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THE INTERDISCIPLINARY JOURNAL OF PROBLEM-BASED LEARNING

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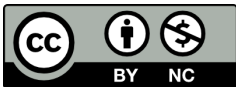

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Educating Students for a Complex Future: Why Integrating a Problem Analysis in Problem-Based Learning Has Something to Offer

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ABSTRACT

The aim of this paper is to raise awareness of problem-based learning (PBL) and more specifically the problem analysis as a set of learning principles and practices offering the potential to bridge higher education to the complexities and uncertainties of science and society. Literature on PBL often argues that PBL supports education aimed at developing students' competences in problem-solving. However, as we increasingly face complex and wicked problems, we cannot assume that problems can be solved based on existing methods and theories; the focus needs to shift from problem-solving to problem analysis and complexity navigation. This paper describes and discusses the need to focus on authenticity, exemplarity, and interdisciplinary as key educational concepts when developing competencies to analyze complex problems. In addressing these key concepts, the paper touches upon the didactical implications of problem analysis as the most important competence to achieve during higher education and as essential when moving beyond education and into a complex world where problems are always interrelated, as reflected in the UN's Sustainable Development Goals.

Keywords: reflective thinking, problem analysis, wicked problems, sustainability, interdisciplinary, John Dewey

Introduction

The establishment of the 17 Sustainable Development Goals (SDGs) by the United Nations (UN) underlines the fact that we are currently standing at a crossroad. The driving paradigms of recent decades—emphasizing material gains and financial prosperity—no longer match the realization that work is needed to secure sustainability and honor the pledge to leave no one behind (United Nations, 2017). Education plays a vital role in the development of a sustainable future, as underscored by SDG 4: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations, 2015). In this context, education systems and pedagogical approaches applied are pivotal in educating the workforce of the future and, not least, safeguarding the skills and competences needed to meet the challenges for humanity that lie ahead.

For example, as resources become increasingly scarce, they need to be used very deliberately. Thus, it is not recommendable to engage in problem-solving processes without a thorough analysis of the problems before us—problem-solving via trial-and-error is no longer a sustainable approach. When engaging in problem-solving processes, it is essential to ensure that we focus on the most relevant and important issues, including a thorough understanding of problems in relation to other problems, in relation to available resources, and in relation to potential consequences if they are not solved. In other words, when working with problems, competences are needed to ensure these problems are assessed and prioritized prior to starting the actual problem-solving process. Thus, a deliberate and through problem analysis is required (Holgaard, Guerra, & Kolmos, 2017; Qvist, 2004). In light of this, it is no longer "enough" to educate students to become excellent problem-solvers. What matters is education

focused on developing the students' skills in identifying and analyzing problems, taking into account the complex and interdisciplinary realities in which problems are usually set.

Applying a responsible research and innovation (RRI)[1] approach and taking inspiration from the SD[1]Gs, the EU Commission has highlighted the importance of interdisciplinary collaboration if we are to develop solutions that adequately tackle the challenges of the future. This demands a greater degree of active involvement on the part of politicians, innovators, researchers, and other stakeholders in analyzing, identifying, and solving problems, incorporating diverse actors in a collaborative approach. Interdisciplinary collaboration is not something that comes easily, however (Frodeman, Klein, & Pacheco, 2017). Interdisciplinary collaboration requires skills that must be developed both in theory and in practice. In this regard, higher education plays a significant role (DeZure, 2010).

As new competencies are required to access political agendas of, for example, realizing the SDG, the debate about pedagogical approaches is becoming more pressing. In this paper, we focus on one such approach, namely that of problem-based learning (PBL), and more specifically the processes of conducting a problem analysis leading to thorough understanding of the problem to be solved. PBL, an acknowledged pedagogical approach within higher education since the end of the 1960s, directly take problems of science and society as a prerequisite and departure for learning. In this paper, we investigate PBL as a potential pedagogical approach enabling students to develop competencies required to handle wicked problems into the future. We introduce and discuss the process of problem analysis as an integrated and essential part of the PBL process and we highlight the notions of inter-disciplinarity, exemplarity, and authenticity as key to the problem analysis and consequently to the use of PBL pedagogy in higher education. These three key notions embedded in PBL, we argue, are central to the assertion that PBL is an appropriate and contemporary educational strategy. Further to this we reflect upon some of the organizational challenges that universities face when aiming to educate students to handle complex problems of the future. With this paper, we wish to bring awareness of PBL as a set of principles about learning, which hold often unrealized potential to bridge higher education to the complexities and uncertainties of science and society.

Higher Education and the Race for the 17 Sustainable Development Goals

The overarching goal of the SDGs is to alleviate poverty, leaving no one behind. The complexities of reaching this goal in a sustainable manner is reflected in the 17 interrelated goals and their respective indicators and objectives. Realization of each of the individual goals is impacted by the others. It is not enough to navigate through a narrow lens of discipline or scientific domain to address the problems implicated in each goal, as real-world problems cannot be confined to one disciplinary box (Petrie, 1992). The 17 SDGs represent a strong articulation of the complexities faced by industry, organizations, public sectors, and civil societies. Together, they articulate particular needs for knowledge, skills, and competencies, which ideally would be matched by the approaches to learning adopted by higher education institutions. Thus, higher education institutions need to ensure that students develop the competencies to understand the problems of their chosen discipline or domain not simply as a delineated problem but always as part of something broader, something bigger, and something more complex.

Both the public and private sectors have already recognized the need for a change in competencies. Employers are focusing extensively on continuous development of competences and skills, with a special focus on digitalization. A high level of professional competence is perceived as essential to stay competitive, followed by an overarching focus on innovation. Attention has focused primarily on how to apply innovative processes in organizational practice while at the same time balancing the act of exploration and exploitation (Andriopoulos & Lewis, 2009; March & James, 1991). Levinsen (2012) argues that in years to come, employers will not only require employees to be highly skilled in their own field but will also increasingly demand global outreach and the ability to collaborate with different cultures and professions.

Moreover, organizations' and companies' growing interest in exploring the potential of SDG-inspired business models (Morioka, Bolis, Evans, & Carvalho, 2017) points to a continuous balancing act of employers. On the one hand, they require specialist knowledge to solve specific problems within specific domains. On the other, they seek competencies to handle wicked problems reaching well and truly beyond the grasp of any single scientific domain or individual.

1 https://www.rri-tools.eu/about-rri

Principles of PBL and Problem Analysis as Potential for Enhancing Student Competencies

PBL was first introduced at McMaster University, Hamilton, Ontario, Canada, as a critical response to the way medical students met the reality of medical problems when they embarked on their residency (Barrows, 1986). The development of a problem-based approach recognized how disciplines and knowledge could not in themselves prepare students for the complexities and uncertainties of a busy hospital ward. A shift in educational approach was deemed necessary. Diving a little deeper into this realization, it could be argued that the essential question was how to design an educational approach that met the needs of these students. The approach would need to offer insights into the world of complex problems awaiting the students upon completion of their studies. At the same time, it was important not to overwhelm the students with all imaginable variations of problems.

Three significant notions underlie PBL and, more specifically, the part of the PBL process relating to understanding and placing the actual problem into context. First of these is exemplarity: How can we ensure students encounter relevant examples from which they can deduce strategies and knowledge that can be brought into new settings? Second is authenticity: How can we, through education, bring the problems and scenarios of professions closer to the ways of thinking of students? Third is interdisciplinarity: How can we educate students to embrace problems and perspectives outside their chosen domain? Thus, the challenges to education are not confined to ensuring state-of-the-art and discipline-specific knowledge, but also include ensuring development of competencies to meet wicked problems and put state-of-the-art theory and method into concrete practice.

When looking at the PBL literature, the concept of the problem analysis, i.e., the process during which students identify, analyze, and formulate their problem, has received limited attention. This is puzzling since the problem-analysis can be considered the first step in the PBL process, and the notions of exemplarity, authenticity, and interdisciplinarity are integrated in the problem analysis process. In the following sections, we outline why a problem analysis is important in light of the SDGs, and why exemplarity, authenticity, and interdisciplinarity are significant pedagogical notions to be considered during a problem-based problem analysis.

The Problem Analysis: What is the Problem?

Schön (1987) argues that it is not enough that students can apply theories in solving a pre-determined problem; they must also be able to define the problem and apply the relevant theories and methods in the problem-solving process. We agree with Schön that students must possess the ability to analyze a problem and critically select the most appropriate theories and methods in the problem-solving process. However, Schön misses one important element, namely the phase of problem analysis. Becoming skilled in problem analysis implies that students learn how to "identify, analyze and formulate the problem in context, as problems do not just magically appear in a format that calls for specific (…) solutions" (Holgaard et al., 2017, p. 1083). If students do not become competent in problem analysis, they do not possess the competences needed to gain an in-depth understanding of what is behind the situation and are not in a position to evaluate the most relevant and important problem(s) to engage in. The process of problem analysis is iterative, as the students (or the employees) continually acquire more knowledge, which widens their perspectives and thus also the trajectories to viable solutions (Holgaard et al., 2017). The objective is to remove the risk of investing resources in a problem of low relevancy and low impact.

Traditionally, the starting point of the learning process in PBL is the problem (De Graaff & Kolmos, 2003) and much literature explains how to define good, suitable, and robust problems (Jonassen, 2010). Developing an exhaustive taxonomy of how to design problems for particular curricula would thus seem advisable. Savin-Baden and Major (2004) find that defining a taxonomy for problem design is only possible in theory and not in practice, due to the nature of knowledge within different disciplines. They also note that knowledge is used in different ways. The discussions regarding problem design are often based on the assumption that the problem is defined by the teacher or instructor and not by the students. Another assumption put forward regarding the complexity of problems is that first- or second-year students cannot work with complex problems, so this approach is reserved for more experienced students in higher semesters. These assumptions point in the direction of the teachers' philosophy of learning. Savin-Baden and Major (2004) point out a paradox: When a study program or a group of teachers decides to implement PBL, content often plays an important role in defining the course, as the problems are defined to fit the content that the teachers believe the students should cover and objectives set out in a curriculum. The intentions behind this way of designing education are good; however, focus remains on students learning pre-prescribed chunks of knowledge that is "highly tutor-directed and gives students little choice about what it is they learn" (Savin-Baden & Major, 2004; 66). PBL is only implemented on the surface. Often the teacher makes a short description or a vignette (Edens, 2010) of the problem, and sometimes a problem formulation is included as well. In this way, the teacher tries to assure the quality of the problem and make

sure the solution will not be straightforward. A number of problem design models have been developed, e.g., Hung's 3C3R model (Hung, 2006), which focuses on core elements that support content and conceptual learning, and processing components that focus on students' cognitive processing and problem-solving skills (Holgaard et al., 2017; Hung, 2006).

What characterizes models like the ones outlined above is that the problem is defined by the teacher, implying that the problem is the teacher's and not the students'. The students are told "this is a problem, go solve it." The students become good at solving problems, but not skilled in problem analysis and even less competent in assessing the relevance of the problem in relation to other problems.

The American pragmatist John Dewey argued that problems to be investigated in educational settings should not be defined by the teacher, because even though the teacher would only present and not solve the problem, the problem would remain the teacher's. Dewey's argument was that learning occurs when one feels perplexity, e.g., when one's way of handling a situation suddenly does not turn out as expected. The problem becomes important to students because they feel it (Dewey, 1933). The teacher presenting a problem does not make it important; it is placed upon the student from the outside. The potential learning outcome is reduced when the teacher defines the problem (Dewey, 1938). Often, Dewey is mentioned as a key inspiration for PBL. It is therefore somewhat surprising that his very explicit focus on learning based on an inner experience of perplexity is absent in the discussion of PBL and the role and contribution of the problem analysis and identification of problems.

It can be tempting to skip the problem analysis part and turn to problem solving, as the former is analytical whereas the latter is action-oriented. Facing a problem, we more or less instinctively turn to problem-solving. To remove the complexity of the problem analysis process, Holgaard et al. (2017) have suggested "a step-wise model for students to identify, analyse and formulate a problem with staff facilitation" (Holgaard et al., 2017, p. 1076). In this model, the students are the ones undertaking the problem analysis and formulating the problem. The teacher's role is to act as a facilitator supporting the process. The model is illustrated in the table below.

The problem analysis provides the opportunity to reflect on the relevance and assess the validity of the arguments that suggest a problem is a scientifically relevant problem, and thereby serves the purpose of "analyzing the background of the problem that eventually is to be defined and articulated in the problem statement" (Throndahl, Velmurugan, & Stentoft, 2018, p. 433). The competence to work out a thorough and structured problem analysis is highly relevant in the face of complex problems in practice, and the five-step model offers useful guidance in this context.

Step	Purpose
1: Relating to a theme	Clarifying the boundaries to (1) align with the learning objectives and (2) provide overview of interacting domains.
2: Mapping the problem field	To screen for opportunities in order not to focus on one problem area by chance but get an overview of what the theme can offer.
3: Narrowing down the problems	To evaluate, narrow down and select one problem to focus on out of several problem areas and problems revealed in the problem field.
4: Problem analysis and contextualization	Analyzing the chosen problem, substantiate claims and expand the knowledge of the problem to pinpoint specific motivations for action.
5: Problem formulation	To clearly state the point of departure for the problem-solving process, creating the bridge between the problem analysis and the problem-solving process.

Table 1: Matrix with the five steps, key purpose of a problem analysis (Holgaard et al., 2017)

The five-step model above is, however, instrumental in the sense that it describes the different elements in the problem analysis process and the types of questions relevant to ask throughout the process. What seems to be missing, though, are the underpinning principles of learning that make the five-step process relevant.

In the following we dive deeper into these principles as we explore what constitutes the problem analysis in PBL. We do this as we uncover the principles of authenticity, exemplarity,

and interdisciplinarity and discuss how these notions connect PBL with the complex problems eminent in, for example, the SDGs.

Authenticity

Authenticity of a problem is often mentioned as that which can trigger students' interest and motivation, challenge and curiosity (Ge & Chua, 2019). Honebein et al. (1993) add that for an activity to be authentic the students must feel they have ownership of their learning and performance—two aspects perceived as positive drivers for learning. However, from our perspective, authenticity is more fundamental than just supporting interest and curiosity. The importance of authenticity of the problem is underscored when considering a problem as a reflection of what is to come for students when they graduate and move into their chosen profession. In work settings, employees are not confronted with well-structured problems, and they are generally not told which methods or theories to apply. Rather, the expectation of graduates is that they have gained skills and competences during their education enabling them to understand the complex problem and design a relevant solution. Thus, students must be exposed to authentic problems to avoid education becoming a laboratory distanced from organizational practice (Dewey, 1933). It is therefore important that students experience the complexity of real-life problems as part of their education, as the problem is placed in a broader organizational or societal context. In this way, problem-solving does not become problem-solving as an isolated phenomenon. Rather, it becomes problem-solving with a broader purpose and any one problem must necessarily be understood in relation to others.

Exemplarity

The principle of exemplarity is important whether learning is intended to take place in organizations or in higher education. Exemplarity is the process of linking the particular to the general and vice versa, showing us that the problem can be re-discovered in other similar contexts. Thus, exemplarity is what makes learning worthwhile, since what we learn in one context can enhance the way we address similar problems in new settings (Illeris, 1974; Negt, 1975; Servant-Miklos, Norman, & Schmidt, 2019). From a PBL perspective, exemplarity is reflected in the problem analysis as students recognize the problem as one representing ways of thinking and acting also relevant in similar authentic contexts. Through identification, definition, and solving of one particular problem, students are expected to reflect on the transfer of theory and methods to other settings. In other words, exemplarity in PBL means seeking the general in the specific problem. This can be described as follows:

> "Exemplarity implies that learning outcomes achieved during concrete project work are transferable to similar situations encountered by students in their professional careers. This requires that the students understand the context of the problem and of the scope of the conclusions reached by the group. The exemplarity of the project ensures that through their project work, the students will acquire knowledge and competences which are applicable in a wider context than that of the project itself." (Aalborg University, 2015, p. 5)

In PBL the quality of exemplarity is often associated with adding new perspectives during the final part of the PBL process when students reflect on the extent to which their findings are useful in other settings. Regrettably, exemplarity attains much less attention during the opening phase of the PBL process, i.e., during the problem analysis (De Graaff & Kolmos, 2003; Kolmos, Fink, & Krogh, 2004). This is unfortunate as exemplarity is key to the phase of problem analysis where experience and competences are required to qualify the problem at hand. Here, transferring knowledge between knowledge domains is difficult yet essential. This is particularly so when confronted with highly complex problems that are not easily delimited. Thus exemplarity is not just about transferring knowledge between contexts—exemplarity becomes a process characterized by intellectualization (Dewey, 1933).

Interdisciplinarity

Interdisciplinarity has attracted much attention, within higher education in general and within PBL in particular, as it is through interdisciplinarity that students acquire (generic) skills and competences that are easily transferred to public and private organizational settings. In the context of this paper, interdisciplinarity becomes important as it supports the development of the metacognitive competences necessary in the face complex problems. Gourgey (1998) describes metacognition as follows:

> "Whereas cognitive strategies enable one to make progress—to build knowledge—metacognitive strategies enable one to monitor and improve one's progress—to evaluate understanding and apply knowledge to new situations. Thus metacognition is vital to cognitive effectiveness." (Gourgey, 1998, p. 82)

This implies that students get to know when and how to use different learning strategies, "how to [independently] plan, monitor, and control learning; and how to transfer learning skills acquired in the classroom to other contexts" (Gourgey, 1998, p. 81). Interdisciplinarity does not primarily promote students' acquisition of in-depth subject-related

knowledge through memorization; instead application of knowledge occurs relatively to the problem to be solved, and requires reflection on the thinking processes (Ivanitskaya, Clark, Montgomery, & Primeau, 2002; Jacobs, 1989). The problem as the starting point underpins this assertion, as problems—and in particular complex ones—can seldom be solved by application of one discipline in isolation. Students are required to apply different theories, methods, and perspectives in order to identify and analyze the problem. In this way, students acquire a holistic understanding of how different subject areas can be combined. When related to organizations, they understand how different professions can positively utilize their differences to comprehend the complexities of one problem in relation to resources, theories, methods, and priorities.

Thus, interdisciplinarity is understood as students combining different elements or subjects of their education in order to fully comprehend the problem; it is not about students from diverse study programs collaborating to solve the problem. What initially seems to be interdisciplinary turns out to be an advanced edition of mono-disciplinarity. Hence, if we truly believe in the appropriateness of interdisciplinary competence, existing structures and perspectives within higher education must be transformed.

Placing Problem Analysis at the Head of the Table: Didactical Implications

In combination, authenticity, exemplarity, and interdisciplinarity are important elements of the pedagogical approach of PBL. They support students in developing the skills and competences necessary for analyzing and evaluating problems that are expected to become increasingly important. In the following, we highlight some of the didactical implications of placing the problem analysis as a central component of PBL.

Intensifying attention on identification and analysis of the problem marks a change in education. Education is here about educating students so they are equipped to handle complex, unknown, and wicked problems, reflect critically on the situation, integrate on an interdisciplinary level, and connect knowledge and methods in new ways—during problem analysis. As resources are scarce, problem analysis plays a crucial role in ensuring that we fully understand the problem and, based on this, invest resources in the most relevant problem.

If we want students to become competent problem analyzers, educational practices must provide this opportunity. One approach is to engage students in problem analysis, e.g., as part of their collaboration with a public or private organization or NGO. In this context, students would be called upon to analyze and define a problem before solving it. It appears that students become much more actively involved in their learning process in this scenario.

Introducing students to work with a problem analysis based on authentic problems reduces the teacher's level of control, as the relevant theories and methods to focus on cannot be determined beforehand but are defined based on rigorous analysis of the problem. What the teacher can do in his or her role as facilitator is to introduce a number of issues, perspective, theories, models, and methods that might be helpful during the problem analysis. However, the students themselves define which aspects should be included in the problem analysis, and they determine which information resources are useful. Thus, working with a problem analysis means active involvement of the students.

Greater attention on problem analysis and the reduction of control certainly change the role of the teacher, and perhaps they will challenge the teacher's identity too. We acknowledge that in PBL teachers do act as facilitators. However, facilitation often takes place within a relatively well-defined frame. In working with the problem analysis, the role of the teacher is more facilitative, as the role is to ensure that the students move through the analysis process (Dewey, 1933). When students engage in problem analysis, their focus will often be on issues for which the teacher does not have a ready answer. The teacher might not know which theory or method to apply. Thus, the teacher will be challenged in terms of the perception that the teacher must be the one possessing the highest level of knowledge. Likewise, if interdisciplinarity is to become more than a show trial in PBL, fundamental changes are required, especially on the organizational level. At present, separation between study programs, departments, and faculties is a barrier to interdisciplinary activities and learning, in particular because the financial structures are rigid and incapable of handling cross-organizational activities. If interdisciplinary activities involve students from different subjects like business development, software development, languages, and history of art, another organizational challenge emerges, namely, how to assess interdisciplinary learning outcomes. Ivanitskaya et al. (2002) argue that existing assessment methods are not useful. Instead, new approaches must be developed, focusing more on process than on content per se.

Discussion

Interest in exploring PBL as an appropriate approach to equip students with the competences needed to handle the complexities of the future touches upon an old discussion regarding the role of universities in defining desired

educational outcomes. To what extent are universities obliged to take into account societal needs and requests? And should universities be allowed to define what the students should become knowledgeable about based on theoretical and scientific rationales (Clark, 1998; Shapin, 2012; Stensaker, 2015)? If we contemplate the argument that universities are obliged to monitor societal developments and incorporate these in study programs, and in the organizational setup as such, we have to ask how this is possible without universities becoming supernumeraries floating without purpose.

Traditionally, universities are described as the institutions developing rigorous scientific knowledge that is diffused to students, organizations, and other relevant actors—an approach that fits well with the understanding that theoretical knowledge is more valuable than knowledge developed in organizational practice. From this perspective, universities do not need contact with the outer world, as scientists being the most knowledgeable are fully capable of defining the direction of future research. This approach has for decades led to hefty critique of universities, not only in regard to research, but also in regard to the didactical approach.

The lack of linkage between research and practice is not new, and the concern is that the aspiration of a balance between research and practice has shifted to focus on either research or practice uninformed by research (Hoffman, 2004). If we play with the idea that PBL is a relevant approach within research and education and that the problem analysis is an essential part of PBL, what would happen then? First, researchers as well as teachers and students would be obliged to shift their focus from purely scientific issues to the world outside the university, signaling that research and higher education to a greater extent must be informed by authentic and interdisciplinary problems. Thus, the interplay between science and society would be strengthened and the impact would be easier to evaluate. Critics might argue that increasing collaboration with, for example, private companies and organizations will remove researchers' freedom to select their research topics and teachers' roles to determine what constitutes relevant learning. Of course, it is important to keep this potential pitfall in mind; however, it does not eliminate the possibility of a closer integration between research, higher education practices, and society. Moreover, an interdisciplinary perspective on university-industry collaboration can provide new ways of collaboration, e.g., researchers as well as students switching between university and company contexts. However, as research has already highlighted, interdisciplinary research as well as education can be challenging (Frodeman et al., 2017).

PBL in Tackling the Wicked Problems of the Future

We started this paper by stating that the establishment of the UN's 17 Sustainable Development Goals clearly underlines the fact that we are standing at a crossroad, and that education plays a vital role in the development of a sustainable future. As mentioned, it is expected that we will face an increasing number of complex problems in the future, requiring new and innovative problem-solving strategies, which we do not currently have. Thus, the problem analysis, interdisciplinarity, authenticity, and exemplarity discussed in this paper become important elements to focus on. These principles underpinning the problem analysis by no means provide a complete recipe for organizing PBL, but they do set out a possible path. Added to this path should be considerations of reflective thinking (Dewey, 1933), as it focuses on the students' abilities to investigate, relate, and evaluate complex and wicked problems. However, complexity in problem-solving is one thing—the exponential increase in the number of changes another. In conjunction with sustainability, particular technological changes in the domains of software, robotics, and artificial intelligence (AI) are outlined as technologies that will challenge and change how we design jobs in the future. Students are told that they will get the opportunity to design their own jobs, because the jobs they are going to take up are not yet envisioned.

Introducing PBL—including a problem analysis phase—as a didactical move bringing universities closer to organizations might also challenge existing and well-established perceptions, identities, and organizational cultures (Stensaker, 2015). Research has extensively focused on the organizational and didactical challenges of implementing PBL in study programs, whereas research focusing on PBL as an organizational approach to research has, to our knowledge, not been in focus. Thus, research within the area of PBL as organizational approach must be conducted to further assess possible positive and negative implications hereof.

Summing up the discussion on the groundbreaking changes expected to occur in years to come clearly points back on education, and raises the question: Do we educate our students to cope with this complex and dynamic future? By introducing PBL, and in particular problem analysis, the intention is to outline how PBL, as a pedagogical approach, can provide some answers on how to educate students to meet the challenges of the future. We are fully aware that introducing the problem analysis as an integrated and essential part of PBL is not easy. Thus more research and, not least, empirical experiments are needed in order to gain a better

understanding of how PBL—and more specifically, the students working with a problem analysis—can leverage the competences needed in the future.

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