A Student Project as an 'Extra Group Member'
A Metaphor for the Development of Creativity in Problem-Based Learning (PBL)

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Abstract
This article focuses on a research question: how can we understand a metaphor describing a student project as an 'extra group member' in creativity development in the particular context of Problem-Based Learning (PBL)? This metaphor takes its theoretical departure from social approaches to learning, creativity, and PBL. It is empirically based upon a Ph.D. study (2008-2012) which aims to explore the influence of the PBL environment on the development of university students' creativity. The empirical data was collected using multiple methods, such as interviews and observation, with 65 students from Electronic Systems, Medialogy, Architecture and Design, and Computer Science at Aalborg University (AAU), Denmark. By focusing on the illustration and discussion of the metaphor, this article contributes to an understanding of the role of student projects in building a situated creative learning community that has practical, theoretical, and methodological significance.

Keywords Creativity, Student Project, Group Learning, Problem-Based Learning (PBL)

Introduction

All innovation begins with creative ideas. The successful implementation of new services, new programs, or new product introductions depends on a person or a team having a good idea – and developing that idea beyond its initial state (Amabile, Conti, & Coon, 1996). Therefore, numerous commentators have argued that enhancing the creative performance of employees is a necessary step if organizations are to achieve competitive advantages (Oldham & Cummings, 1996). The increasing need for creativity has also changed educational strategies – so that creativity becomes one of the key elements emphasized in the curriculum across domains such as engineering, science, economics, business, art (Jackson, Oliver, Shaw, & Wisdom, 2006), and design (Li, 2011), etc.

Recent studies (Tan, 2009) have suggested that Problem-Based Learning (PBL) can be a potential strategy for fostering creativity in university students. According to the literature (De Graaff & Kolmos, 2007), Don Woods, who worked with chemistry students in McMaster University in the 1960s, originally coined the term 'PBL'. However, the popularity and subsequent worldwide spread of PBL is mostly linked to the introduction of this educational method at the medical school of McMaster University. PBL has since been introduced into many educational fields and appears to be of growing interest to various countries. Although PBL has diverse models, its core philosophy is 'student-centered learning' (Tan, 2009). In practice, students' learning centers on complex problems that do not have a single answer or on solving real-life projects. Students work in collaborative groups to identify what they need to learn in order to solve problems. The teacher acts to facilitate the learning process rather than to provide knowledge (Dolmans et al., 2005). Since using student projects is a popular way of organizing learning activities in PBL, the links between creativity and the influence of project contexts have been mainly built on theories of social approaches (Tan, 2009). As the literature (Amabile, Conti, & Coon, 1996) argued, departing from the earlier traditional psychological approach to creativity, which focuses on the characteristics of creative persons, the social environment becomes the focus in later studies which see creativity as a context-based activity. Relating this point to social theories of learning that understand learning as changing the form

of participation in social practice (Wenger, 1998), creative learning is located in the situated model (Tanggaard, 2014).

In light of the above, this article particularly pays attention to the role of the student project in creativity development in a PBL environment. A metaphor is proposed describing a student project as an 'extra group member.' In a broader sense, such a metaphor is inspired by previous studies on relationships between actors, practical context, and their dialogues from diverse approaches such as phenomenology and hermeneutics (Ricoeur, 1975). For example, Gadamer (2004) emphasizes that understanding and interpretation are related to verbal tradition in a specific way. But at the same time they transcend this relationship not only because all the creations of human culture, including the nonverbal ones, can be understood in this way, but more fundamentally because everything that is intelligible must be accessible to understanding and to interpretation. Van Manen (2007) suggests a phenomenology of practice operates in the space of the formative relations between who we are and who we may become, between how we think or feel and how we act. Halling (2012) emphasizes teaching students about phenomenology by highlighting experience. However, the 'experience' refers not only to what the research students do to get experience, but also the collective reflection on experience as a source of understanding. However, the metaphor to be discussed in this paper is empirically based on a Ph.D. study (2008-2012) in a particular context of PBL. As mentioned, most discussions on the link between PBL and creativity have been explored within the framework of teaching and learning (Tan, 2009), which is greatly influenced by theories such as situated learning in community of practice (Lave, 1996; Wenger, 1998), social constructivism and social culture, etc. (Zhou, 2012). Thus, this paper takes the social approaches to creativity, learning, and PBL as the theoretical departure of the metaphor. It not only contributes to how to better develop creativity in PBL, but also to deepen understanding on the interaction between the creators and their practice in a group learning context.

Theoretical Departure: Social Approaches to Creativity, Learning, and PBL

Creativity as Shaping New Knowledge in Learning Context

Creativity is typically defined as the ability to produce work that is novel (i.e., original, unexpected), high in quality, and appropriate (i.e., it is useful, meets task constraints) (Beghetto & Kaufman, 2007). Although any creative ideas are generated from personal minds, creativity does not occur in a vacuum. This means that when we examine a creative person, a creative product, or a creative process, the environmental milieu cannot be ignored (Lubart, 1999). Thus, creativity is a context-based activity. It cannot be dissociated from its social, cultural, or evolutionary contexts (Mayer, 1999). These are the core points of the social approach to creativity. When something is social, it is automatically interconnected and has reference to other people and to its environment (Zhou, 2012). Similarly, social theories of learning emphasize that learning is a process that takes place in a participatory framework, not just in an individual's mind (Wenger, 1998). Learning is a search for meaning rather than just a matter of memorizing the 'right' answers and repeating someone else's meaning. Thus, social approaches to education call for learning by doing, hands-on problem solving and the construction of interactive understanding (Zhou, Kolmos, & Nielsen, 2012).

Therefore, learning is a fundamentally social and everyday phenomenon and the changes in social practice which it involves are likely to require creativity on behalf of the participants to come through and this can sometimes also cause innovative changes in the practices involved. As such, creativity is a necessary ingredient in learning processes which involve the handling of situations, tasks, and practices in new ways (Tanggaard, 2014). Moreover, we can see creativity as, effectively, offering students opportunities to shape new knowledge. When students learn something new, they are making new connections between ideas and making sense of them for themselves and are thus constructing knowledge. In this sense, we could perhaps describe what the students are doing as 'being creative' (Craft, 2005). In this way, learning and creativity can go hand in hand, especially in collaborative contexts (Eteläpelto & Lahti, 2008).

PBL as a Learning Model for Creativity Development

Previous studies (Zhou, 2012) have discussed that there are at least three aspects of PBL that satisfy the conditions of creativity development: 1) problem orientation and project work: the point of departure in open and real life problems; 2) group learning context: the process of group collaboration in searching for solutions; and 3) the shift from teaching to facilitation: the idea of facilitating student directed learning rather than teaching. So the researchers (Tan, 2009) also discussed how to better develop creativity and group dynamics in PBL. For example, Gerhardt and Gerhardt (2009) emphasize the group context affords opportunities to enhance creative output. Groups involve general participants, implying increased resources, ideas, and energy. Groups have the potential to generate their own synergy, ideally allowing the group to go beyond the capacities of individuals working by themselves. However, attention to group structure, group management, and conflict resolution, as well as knowledge of common group-related difficulties, can help the facilitator in making PBL a success.

Regarding the role of the student project in creativity development in PBL, the literature has emphasized how project tasks can help to increase motivation, stimulate interplay between individual and group creativity (Zhou, 2012), and construct a learning community (Porath & Jordan, 2009). There are also discussions in relation to learning and games (Gee, 2008) and play-based PBL (Kiib, 2004). However, most of the previous studies have not paid special attention to that in order to build a successful PBL environment, the student project should be integrated into parts of group learning life in creativity development. This calls for this paper to fill this research gap both theoretically and empirically.

Empirical Resource: Selected Work from a Ph.D. Study

This article draws its selected research resource from a Ph.D. study (2008-2012) (Zhou, 2012) which focuses on the influences of PBL on the development of creativity in higher education. Aalborg University (AAU) in Denmark, which has a long tradition of PBL, was the main site for the research. Students at AAU are required to complete approximately 50% course work and 50% project work in groups in each semester (Larsen, Nielsen, & Zhou, 2013). The selected empirical work was carried out with students from Electron-

ic Systems, Computer Science, Architecture and Design, and Medialogy (Table 1).

Table 1. Selected Empirical Work from a Ph.D. Study

Topic	Group creativity development in a Problem and Project-Based Learning (PBL) environment in engineering education
Research Context	Aalborg University, Denmark
Research Time	2008-2012
Research Questions	How do engineering students develop group creativity in a PBL environment (in Denmark) and how can the use of PBL contribute to the development of group creativity in engineering education?
Research Methods	Qualitative methods
Data Resource	53 interviews with students from Computer Science, Architecture and Design, Electronic Systems, and Medialogy at AAU. The students were in their third, fifth, and seventh semesters. The interviews were focused on the interplay between individual and group creativity in a PBL context.
	12 interviews with students and observation (across three semesters) in a student project AAUSAT3*. The interviews focused on the motivation for creativity in project groups. The observation focused on the students' group meetings and the processes being used for solving problems.
	*AAUSAT3 is the third student satellite; the project began in 2007 and it was launched late in 2010. The mission of the satellite project was to carry out and operate the Automatic Identification System (AIS) payloads which are intended to be used by ships to communicate with each other. AAUSAT3 is a joint venture with several departments including Electronic Systems, Mechanical Engineering, Computer Science, and Energy Technology. Students from the 1st to the 10th semesters were encouraged to participate in AAUSAT3 according to the different rates of the task.

As Table 1 shows, a total of 65 students were involved in selected empirical work. The data was collected by multiple methods such as interviews and observation. As the collection of the data has led to valuable findings in the Ph.D. study (Zhou, 2012), this article builds upon those findings that further contribute to theoretically forming the metaphor.

A Metaphor: Student Project as an 'Extra Group Member'
What Does the 'Extra Group Member' Mean?

The Ph.D. study (Zhou, 2012) involved interviewing students about topics such as the interplay between individual and group creativity and the motivation for group creativity. The data showed that most of the students in one group were not only learning partners but also friends. They had shared leadership – every member is responsible for different parts of the project tasks. Peer learning and group facilitation can improve motivation. Thus, findings which underpin group learning provide the conditions for the development of creativity. This provides a means for students to share and examine others' interpretations and perspectives as they work through a problem. Another feature of group learning is that it can be facilitated by reflection from practice. For example, in AAUSAT3, students can make sense of their project experience and assess its meaningfulness by means of reflective practices. Based on these observations, when a group has a particular problem, members tend to collect data or look for different solutions first, and then identify the best one through discussions with each other. Finally, they examine ideas in practice. If the ideas do not work, they will reflect on and discuss the situation further until the problem is solved (Zhou, Kolmos, Du, & Nielsen, 2011).

As all students' learning activities center on project work, progressing through projects leads to the achievement of both individual and group learning goals. So the metaphor is inspired by the above points that regard a student project as an 'extra group member' in the creativity development of student groups in a PBL environment. This means that students' creativity can develop out of 'conversations' between students and an 'extra group member.' The conversations are 'back and forth' processes – the 'extra group member' 'asks' students to meet task challenges, 'calls for' group discussions, 'speeds up' group decision making, and 'gives reminders' of

the deadline of project reports; the students react in collaborative ways in order to 'answer' the 'extra group member.' The creative group ideas are the results of such 'conversations.' During such processes, individual motivation is stimulated and the group dynamic is strengthened, thereby facilitating deeper learning in the process of converting tacit experience into explicit knowledge (Zhou & Kolmos, 2013). Accordingly, the 'extra group member' contributes to setting students in a situated creative learning community.

Setting a Situated Creative Learning Community

Broadly, the concept of community refers to a group of people working together with a common set of goals and interests. So the learning community emphasizes its support of the building of 'intellectual camaraderie' – people constructing knowledge based on their personal understanding and shared experiences, and explaining how meaning is made out of the similarities and differences between their own understandings and their new insights (Porath & Jordan, 2002). The Ph.D. study (Zhou, 2012) shows that, by solving real-life problems, student projects provide opportunities for students and teachers to become partners within a creative learning community. Social support groups or networks are vital for creativity to flourish. Interpersonal relationships within a creative learning community promote a sense of group loyalty, a willingness to help each other, a sense of inclusiveness that respects diversity as well as personal and social growth, high levels of participation, greater quality of discussion and questioning, the use of diverse strategies for problem solving, and increased risk taking in forming points of view or opinions (Porath & Jordan, 2009).

In such a creative learning community, students engage themselves in interdisciplinary learning (Savin-Baden, 2000). Interdisciplinary projects require the contributions of multiple disciplines. For example, in AAUSAT3, students should learn knowledge related to communication, electronics, mechanics, physics, and energy technology, etc. Creativity usually happens when the boundaries between disciplines are broken. As Wenger (1998) suggests, participating in interdisciplinary projects exposes practitioners to others in the context of specific tasks that go beyond the purview of any view of any practice. People confront problems that are outside the realm of their competence but this forces them to negotiate their

own competences with regard to the competences of others. Competence and experience have different relationships at the core and at the boundaries of practices, at the encounters between generations and in the relationships of power among participants. The innovation potential lies in the combination of strong practices – people who can engage across boundaries, but have enough depth in their own practice so that they can recognize when something is really significantly new.

However, students can gain more than knowledge in a situated learning context. Students involve themselves in self-directed learning, group coordination, and project management. So they can improve themselves by dealing with complexity and uncertainty in learning processes. As well as a series of creativity-related skills such as critical thinking, openness, and leadership which can be mastered, collaboration over the situated learning can lead to outcomes that could not be predicted solely from the student groups. This is what Sawyer (2003) suggests – that creativity is an emergent process that involves a social group of individuals engaged in complex, unpredictable interactions. However, solving real-life problems in project work can meet the conditions of the emergence of creativity.

Why the Metaphor? Practical, Theoretical and Methodological Significance

Situating creativity as emerging from systems implies that it has something to do with 'being in a relationship.' But can we also understand creativity in a more holistic, connected, and perhaps even constructive sense of relationship? By regarding a student project as an 'extra group member,' the metaphor contributes to the response to the question asked in the particular context of PBL. This 'relationship' can be seen as a form of dynamic interaction, including that between learner and learner, learner and teacher, teacher or leaner and themselves. It also includes the relationship between the learner and the discipline itself. Creativity is social-constructed as dialogic and not as unitary (Craft, 2006).

In PBL practice, the metaphor implies being more aware of the complex interactions and interdependencies between teacher, learner, and project task. As Jackson and Sinclair (2006) suggest, in order to have a maximum impact, every teacher must be deliberately aware of the ways in which they are likely to impact on any kind of

provision and any learner response. This could be of particular interest in the context of innovation in general, where, for example, students may not be motivated to try out new ways of working, where they may not have adapted appropriate cognitive and metacognitive strategies, and may find this difficult without support, and hence may lose their perceptions of efficacy – again impacting on motivation. In PBL, the metaphor calls on the supervisors to give greater attention to group dynamics and to the relations between project and group dynamics. As the 'extra group member,' the student project paves the way for student groups to step into the situated creative learning community.

A recent study (Tanggaard, 2014) has suggested a situated model for creative learning, by emphasizing three learning principles: (1) immersion in the topic of interest, (2) experimentation and inquiry learning, and (3) resistance to the material of interest. The three principles are coherent with each other and underline different aspects of supporting creativity such as domain and knowledge, experience of experimentation, and relations between materiality and creators. In a PBL context, the student project helps the student groups to cross all three learning principles involved in developing creativity. In this sense, the metaphor in the article deepens the situated conceptualization of creativity. Meanwhile, as the metaphor is given with the subject matter of meaning, it brings lively descriptions about how creative ideas are generated through the learner's participation, collaboration, and engagement in social practice. It underpins the previous points including 'creativity is constructive,' 'creativity comes from dialogue,' and 'creativity is in relationship,' etc. (Craft, 2005) which have been argued from social approaches.

The theoretical significance of the above may lead to some methodological rethinking. As Craft (2005) states, since the 1990s the predominant methodologies for investigating creativity in education have shifted from large-scale studies aiming to measure creativity towards ethnographic, qualitative approaches to research focusing on the actual site of operations and practice, again situating creativity in the specifics of the underlying disciplines, and in the social and cultural values and practices of the particular setting. Therefore, the metaphor discussed in this article is the epitome of such a shift. Although many studies have attempted to explain the relationship between creativity and the social environment, this metaphor particu-

larly emphasizes the systematic view of creativity and creative co-construction. This firstly avoids there being an unnecessary focus on the creators' behavior and secondly allows for a consideration of the context the creators are operating in. In short, the metaphor indicates, using the research language of creativity, 'who is creative,' 'where creativity happens,' and 'how creativity comes into being'; questions which cannot be isolated from each other. Thus, in future studies, it may be necessary to break the codes of the dialogue in creative co-construction, and to take notes of the relationships that exist with regard to creative interaction. So the 'extra group member' should 'speak' with other members in the student group in a way that requires more effort to re-write the research language of creativity for a situated learning context in the future.

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