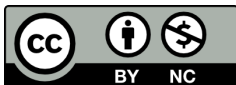# THE INTERDISCIPLINARY JOURNAL OF PROBLEM-BASED LEARNING

The Role of Interdisciplinarity in Bringing PBL to traditional Universities: Opportunities and Challenges on the Organizational, Team and Individual Level

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ABSTRACT

Problem-based learning (PBL) has emerged as a suitable approach to shift from teacher-centered to learner-centered education. However, higher education institutions (HEIs) experience obstacles stemming from lecturers' and students' reservations as well as organizational challenges. Following action research, the author reflects on her implementation of interdisciplinary PBL within one exemplar case study to explore opportunities and challenges of interdisciplinarity in the transition toward a PBL curriculum in a traditional HEI. At the organizational level, interdisciplinarity facilitates collective knowledge creation about PBL by providing interdisciplinary learning spaces and in-house training. At the team level, lecturers as well as students can collectively learn about PBL. At the individual level, interdisciplinary student-to-student and lecturer-to-lecturer learning can enhance personal knowledge about PBL. Monodisciplinary structures, discipline-based differences in teaching and knowledge traditions, as well as individual prejudices are sources of challenges associated with interdisciplinarity in organizational learning.

Keywords: Interdisciplinarity, Problem-based Learning, PBL, Organizational Learning, Higher Education Institutions

Introduction

A 21st century view of education calls for students to develop strong competence and skills in critical thinking and problem-solving, communication, collaboration and team-building, and creativity and innovation (P21, 2012). Higher education institutions (HEIs) are responsible for providing suitable teaching-learning spaces that enable students to develop these competences (Kolmos, Hadgaft, & Holgaard, 2016). The problem-based learning (PBL) approach represents such a pedagogy, marking a shift from teacher-centered to learner-centered perspectives that foster students' competence and skills development (Dole, Bloom, & Kowalske, 2016).

Unfortunately, previous research shows that HEIs experience several obstacles in the shift toward PBL. Lecturers, students, and the organization itself need to be on board to support transition toward this new curriculum. Despite the obstacles, enthusiastic individuals or small teams have sought to bring PBL to formerly "unPBLed" or seemingly "unPBLable" contexts (Savery, 2015). Due to the high potential of switching toward learner-centered teaching, PBL could increasingly be implemented beyond individuals or small teams to foster a wider change within a university. This raises the question of how HEIs can enhance organizational learning to support implementation of PBL. As organizations, HEIs are replete with deep individual expertise, but they lack mechanisms for transferring learning from the individual to the group and then the organization (Reese, 2017). Interdisciplinary interaction and collaboration have been described as a potential way to change HEIs from within (Örtenblad & Koris, 2014), especially in the context of implementing PBL (Braßler & Dettmers, 2017; Dole et al., 2016; Mansor et al., 2015).

The present paper explores the role of interdisciplinarity in the implementation of PBL in traditional universities. More precisely, the present paper investigates the question: Can interdisciplinarity help bring PBL to the unPBLed HEIs?

Rooted in the tradition of action research, the author describes and analyzes her own implementation of an interdisciplinary PBL course to further investigate how organizational learning unfolded within a traditional university. In a first step, the author describes the organization and intervention of one interdisciplinary PBL course in an example case study. Second, the author reflects on processes, impacts, and outcomes in the example case on each embedded subunit within the integrative framework for organizational learning: opportunities and challenges on the organizational level, the team level, and the individual level. Third, the author discusses her findings regarding related literature in organizational learning and interdisciplinarity.

The present paper strongly contributes to the understanding of PBL implementation in previously unPBLed HEIs by identifying opportunities and challenges that come with an interdisciplinary approach on the organizational, team, and individual level.

Obstacles to Implementation of PBL and the Potential Role of Interdisciplinarity

Previous research regarding the implementation of PBL reports several obstacles in the transition toward this new curriculum. First, teaching staff refrain from implementing PBL due to unfamiliarity with the PBL concept, uncertainties regarding their potential new role as facilitators rather than transmitters of knowledge, and avoidance of work overload (AlBuali & Khan, 2018; Dole, Bloom, & Kowalske, 2016; Hung, 2011; Mansor et al., 2015). Furthermore, lecturers experience difficulties in convincing students and administrative staff of the benefits of PBL in an environment where conventional teaching approaches remain predominant (Dole, Bloom, & Kowalske, 2016; Mansor et al., 2015).

Second, there is the issue of organizational resistance to the introduction of PBL. Specifically, this relates to the need for substantial change in the management system and organizational structure within HEIs (AlBuali & Khan, 2018; Dole, Bloom, & Kowalske, 2016). To implement PBL, HEIs need additional space to host PBL sessions and financial resources to pay tutors (AlBuali & Khan, 2018; Hung, 2011) as well as administrative support to handle the challenging logistics of time management (Dole, Bloom, & Kowalske, 2016), classroom coordination (Park et al., 2005), and a shift in assessment formats (Hung, 2011).

Even though there are many obstacles, some lecturers still dare to implement PBL in traditional HEIs. These lecturers gain experience in PBL teaching and could serve as ambassadors for the PBL concept. HEIs often experience difficulties in transferring knowledge from the individual to the group and then the organization (Reese, 2017). HEIs have a strong need to foster knowledge creation and sharing across group boundaries (Dee & Leisyte, 2017).

The present paper explores the potential of interdisciplinarity to bring PBL to formerly "unPBLed" HEIs. The Oxford English Dictionary defines interdisciplinary as being: "Of or pertaining to two or more disciplines or branches of learning; contributing to or benefiting from two or more disciplines." Pursuing the aim of implementing interdisciplinarity in the PBL concept requires two types of interdisciplinarity: interdisciplinary teamwork and interdisciplinary learning. First, there is a need for lecturers to come into interdisciplinary contact and form a team. Then they can plan and execute interdisciplinary PBL. An interdisciplinary team is one constituted of team members from two or more disciplines or functions who have complementary skills and share a common goal and accountability (Clark, Spence, & Sheehan, 1996). For successful implementation of interdisciplinary PBL, an interdisciplinary team of lecturers applies different discipline-based teaching skills and discipline-based knowledge; they share the goal of enabling students to develop interdisciplinary solutions and share accountability for planning and executing a successful teaching-learning arrangement. Second, within the interdisciplinary teaching-learning arrangement, students learn in an interdisciplinary manner. Interdisciplinary learning is defined as a process by which "learners integrate information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines to craft products, explain phenomena, or solve problems, in ways that would have been unlikely through single-disciplinary means" (Boix Mansilla, 2010, p. 289).

Interdisciplinary contact across students and lecturers, collaboration in a PBL setting and exchange and reflection on PBL processes could increase organizational learning across discipline-based boundaries.

Method

Rooted in the tradition of action research (Mertler, 2019), the present paper uses a longitudinal, embedded, single-case design (Yin, 2018) to reflect on and analyze one example case study within a multilevel framework of organizational learning (Brix, 2017). The work presented here is rooted in the tradition of action research because the author took action to drive change within her university. The author served as a participant observer. She intended change towards a PBL curriculum and was driven by her hope for improvement. Her work is based on a positive view on PBL and strong believes in its advantages in contrast to traditional teaching

approaches. In this paper, she reflects on the process, impact, and outcomes of implementing an interdisciplinary PBL course and its function as an intervention for organizational learning within her HEI. For the analysis, she chose a longitudinal single-case design, which she investigated following a before-and-after logic on how certain conditions, processes, and consequences change in one example case (see Yin, 2018, p.51). This analysis and reflection is embedded in subunits of the single case, which are selected due to the integrative framework for organizational learning and knowledge creation: the organizational level, the team level, and the individual level (Brix, 2017). The organizational level addresses the collective and cultural knowledge of the organizational members, i.e., the process of integrating and institutionalizing knowledge about PBL in the example case across discipline-based university departments. The team level addresses the collective knowledge, i.e., the process of interpreting and integrating new knowledge about PBL in interaction with others, in the example case across disciplines. The individual level addresses personal knowledge about PBL, i.e., the process of intuiting and interpreting new information by individuals from different disciplinary backgrounds.

Description of the Example Case

In this section the author gives a brief description of the organizational level of the HEI, the University of Hamburg. Thereafter, the author describes the intervention within the HEI, the development and the implementation of an interdisciplinary PBL course at the team level. Then, the author describes the PBL status quo at the individual level. Further, the author reflects on and analyzes opportunities and challenges of interdisciplinarity in knowledge creation and the implementation of PBL on the organizational, team, and individual level.

Description of the Organizational Level

Founded in 1919, the University of Hamburg has grown to be the largest public HEI in northern Germany. The university's main campus, home to most of the various university departments, is located centrally in the city of Hamburg. Key research areas of the university are: climate, earth, and environment; photon and nano sciences; manuscript research; neurosciences; infection research and structural biology; particle, astro, and mathematical physics; and health economics. With approximately 50,000 students and 13,000 members of staff, the University of Hamburg comprises eight faculties: Law; Economics and Social Sciences; Medicine; Education; Humanities; Mathematics, Informatics and Natural Sciences; Psychology and Human Movement

Sciences; and Business Administration. Each department is independently accountable for its research and teaching organization.

The university's mission statement includes the mission of "interdisciplinary cooperation." In line with its mission statement, the University of Hamburg established several platforms for interdisciplinary contact across different university departments. First, there is the Hamburg Center for University Teaching and Learning as a central interdisciplinary institution for higher education research, teaching, and consulting. Second, the interdisciplinary Center for a Sustainable University acts as a research network, a laboratory for innovation, and an incubator for new approaches, concepts, procedures, and methods. This center is part of the University of Hamburg's identity as a University for a Sustainable Future and facilitates the university's third mission to enable students to address urgent problems regarding sustainability across disciplines (Schmitt & Palm, 2017). Third, there is the Science Café, which aims to connect all members of the University of Hamburg and enable discussion of various aspects of sustainability sciences and provide interdisciplinary insights into sustainable development. While interdisciplinary contact and scientific cooperation are facilitated and installed, interdisciplinary teaching and learning is somewhat neglected and only occurs sporadically. The "Guidelines for University Teaching" at the University of Hamburg call for cooperative learning; PBL, however, is not mentioned and not implemented in practice. Moreover, even though the Center for a Sustainable University is highly interested in identifying and facilitating novel best practices in teaching sustainability, the PBL concept has so far been neglected. Therefore, the University of Hamburg qualifies as an unPBLed HEI.

Description of the Team Level

Three lecturers representing the departments of Psychology, Economics, Education, and Geography met at the Hamburg Center for University Teaching and Learning and quickly discovered their common interest in sustainable development and their desire to improve teaching and learning at the University of Hamburg by implementing an interdisciplinary course on sustainability. After a discussion on preferred teaching methods, the lecturers decided on the PBL approach. The lecturers developed, planned, and executed an interdisciplinary PBL course in the winter term of the academic year 2015/16. The twelve-credit course at bachelor level was attended by 86 students from the departments of Psychology, Economics, Education, and Geography.

Students were first divided into ten interdisciplinary teams with approximately the same proportion of individuals from each academic discipline. Each interdisciplinary

team followed the same steps toward identifying interdisciplinary solutions to a complex problem regarding sustainable development. Students were asked to integrate knowledge from all involved disciplines at every step. First, each interdisciplinary team chose one broad sustainability topic from a selection of newspaper articles. Examples included the refugee crisis, plastic consumption, post growth/sustainable consumption, or recycling. The assignment was to identify a broad problem that cannot be solved within a single discipline and, at the same time, address different disciplines. Additionally, the problem should call not only for a scientific approach, but also a personal and ethical approach, fostering discussion and increasing innovation potential. Second, the students discussed unfamiliar concepts and discipline-based technical terms related to the topic. Third, within their chosen sustainability framework, they defined their interdisciplinary problem statement by integrating viewpoints across disciplines. With regard to their interdisciplinary problem, they brainstormed discipline-based information, data, techniques, tools, perspectives, concepts, and theories related to their problem and collected ideas, explanations, and hypotheses for the underlying problem across disciplines on a pin board. Thereafter, they identified discrepancies, interrelationships, and gaps between the disciplines. Next, they defined interdisciplinary learning objectives by formulating questions that are relevant to the team and addressing each discipline involved. Guided by their questions and interests, students searched for and read academic research papers across disciplines. Back in session, students presented the answers they had found and learning objectives across disciplines, and discussed and integrated their new ideas. They formulated an integrative team statement in regard to their interdisciplinary problem statement by integrating discipline-based information, data, theories, and related research outcomes. Finally, they wrote an interdisciplinary paper with their interdisciplinary solution approaches.

To communicate their interdisciplinary solution strategies addressing complex sustainability problems in society, the interdisciplinary student teams were tasked with producing "lessons learned" videos. In a first step, the students identified their main ideas and developed a story board. Each interdisciplinary team presented their ideas to their peers to gain feedback. Next, they shot and cut their video before finally publishing it as open content on a sustainability blog. To celebrate the students' ideas regarding their sustainability problems, the lecturers organized a short film festival to screen the "lessons learned" videos to a wider audience such as friends and family as well as all interested members of the university and society. All students were graded on their interdisciplinary scientific papers and their interdisciplinary "lessons learned" videos.

During each session, the lecturers rotated between the interdisciplinary PBL teams. Off-sessions, they supported their students with weekly consultation hours: discipline-based expertise on demand, technical expertise on demand regarding shooting and editing of videos, and team expertise on demand in case of conflict within the interdisciplinary PBL teams.

Description of the individual Level

Most lecturers and students had no PBL experience before the implementation of the interdisciplinary PBL course. Only one of the lecturers – the psychology and economics lecturer – has given PBL courses beforehand. Therefore, few students from the economics and psychology department, who participated in these courses knew the PBL method and could apply their knowledge in the interdisciplinary PBL course again.

Description of Opportunities and Challenges on the Organizational Level

PBL-friendly third mission. In line with the University of Hamburg's self-identification as a "University for a Sustainable Future," the lecturers of the interdisciplinary PBL course were highly committed to their personal responsibility for the sustainable development of our world. They strongly identified with the University of Hamburg's third mission to enable students to address urgent problems regarding sustainability across disciplines. The common theme of sustainability was a trigger for them to join educational forces. With the aim of raising awareness on sustainability issues, they chose the PBL approach to address complex real-world problems and promote student learning of different discipline-based concepts and principles regarding sustainable development. Besides the sustainability content across disciplines, the PBL approach was found to be suitable to promote the development of critical thinking skills, interdisciplinary problem-solving abilities, and interdisciplinary communication skills. All of these are strongly called for to facilitate global change with novel ideas and integrative solutions.

Financial support. The university's identity as a University for a Sustainable Future was a thematic aspect of the motivation to implement PBL. Besides the lecturers' thematic impulse to collaborate and choose PBL as the appropriate educational pedagogy, the university's commitment to sustainability was backed up by its provision of the additional financial support needed to successfully implement PBL. Several student assistants were employed to support the interdisciplinary student teams in their learning process, and

additional teaching materials could be purchased. Moreover, the lecturers received additional administrative support from each of the four departments.

Raising PBL awareness. Alongside the additional financial resources, the theme of sustainability attracted students' interest in the course in general. In addition, the final short film festival on sustainability attracted many participants besides students. Other lecturers within all four departments were particularly interested, and this raised awareness of and confidence in the PBL concept.

To facilitate interdisciplinary communication and collaboration, the University of Hamburg implemented several initiatives to incorporate organizational learning across discipline-based boundaries. The Center for a Sustainable University collected best teaching practices in education for sustainable development. The interdisciplinary PBL course was selected as one of the best practices. All collected practices were published as the basis for discussion of the status quo in teaching and to foster further exchange. Based on this publication the lecturers were invited to present their PBL approach and its advantages at a teaching conference within the university. In this context, many lecturers across all disciplines and departments were informed about PBL.

Top-down PBL-questionnaire. Convinced of the advantages of the interdisciplinary PBL approach, the interdisciplinary Center for a Sustainable University developed a semi-structured questionnaire for both lecturers and deans in each university department to identify barriers and obstacles to implementing interdisciplinary learning as well as PBL at the level of the university as a whole. The results indicated that most faculties offer proportionally lower financial compensation for lecturers involved in interdisciplinary teaching formats alongside multiple lecturers due to a presumed reduction in the workload. Accordingly, most lecturers explained that their decision against interdisciplinary teaching is based on the reduction in financial reward. Likewise, deans admitted that inflexible legislation and examination regulations inhibit the implementation of PBL. This whole-university approach enhanced awareness, understanding, and consequently knowledge about the PBL concept and status across all departments and within the HEI as a whole. The University of Hamburg was now aware of its organizational challenges in implementing PBL and was able to draw conclusions. This process is still ongoing.

In-house PBL-Training. One further interdisciplinary institution was also a key stakeholder in the implementation of PBL: The Hamburg Center for University Teaching and Learning. First, the center hosted the first meeting between the three lecturers. Without the interdisciplinary structure of the center, the three lecturers would not have met and, in turn, would probably not have implemented their PBL

course. Second, the center gained awareness of the success of the interdisciplinary PBL course. As a consequence, the Hamburg Center for University Teaching and Learning implemented in-house training for lecturers with special focus on PBL and interdisciplinary PBL. Moreover, the center created learning spaces in the form of fellow-workshops to disseminate PBL teaching practices across departmental boundaries of the HEI. All sessions were met with increasing demand.

Challenging monodisciplinary structures. Due to monodisciplinary structures within the HEI, several challenges on the organizational level can be reported. First, the lecturers had difficulties identifying a mutually acceptable timetable, available rooms, and course registration system for PBL students across all the disciplines. Time schedules, room allocations, and course registrations are organized independently within each university department. Second, the lecturers experienced difficulties in incorporating the PBL course within the discipline-based curricula. As a consequence, psychology students could choose the PBL course within their discipline-based curriculum, while the course was creditable only in the general studies segment for students of economics, education, and geography. This led to different grading, with psychology and geography students receiving traditional grades, education students receiving a pass or fail, and economics students receiving grades that were not counted toward the final grade in their studies.

Description of Opportunities and Challenges on the Team Level

PBL-learning space for lecturers. Interdisciplinarity brought many opportunities on the team level. Since only one of the lecturers was experienced in PBL, the very implementation of the interdisciplinary PBL course represented a collective PBL learning space between a PBL expert and PBL novices. The lecturers' collective PBL knowledge was developed through constant discussion about their new role as facilitators instead of educators and the benefits of the self-directed learning approach aligned with supportive steps. Moreover, the interdisciplinary team-teaching approach led to a perceived easing of the workload due to shared responsibilities among the lecturers.

Sharing PBL-lessons learned. Based on their common PBL experience and personal reflection, the lecturers published a book describing PBL and the lessons they had learned in implementing interdisciplinary PBL within the framework of sustainability. Spreading the PBL concept among teaching staff in each faculty meant that many followers integrated newly gained knowledge about PBL either in monodisciplinary or interdisciplinary PBL.

Establishment of a working group. Moreover, the lecturers connected with other sustainability enthusiasts and established the Working Group Education for Sustainable Development (Block, Braßler, Diener, & Sommer, 2020). The working group consisted of students, lecturers, and higher education didacts as well as administrative staff, who collected and continue to collect information on best teaching practices regarding sustainability across all university departments. They commonly developed and implemented novel teaching practices and facilitate university-wide dialogue and discussions on sustainability in higher education. Their shared vision and collective knowledge flow originated in educational ideas such as participative learning, interdisciplinary learning, problem- and project-based learning, constructive alignment, and real-world learning. All teaching practices generated in this working group were problem or project-based learning approaches, indicating an increase in PBL implementation at a previously unPBLed university.

PBL-learning space for students. Similarly, the students also benefited from the interdisciplinary PBL approach at the team level. Some students were already experienced in PBL, while others were complete PBL novices. Together they were able to collectively reflect on and learn about PBL and the procedural steps and roles of lecturers and students in this context.

Overcoming discipline-based differences. Besides the positive multiplier effects among lecturers and students of collective learning and reflection on PBL, the interdisciplinary approach also resulted in many conflicts in both groups. The lecturers had to overcome discipline-based differences regarding views on the philosophy and sense of quality of education. Due to the multidisciplinary composition of the interdisciplinary team-teaching, the lecturers experienced many differences in their understanding and usage of various terminology. First, the aim of providing students with a framework to learn about sustainability was understood with contrasting meanings. The geography lecturer wanted to focus on ecological issues regarding sustainable development whereas the psychology and economics lecturer preferred social issues and the education lecturer was indifferent. Moreover, the lecturers also differed in their interpretation of the PBL concept. While one was trying to implement a problem-based lecture with the lecturers discussing multidisciplinary perspectives on sustainability, another advocated a stronger project-based approach with limited guidance from the lecturers. In the end, the lecturer experienced in PBL asserted herself by advocating a PBL approach with several steps. Furthermore, the lecturers experienced a lot of misunderstandings regarding tasks, time management, wording, and common ground. Also, the lecturers designed tasks singularly based on expected discipline-based roles, such as the psychology lecturer being single-handedly responsible for resolving interdisciplinary conflicts in student teams.

Similarly, the interdisciplinary student teams also experienced interdisciplinary conflict. They struggled with interdisciplinary misunderstanding and different interpretations of meanings, values, knowledge traditions, and behaviors. However, the most intense conflicts arose from asymmetric workload sharing, which stemmed from grading differences and differences in motivation and commitment to developing strong interdisciplinary ideas.

Most conflicts in both student and lecturer teams could be resolved by refocusing on a shared goal of identifying interdisciplinary strategies toward sustainable development.

Description of Opportunities and Challenges on the Individual Level

Raising lecturers' individual PBL-awareness. Several realizations of opportunities on the organizational and team level provided opportunities to individually gain knowledge about PBL. The short film festival incorporated within the interdisciplinary PBL course as well as the presentation of the PBL approach within the internal teaching conference facilitated information intake at the individual level of lecturers across all university departments. Moreover, the questionnaire on PBL and interdisciplinarity across the entire university served as an awareness-raising tool for staff previously unaware of PBL within the HEI. To a greater degree, interdisciplinary in-house training and fellow-workshops enabled knowledge growth regarding PBL for participating individuals. Furthermore, the book published on lessons learned enabled lecturers to interpret PBL processes firsthand. Again, within the interdisciplinary working group individuals could directly ask questions about the PBL approach and thereby gain knowledge about PBL. Also, the interdisciplinary PBL course itself allowed for both lecturers and students to gain individual knowledge. They could intuitively observe and reflect on PBL processes or actively seek more information from their more experienced PBL peers.

Raising students' individual PBL-awareness. Due to this individual PBL experience and knowledge gain, individual students supported PBL information sharing across the university. One of the students of the interdisciplinary PBL course was the head of the student union. To further facilitate institutional change toward PBL implementation he discussed the PBL approach within the student union. As a consequence, they added PBL to the student union's list of claims regarding necessary educational improvements at the HEI.

Overcoming individual prejudices. Besides the many opportunities for individual PBL knowledge growth, the interdisciplinary approach also included many challenges on the individual level. Both lecturers and students were confronted with different discipline-based knowledge traditions, methods, technical terminology, and teaching and learning cultures. Each lecturer and student had to cope with these differences and try to stay open to others' disciplinary views. Initially, lecturers as well as students had prejudices regarding the "others." Their own ideas were repeatedly mentioned as being more sustainable or better in general.

Overcoming personal challenges. Each of the lecturers in the interdisciplinary team-teaching had individual difficulties dealing with their frustration at constantly renegotiating meanings, tasks, and teaching methods. Individual "business as usual" was not possible. Moreover, each lecturer also had to contend with their own personal challenges outside the interdisciplinary teaching. For example, one lecturer was experiencing personal problems at the time while another indicated pressure to publish more scientific papers.

Discussion of the Role of Interdisciplinarity in Bringing PBL to the unPBLed

In this section the author discusses findings on the organizational, team, and individual level from related literature on organizational learning and interdisciplinarity. Table 1 starts by summarizing the findings of the example case study by describing opportunities and challenges of interdisciplinarity in terms of organizational learning about PBL and its implementation at each level.

Discussion of Opportunities and Challenges on the Organizational Level

In our globalized, interconnected world with its widespread pressing issues, HEIs around the world are increasingly seeking to identify as a sustainable university (Vargas, Lawthom, Prowse, Randles, & Tzoulas, 2019). Like the University of Hamburg in the example case study, other HEIs tend to define a third mission toward sustainable development while implementing education for sustainable development (Leal Filho, Evangelos, & Pace, 2015; Trancher, Yarime, McCormick, Doll, & Kraines, 2014; Hoover & Harder, 2015). HEIs as "transformative institutions" are engaged in co-creating social, technical, and environmental change by addressing the topics and global goals of sustainable development in education, including ending poverty and hunger, protecting the planet from degradation, securing prosperity, and fostering peace as well as global partnership (UN, 2015). Since these problems are too complex to be solved and addressed within one discipline, there is a pressing need to address these problems with an interdisciplinary approach (Blake, Sterling, & Kagawa, 2013). In pursuit of interdisciplinary problem-solving in higher education for sustainable development, PBL was identified as more successful than project-based learning (Braßler & Dettmers, 2017). Students experience comparatively more interdisciplinary conflicts in project-based learning, while PBL students are guided toward interdisciplinary solutions and therefore experience less conflict. Especially in the context of higher education for sustainable development, HEIs are called upon to implement interdisciplinary PBL as a suitable teaching-learning arrangement (Braßler & Dettmers, 2017; Power & Handley, 2019).

The development of a shared vision – like the vision of sustainable development in the example case – is well known to foster institutional change in HEIs (Gentle & Clifton, 2017). A shift in values causes stakeholders to question their previous mind-set, allowing a new one to emerge (Örtenblad & Koris, 2014). This form of transformational governance can create institutional change toward "a sense of purpose and a feeling of family" (Bass & Riggio, 2006, p. 3) within an organization. Besides contracts and obligations, professors and lecturers can perceive their institutional environment as having this sense of purpose and family, and are described to be committed to mutual interests (Bass & Riggio, 2006). Lecturers as in the example case went beyond their self-interest or expected rewards for the sake of the team, the organization and consequently for society. Lecturers and administrative staff often abstain from implementing PBL as they fear the unfamiliar or wish to avoid work overload (AlBuali & Khan, 2018; Hung, 2011; Mansor et al., 2015). This can be overcome by inculcating teaching staff and support staff with a shared vision regarding sustainability and a clear understanding of the importance and necessity of PBL to address issues of sustainable development (Jones, Epler, Mokri, Bryant, & Paretti, 2013). If the benefits are well communicated and – consequently – perceived positively by all parties, HEIs can motivate staff to move toward a common goal of implementing interdisciplinary PBL (Mansor et al., 2015).

Facilitating interdisciplinary communication and collaboration in HEIs involves organizational learning across discipline-based boundaries (Dee & Leisyte, 2017). Providing deliberative structures like the different interdisciplinary institutions in the example case, including both general administrative structures and temporary structures, can foster knowledge-sharing in HEIs (Jones et al., 2015).

Viewing HEIs as learning structures (Örtenblad & Koris, 2014), interdisciplinarity can facilitate a reformation of processes and organization as well as HEIs' financial situation due to economies of scale across departments. More

	Opportunities	Challenges
Organizational level	Establishing the university's third mission that addresses complex problems that trigger a PBL approach	Renegotiation of third mission due to different discipline-based values
	University-wide financial support of PBL	Monodisciplinary structures within the university
	Using questionnaires regarding PBL to raise awareness and assess status quo	Different time schedules in each university department
	Using economies of scale across university departments in regard to resources like space and administrative support	Different curricula designs in each university department
	Implementation of in-house PBL trainings across disciplinary departments	Discipline-specific curricula
	Implementation of interdisciplinary learning spaces for PBL	Different and PBL-hindering examination regulations in each university faculty or even department
Team level	Collective learning and reflection across PBL experts and PBL novices among lecturers	Interdisciplinary conflict
	Collective learning and reflection across student PBL experts and PBL novices	Interdisciplinary misunderstandings and communication difficulties
	Reduction of typical PBL barriers due to sharing workload and responsibility in interdisciplinary team-teaching	Difficulties in finding common ground
		Different technical terms across disciplines
	Collective PBL knowledge sharing by publishing "lessons learned"	Different teaching traditions, cultures and teaching philosophies across disciplines
	Formation of interdisciplinary working groups addressing PBL approach	Different definitions of the term "problem"
		Different understandings of PBL
	Possibilities to design realistic interdisciplinary PBL problems	Allocating assignments based on discipline-based stereotypes
		Discipline-based discrimination
		Underestimation of workload originating in the interdisciplinary approach
Individual level	Making use of PBL learning offers provided by both the organization and teams across university departments	Overcoming individual discipline-based prejudices
	Student-to-student and lecturer-to-lecturer learning about PBL	Overcoming individual profession centricity
	Expanding one's (PBL) teaching repertoire	Staying open for other disciplines' views on PBL and education in general
	Gaining contacts for future (PBL) collaborations	Struggling with other professional or private demands
	Using one's political voice to inform about PBL	

Table 1. Overview of opportunities and challenges of interdisciplinarity in terms of organizational learning about PBL and its implementation

precisely, all resources – from teaching staff, allocable rooms and teaching knowledge – can be shared across all university departments, thereby reducing overall costs.

Moreover, interdisciplinarity represents an organizational boost to implementation of PBL as it tackles the typical structural barriers within the HEIs. Interdisciplinary networks and learning spaces allow informal transfer of PBL knowledge between lecturers and staff across departments. In addition, sharing and exchanging resources such as rooms and teaching equipment across disciplinary borders mitigates typical PBL challenges (AlBuali & Khan, 2018; Hung, 2011). Again, previous research indicates experience that interdisciplinary collaboration across university departments can be helpful in dealing with potentially challenging PBL logistics in the areas of time management and classroom coordination (Golding, 2009; Park et al., 2005).

There are several challenges associated with facilitating PBL in an interdisciplinary sustainability framework. A shared vision regarding sustainability and a clear understanding of the importance and necessity of PBL among teaching and support staff might be challenged by constant negotiation and renegotiation of common visions and goals due to discipline-based differences in values and code of conduct (Dee & Leisyte, 2017; Nancorrow et al., 2013; Rooks & Winkler, 2012). Another barrier is the discipline-specific curricula (Dole, Bloom, & Kowalske, 2016).

Successful implementation of PBL needs appropriate assessment possibilities (AlBuali & Khan, 2018) such as performance-based, formative, multiple-source-oriented formats like reasoning exercises, practical portfolios, group assessment tasks, and reflective journals (Hung, 2011). These assessment formats might not be covered by examination regulations across all disciplinary departments (Golding, 2009; Rooks & Winkler, 2012). Consequently, identifying appropriate assessment tools – a well-known obstacle to implementing PBL (AlBuali & Khan, 2018; Hung, 2011) – remains a challenge and could present as even more complicated in an interdisciplinary approach.

Discussion of Opportunities and Challenges on the Team Level

Sharing through interdisciplinary teams and practice communities disseminates teaching improvement practices across the departmental boundaries of an HEI, especially in the case of active forms of knowledge creation as in the example case study (Treleaven et al., 2012). Interdisciplinarity has dual potential in boosting efforts toward implementation of PBL in that it benefits both lecturers and students. The implementation of interdisciplinary team-teaching decreases several well-known obstacles in realizing PBL. If one lecturer acting alone refrains from implementing PBL due to unfamiliarity with the PBL concept and uncertainties surrounding their potential new role as facilitator (AlBuali & Khan, 2018; Dole, Bloom, & Kowalske, 2016; Mansor et al., 2015), interdisciplinary team-teaching can offer a valid alternative, allowing the individual to learn from a more experienced PBL lecturer from another disciplinary background. Since there are huge differences between disciplines in terms of educational traditions and philosophies (Dee & Leisyte, 2017; Shibley, 2006), interdisciplinarity offers large potential for colleague-to-colleague transmission and learning across disciplines (Baruch & Hall, 2004; Örtenblad & Koris, 2014). Moreover, lecturers in interdisciplinary team-teaching, like in the example case, can share the responsibility and the workload that so many lecturers dread in implementing PBL (AlBuali & Khan, 2018; Hung, 2011; Mansor et al., 2015). Furthermore, realization of interdisciplinary PBL enables lecturers to design realistic interdisciplinary problems that can only be solved by combining all disciplines involved (Braßler & Dettmers, 2017). As a result, the interdisciplinary approach brings marked benefits and enables lecturers to provide appropriate support by modeling interdisciplinary cooperation and communication in working toward an integrative solution to complex problems. This has obvious advantages, which are highly needed in implementing PBL (Dole, Bloom, & Kowalske, 2016; Hung, 2011; Mansor et al., 2015). Lecturers who implement interdisciplinary PBL can function as "institutional teaching entrepreneurs" (Schmid & Lauer, 2016) by becoming key drivers of organizational change through an uprising interdisciplinary network among lecturers like the establishment of the working group in the example case.

The implementation of interdisciplinary PBL also prevents typical obstacles on the student side in relation to PBL realization. As with the lecturers, students from one discipline could be more experienced in PBL and therefore support unexperienced students from another discipline within their interdisciplinary PBL team, thereby reducing their anxiety (AlBuali & Khan, 2018; Hung, 2011). Moreover, since interdisciplinary problems in PBL cannot be solved with one discipline alone, they require active contributions from all team members across disciplines. This prevents "free-riding" and fosters appreciation of team members across disciplines (Hung, 2011; Wells, Warelow, & Jackson, 2009). Interdisciplinarity provides a learning space for both lecturers and students. By building a social network across boundaries (Vogel, 2009), both can gain new perspectives on the PBL concept, learn from their experiences, and share their knowledge as multipliers across discipline-based category groups within HEIs.

Many of the described challenges on the team level are well known in the literature on interdisciplinarity. Most importantly, interdisciplinary teamwork carries large potential for conflict (Letterman & Dugan, 2004; Repko, 2007; Epstein, 2005). Accordingly, Kezar (2005) reports that interdisciplinary collaboration in HEIs tend to fail.

Interdisciplinary conflict often originates in interdisciplinary misunderstandings (Repko, 2007). Each discipline has its own patterns, meanings, values, knowledge traditions, codes of conduct, and ways to interact with society (Lélé & Norgaard, 2005). Gupta (2006) reports evaluation results of interdisciplinary learning that point to territorial issues as the most common barriers to interdisciplinarity in the early stages; these often stemmed from participants' lack of understanding of other disciplines. Due to discipline-based differences, educators have different views on the quality of education (Dee & Leisyte, 2017; Shibley, 2006). Besides these different perspectives, interdisciplinary collaborations often experience conflict due to loose agreements and diffusion of responsibility (Bronstein, 2003). Every educator assumes the other has the same work and teaching culture. However, the cultures are highly distinct (Repko, 2007).

Due to discipline-based differences in educational traditions and understandings of what constitutes good teaching practices (Dee & Leisyte, 2017; Shibley, 2006), lecturers experience conflict in interdisciplinary team-teaching, as in the example case study. Moreover, different academic departments use various terms to refer to problem-based learning (Dee & Leisyte, 2017; Shibley, 2006). Each discipline has its own jargon and terminology (Repko, 2007), which renders it rather difficult to find a shared definition of common themes or problems across disciplines (Brandstädter & Sonntag, 2016). Moreover, the very term "problem" has different meanings according to each discipline. Thus, identifying an interdisciplinary problem in PBL might prove challenging since finding common ground is a typical barrier in interdisciplinary cooperation (Newell, 2007; Oberg, 2009; Repko, 2007).

Furthermore, educators usually think in discipline-based stereotypes. Allocating assignments on the basis of discipline-based group affiliations – like the psychology lecturer being the only one responsible for student team conflicts – and professional stereotypes is often seen as an act of discrimination (Cook & Stoecker, 2014). Research into interdisciplinary teamwork and team-teaching shows that additional work regarding interdisciplinarity is often underestimated (Epstein, 2005; Letterman & Dugan, 2004; Repko, 2007; Rooks & Winkler, 2012). Interdisciplinary teaching practices like PBL often require significant investments in time and relationship building (Kellogg et al., 2006), as well as a willingness to transcend differences in power, authority, and values.

Discussion of Opportunities and Challenges on the Individual Level

In line with the concept of HEIs as learning-at-work organizations (Baruch & Hall, 2004; Örtenblad & Koris, 2014), individuals can learn and gain knowledge in the course of their professional work at the university. Interdisciplinary networks and learning spaces allow individuals to rethink their current mindsets (Dee & Leišytė, 2017). In the example case, individuals function as multipliers, with staff-to-staff learning and student-to-student learning about the PBL concept (Baruch & Hall, 2004; Örtenblad & Koris, 2014).

Moreover, individuals – students as well as lecturers – can function as change agents within their HEIs (Schmid & Lauer, 2016). The lecturers in the example case can be interpreted as "institutional teaching entrepreneurs" (Schmid & Lauer, 2016) that become key drivers of organizational change toward further implementation of PBL. Also, individual students embody change agents that foster dialogue across discipline-based borders in HEIs.

There are several challenges associated with an interdisciplinary approach on the individual level. Individual discipline-based prejudices and profession centricity – the belief of discipline-based superiority – are typical barriers of interdisciplinary encounters (Pecukonis, Doyle, & Bliss, 2008).

Moreover, even if HEIs implement interdisciplinary networks and learning spaces, individual academics in general usually decline such offers. Academics tend to focus their resources on research rather than on innovations designed to improve university performance as a whole (Dee & Leišytė, 2017). Members of teaching staff do not actively seek information on teaching outside their reputation, class hours, and development courses due to their focus on writing research applications and winning research grants (Örtenblad & Koris, 2014). Moreover, top-down approaches are often perceived as powerful groups imposing their will upon other groups (Dee & Leisyte, 2017), which even might even lead to academic resistance (Lauer & Wilkesmann, 2017).

Conclusion

The implementation of the PBL approach represents a welcome shift from teacher-centered to learner-centered teaching to foster students' competence development. Unfortunately, previous research shows that HEIs experience several obstacles to PBL implementation and rely on lecturers, students, and the organization as a whole to enable the transition toward this new curriculum. Applying

a longitudinal, embedded, single-case design, the present paper reflects on and analyzes one example case within a multilevel framework of organizational learning to investigate if interdisciplinarity supports bringing PBL to unPBLed HEIs.

Interdisciplinarity offers opportunities on each level of organizational learning. Regarding the organizational level, HEIs can support collective knowledge creation about PBL by providing interdisciplinary structures such as learning spaces, in-house training, and questionnaires regarding PBL across all university departments. With an interdisciplinary approach at the team level, lecturers as well as students can collectively learn and reflect, whether PBL experts or novices, in an interdisciplinary PBL setting. At the individual level, interdisciplinary student-to-student and lecturer-to-lecturer learning can enhance personal knowledge building about PBL and, in turn, activate further change agents toward additional PBL implementation. These findings are in line with previous research describing opportunities of learning structures, shared knowledge, and change agents in organizational learning (Dee & Leisyte, 2017; Jones et al., 2015; Örtenblad & Koris, 2014; Schmidt & Lauer, 2016). The present paper supports these findings by adding an interdisciplinary approach in organizational learning within the specific context of HEIs. Besides knowledge creation about PBL at each level of organizational learning the present findings indicate that an interdisciplinary approach also decreases several well-known obstacles in realizing PBL (AlBuali & Khan, 2018; Hung, 2011; Mansor et al., 2015; Wells, Warelow, & Jackson, 2009). Thus, an interdisciplinary approach facilitates PBL implementation by using economies of scale across university departments, sharing workload and responsibility across lecturers, and activating contributions across students from different disciplinary backgrounds.

At each level, interdisciplinarity provides several challenges. At the organizational level, HEIs must overcome monodisciplinary structures regarding different time schedules, curricula designs, and examination regulations in each university department. At the team level, both lecturers and students must solve interdisciplinary conflicts originating in discipline-based differences in teaching and knowledge traditions. At the individual level, both lecturers and students need to overcome individual discipline-based prejudices as well as personal profession centricity. These findings support previous research in interdisciplinary learning (Braßler & Dettmers, 2017; Golding, 2009) and interdisciplinary teamwork (Brandstädter & Sonntag, 2016; Cook & Stoeker, 2014; Newell, 2007; Oberg, 2009).

The work presented in this paper has several limitations. First, the study is rooted in the tradition of action research and thereby potentially subjective and possibly biased, since the lecturer is also the researcher (Mertler, 2019). Second, the single-case design is limited to only one example case which raises issues of construct validity and concerns about reliability and replicability (Yin, 2018). Future research should investigate further cases in different HEIs, analyze interdependencies across all levels of organizational learning, and validate findings with quantitative measures.

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