (Leonard & Swap, 1999). Ideal team should be highly diversified in the

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talents and knowledge each member contributes, while maintaining open, supportive, and non-threatening communication (Bradley & Frederic, 1997). As transdisciplinary teamwork entails continuous juxtaposition of ideas, knowledge and concepts, conflict is highly predictable; nevertheless, if a team is well-prepared to tackle transdisciplinary issues and have a positive and supportive attitude towards reaching joint goals, this approach becomes a starting point for idea integration and higher probability of successful outcomes. Idea juxtapositioning entails being open to change, innovation and creativity; therefore, it is important to cultivate a team spirit of constructive criticism and authentic non-evaluative feedback (Harris & Harris, 1996) and experimentation with new ways to work more effectively (Wageman, 1997).

Effort synchronization management: towards overcoming process incoordination in transdisciplinary teamwork

Successful teams are supportive, motivated, highly engaged and aim to achieve their goal at the highest level. In order to support effective transdisciplinary teamwork, team members must synchronize their plans and processes for accomplishing the shared task. Successful teams must come to a common understanding of the task definition, agree on the evaluation of ideas, and work interpersonally with each other. Furthermore, they should develop communication and interaction patterns that aid the team in working together successfully (Al-Rawi, 2008). Effective transdisciplinary teamwork involves an analysis of transdisciplinary interests, discussion of possible benefits from particular areas of expertise and commitment to start their joint learning journey through the process. Transdisciplinary team members must share a strong common goal (Francis & Young, 1979; Kets De Vries, 1999; Sawyer, 2007) and promote group cohesion (Bradley & Frederic, 1997), because otherwise teamwork will face much conflict, time wasting and misunderstandings. This situation implies the need for exploring the possibilities to prepare transdisciplinary team members for effort synchronization, which could help them to overcome teamwork process incoordination. In this paper effort synchronization management refers to the development and management of team's capability to coordinate teamwork activities and processes in order to achieve shared goals. Effort synchronization implies that it must be clear from the beginning about the aims and objectives of the transdisciplinary teamwork and its processes. Based on the observations under this investigation, the following problematic implications could be indicated as related to the need of better effort synchronization management for transdisciplinary teamwork:

- Some team members felt that they had little time to share their ideas since their team discussion was predominated by other team members;
- Some team members consumed a lot of time on sharing such knowledge that other team members considered as unrelated to their goal and as a digression from their plan;

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- Some team members were highly critical and provided negative feedback on other comments, which made some team members to become more passive in their engagement.
- Some team members were highly motivated to achieve a highly creative product solution and showed much enthusiasm, though others were content with minimal effort and remained rather passive. This situation caused some frustration and disappointment among remaining team members.

Transdisciplinary team members need to be accountable for their contribution to the team and the project, since team members are accountable for their share of the work (Smith, 1996). They need to be aware of team processes, best practice and new ideas; nevertheless, effective leadership is essential for team success including shared decision-making and problem solving. Effort synchronization management entails that transdisciplinary teamwork is based on the assumption that all members are aware of the importance of everyone's role within the team and the process used by the team to plan and track the timing and quality of required tasks. The literature review suggests that transdisciplinary teams should monitor the team's progress and perform post-project analyses to find out what worked and what didn't (Johnson, Heimann, & O'Neill, 2000), since the creativity of a team depends on how the process is managed (Levi, 2001). In this respect, clarity of the teamwork process provides guidance for the team members on how they can collaborate effectively to ensure that each team member provides an effective contribution into the teamwork goals. Effort synchronization entails that team members need to find a common definition of their central goal, expected outcomes, teamwork processes and their goal translation into concrete steps during which each of the disciplines can contribute.

Synthesis management: towards overcoming input disconnection and wasting of ideas in transdisciplinary teamwork

Creative synthesis provides a way for teams to combine their ideas and knowledge into an extraordinary output as creativity involves the ability to synthesize and combine data, concepts, theories and information. New creative outputs comes from the synthesis of making new combinations of existing ideas as creative synthesis recognizes and develops complex connections between previously unrelated concepts (Koestler, 1964). Creative outputs can range from incremental improvements to radical creative ideas for breakthrough new products, services, or processes (Madjar, Greenberg, & Chen, 2011). Nevertheless, to synthesize unrelated concepts and ideas is a challenging task, involving much effort for input re-combination and transdisciplinary teamwork optimization. This situation implies the need for exploring the possibilities to prepare transdisciplinary team members for managing synthesis of ideas and knowledge, which could help them to overcome input disconnection and wasting of ideas. In this paper synthesis management refers to the development and management of team's capability to combine ideas from multiple sources and separate team inputs into a cohesive viewpoint. It entails the combining of different ideas in order to construct a new

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idea or outcome. Based on the observations under this investigation, the following problematic implications could be indicated as related to the need of better synthesis management for transdisciplinary teamwork:

- Some team members were highly competitive in promoting their ideas as the most powerful ones and, in turn, they suppressed the development of a synergistic team environment for joint idea synthesis and encouraged the predominance of one disciplinary perspective;
- Some team members felt that their ideas were not fully incorporated into the final teamwork outcome and believed that the incorporation of their ideas could have resulted in a more effective outcome;
- Some team members didn't show their interest to explore deeper possible complementarities of different disciplines and didn't value the potential benefits of discipline-based differences, which affected the final synthesis of ideas;
- Teamwork lacked neutral and objective leadership for synthesis management of ideas in order to ensure that each discipline contributed sufficiently to the expected outcome of the teamwork.

Synthesis management infers that transdisciplinary teamwork must be open and flexible in the recombination process of ideas, knowledge and concepts. Sometimes potential synthesis possibilities are not immediately clear; therefore, team members must work more synergistically in order to make sense of them and find new connections leading to new creative outcomes. Usually synthesis based on the inputs from different domains and disciplines is a challenging task since specialists tent to think within the boundaries of their field. Creativity has strong ties with a domain, as it was suggested in a three-part theory of creativity that includes interactions among the individual, field, and domain (Csikszentmihalyi, 1988). Despite that a creative person contributes the necessary ability and talent for creative outcomes; nevertheless, specialist receive formal education in a domain, or discipline, which includes exposure to rules, structure, and practices within a specific area of knowledge. Specialists in different domains apply different criteria to evaluate creative products and their domain affects specialist's cognitive processes and approach to problem solving. In order to ensure effective synthesis management process, team interdependence and consensus building play a considerable role as team members build on the capabilities of their fellows – the combinations energized through synergy (Francis & Young, 1979; Johnson & Johnson, 1999).

Developing the conceptual framework for student transdisciplinary teamwork

Research on creativity and transdisciplinary teamwork is still in need for practical application as the gap between research and practice remains. In order to develop a conceptual framework for transdisciplinary teamwork (Figure 1), more emphasis is placed on specific transdisciplinarity-associated capabilities that are necessary for transdisciplinary teamwork and their synergistic potential. The framework presented below identifies essential capabilities necessary for successful

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transdisciplinary teamwork and attempts to answer the question of how to make transdisciplinary teamwork more effective. The literature review suggests that ability to participate productively in reflective, transdisciplinary teams are based on a deep understanding of the nature of communities, effective communication and metacognitive skills, as well as mindsets for engaging in transdisciplinary work and study (Arias et al., 2000). This framework is designed as a synergistic version of necessary capabilities for the management of effective transdisciplinary teamwork and developed as a network of interlinked concepts (effort synchronization management, uncertainty management and synthesis management) that together provide a comprehensive understanding of necessary transdisciplinary teamwork capabilities and mindsets. The literature review suggests that synergy results from the members' interactions as they carry out the task, and when group synergy is achieved, process losses are minimized and synergistic gains are created; therefore, a set of conditions should be in place that enhance the chances of group members working together effectively to get a specific task accomplished (Hackman, 1987; 2002).

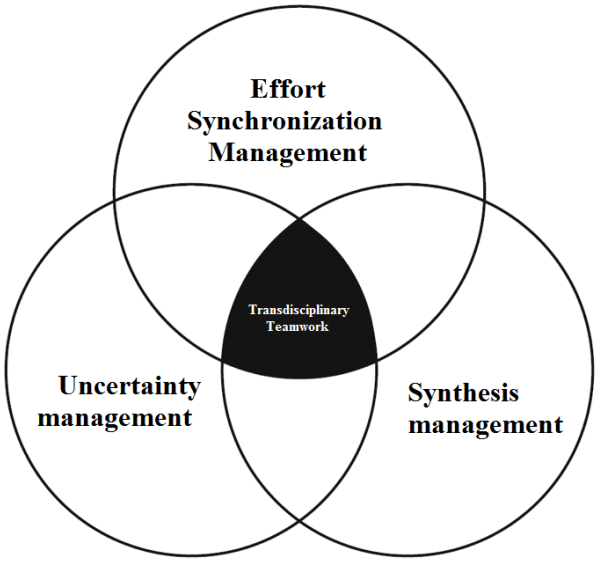

Figure 1: The conceptual framework for transdisciplinary teamwork.

To some extent, this framework has some reference to the systems approach to teamwork, based on the input-process-output model, which examines the factors that individual members bring to the team (input), the interaction (process), and the product (output) (McGrath, 1964; Gladstein, 1984; Hackman, 1987). However, while developing this framework, more emphasis is placed on the specificity of transdisciplinarity in a teamwork setting and the necessary capabilities and their management directly related to transdisciplinary context. In comparison to the input-process-output model of teamwork, under this framework 1) teamwork input infers uncertainty management in order to

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overcome input ambiguity and perplexity; 2) teamwork process infers effort synchronization management to overcome process incoordination; 3) teamwork output infers synthesis management to overcome input disconnection and wasting of ideas. Furthermore, the concepts under investigation in this framework (effort synchronization management, uncertainty management and synthesis management) could potentially be further developed as specific teamwork roles, which are necessary for transdisciplinary teamwork. The literature review suggests that there are many instances of such role-shaping approaches like the coordinator, shaper, planter, specialist, completer, implementer, monitor evaluator, teamworker, and resource investigator (Belbin, 1993); the collaborator, contributor, challenger, and communicator (Parker, 1996); and the contractor, creator, contributor, completer, critic, cooperator, communicator, calibrator, consul, and coordinator (Mumford et al., 2006). Academic research points out that it is important to determine roles by situation and allows team members to review the situation and acclimatize to the needed role (Mumford, Morgeson, Van Iddekinge, & Campion, 2008).

Conclusions

This paper introduced the conceptual framework for student transdisciplinary teamwork by reconciling different streams of literature on teamwork, creativity and transdisciplinarity, and by testing this framework appropriateness in practice by observing three transdisciplinary teams, which were assembled for a new product development ideation. Exploratory results indicated that transdisciplinary teamwork is based on the network of three interlinked approaches related to transdisciplinary teamwork capability development and their management: uncertainty management, effort synchronization management, and synthesis management. The proposed synergy-driven framework is a construct in which each approach plays an integral role and presumes relationships among them. The development of this framework placed focal emphasis on the specificity of transdisciplinarity in teamwork by introducing the necessary capabilities and the importance of their management. This paper provides insight into how some transdisciplinary teams could achieve extraordinary levels of creativity by reconsidering the collective process through which a variety of perspectives, ideas, knowledge and expertise are being integrated in order to create new, creative and extraordinary outputs.

The framework has a potential to be further developed into transdisciplinary teamwork guidelines, which could be applied for team preparation to tackle transdisciplinarity-related issues. The premise is that by knowing about the process and specificity of transdisciplinary teamwork, team members may better coordinate the ideation process and take creativity and innovation to a higher level. The framework also have implications for team facilitators willing to improve team performance and cohesion in a transdisciplinary setting. Moreover, this exploratory research offers many opportunities to advance future research on transdisciplinary team creativity in an applied setting by bridging the gap

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between research and practice. The limitation of this research is that data was collected within few teams; therefore, this has clear implications for external validity of the findings. Future research could extend this framework appropriateness in more diverse transdisciplinary teams and on a larger scale. Another potential of this research is to explore the potential of training before team engagement and its effect on team performance.

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