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PBL Tutors' Conceptions of Teaching Problem-Solving

A Phenomenographic Exploration

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Abstract

Problem-solving (PS) is taught and practised in many higher education institutions across various disciplines. However, there is a lack of understanding of how to teach PS in a way that aligns with the specific principles and methods associated with its pedagogy. This study aimed to understand how tutors of Problem-Based Learning (PBL), a problem-centered instructional practice, conceptualize teaching problem-solving (CoTPS). Through qualitative interviews followed by phenomenographic analysis, we developed a model of CoTPS, which analyses how PBL tutors conceive problems in instruction, the process of problem-solving, and their role in

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tutorial groups. The categories of description, forming a hierarchy of inclusivity, enabled us to identify the least and most complex conceptions of teaching problem-solving. This model allows PBL tutors and, more broadly, higher education teachers to reflect on their conceptions and enables academic developers to create programs that enhance both conceptual understanding and practical application of problem-centred instruction.

Keywords: Conceptions of problem-solving; PBL tutors; PBL tutors' conceptions; Problem-based learning; Phenomenography

Introduction

The development of generic skills, particularly problem-solving, has become increasingly important in contemporary education. Research indicated that collaborative and interactive teaching practices, along with constructive learning environments, are more effective in fostering generic skills compared to traditional lecturing methods (Virtanen & Tynjälä, 2018).

However, teaching problem-solving in higher education presents unique challenges, as it is more complex than imparting subject knowledge (Jonassen & Hung, 2008; Jonassen, 2014; Mayer & Wittrock, 2006). To address this, higher education (HE) teachers are exploring various approaches, from direct teaching to innovative classroom processes (Csapó & Funke, 2017). One of the reasons why this issue remains prevalent is that educators' views significantly vary about what constitutes problem-solving, what their roles are, or how it should be taught (Van Merriënboer, 2013; Phang et al., 2018). While fields such as medicine and engineering benefit from having a well-defined understanding of problem-solving pedagogies, specifically in Problem-Based Learning (BPL), many disciplines, including social sciences, business management, teacher training, architecture and counselling, suffer from having less clarity about different aspects of teaching problem-solving (Hallinger, 2023).

Problem-based learning has emerged as a notable inquiry-based approach aimed at fostering students' problem-solving capabilities (Norman, 2008). PBL engages students in real-world problems and encourages active learning, critical thinking, collaboration, and independent inquiry. However, the successful implementation of PBL varies significantly across different educational contexts. Factors such as institutional support, curriculum design, and teacher expertise can profoundly influence its success (Dolmans et al., 2016). Researchers have expressed concerns about the "mistranslation of PBL"

and its core pedagogical philosophy (Servant-Miklos et al., 2019; Kwan, 2019). Common issues relate to using problems merely as tools to reinforce lecture content rather than as the basis for independent inquiry and knowledge construction (Dolmans et al., 2002). Failing to give students opportunities to activate prior knowledge or not giving inadequate time for individual learning. Undermining the collaborative aspects of PBL by putting students in team-based learning settings and reinforcing group work rather than collaboration. Insufficient time and resources for individual or group reflection (Kwan, 2019 & Savery, 2006).

Given these challenges, this study shifts focus from describing how PBL is practiced to exploring the underlying conceptions of problem-solving held by PBL teachers (in this study context, PBL tutors). While specific PBL practices may not be directly transferable across different educational contexts, the underlying conceptions of what it means to teach problem-solving are more likely to transcend these boundaries. By examining these conceptions, we aim to develop a framework that can assist HE teachers in understanding the diverse, complex and more complete ways in which teaching problem-solving is conceptualised. This framework will serve as a resource for developing professional development programmes or encouraging self-reflective academic practice regardless of institutional context and disciplines. While the term 'tutor' is used frequently in this article in the context of PBL, specifically within the setting of this study, where it refers to HE teachers facilitating small tutorial groups, the findings and implications are also relevant to teachers in higher education.

Literature Review

Theoretical and conceptual framework

The theoretical framework underpinning this study centres on the alignment between teachers' conceptions of teaching and their actual practices. The exploration of teaching conceptions became particularly influential as educational theorists and researchers have discovered that teachers' personal beliefs and knowledge systems influence their instructional practices (Gow et al., 1993; Lam & Kember, 2004; Kember & Kwan, 2000; Åkerlind, 2003). The most well-known framework which has been used to explain the alignment between teachers' conceptions and approaches belongs to Kember and Kwan (2000), where teaching is seen as "transmission of knowledge'' vs "teaching as learning facilitation", which has respectively been associated with "content-centred" and "learner-centred'' approaches to teaching. While PBL tutors'

perspectives and approaches have been studied using different theoretical and conceptual models, tutors' conceptions have not been addressed.

In this study, the concept of "conception" is explored from a phenomenographic research perspective, which focuses on the "ways of being aware of" or "ways of understanding" a phenomenon. Unlike cognitivist approaches, which focus on beliefs, values, or traits, phenomenography defines conceptions based on awareness—how individuals perceive and experience aspects of a phenomenon (Marton & Pang, 2005). In this view, teachers' actions are not primarily shaped by their beliefs or values about teaching but by their awareness of what teaching can encompass and how it can be practiced (Åkerlind, 2024). In this paper, terms such as conception, awareness, and understanding are used interchangeably to reflect their phenomenographic meaning. This usage aligns with Åkerlind's definition of conception, which emphasizes the relational nature of awareness and understanding. "Our awareness of phenomena, or the way in which we experience them, constitutes our understanding of the phenomena, which is the meaning that they hold for us" (Åkerlind, 2024, p. 3).

By adopting this framework, the study examines how varying levels of awareness influence PBL tutors' conceptions, offering insights into the diversity and progression of their understanding. By investigating what constitutes the conceptions that make the PBL approach successful, we aim to uncover insights that are less explored, particularly demonstrating more nuanced, complete conceptions of teaching problem-solving. We believe that understanding PBL tutors' conceptions is crucial for preserving the essence of PBL when adapting it to new contexts. By exploring tutors' conceptions, we aim to facilitate more meaningful translations of PBL principles across various educational settings and provide more clarity on how problem-solving skills should be fostered in higher education institutions.

Using phenomenographic research outcomes for academic development

Phenomenographic research outcomes have a critical role in designing academic development programs and facilitating changes in teaching conceptions. Central to phenomenographic epistemology is the idea that conceptual development does not involve discarding existing understandings but rather expanding awareness to include previously unnoticed aspects of a phenomenon (Åkerlind, 2008b). The outcomes of phenomenographic research, organized into a hierarchy of complexity, allow academic developers to identify qualitatively different ways of understanding a phenomenon and prioritize where pedagogical efforts should focus on guiding teachers (as learners) toward more complex levels of understanding (Kettunen & Tynjälä, 2021, Åkerlind, 2015). This hierarchical structuring offers a practical framework for

enhancing teaching conceptions by pinpointing the dimensions along which teachers' awareness needs to evolve.

From a phenomenographic perspective, conceptual development is characterized by enabling learners to discern the full range of critical aspects of a phenomenon, fostering a more comprehensive understanding. Variation theory, which complements phenomenography, informs the design of academic development by focusing on how variation in experiences helps individuals discern critical features (Marton and Booth, 1997). Specifically, the four-component method—contrast, generalization, separation, and fusion—provides a structured approach for educators to design learning activities that guide participants toward deeper and more inclusive conceptual development (Åkerlind, 2018). For instance, contrast enables learners to distinguish a phenomenon by comparing it with something else, while fusion allows the simultaneous integration of multiple critical aspects for holistic awareness.

Academic development programs play a pivotal role in reshaping HE teachers' conceptions of teaching and learning, which are foundational to their instructional practices. Research highlights that targeted pedagogical training can bring about significant shifts in teaching approaches, fostering more learner-centred and transformative practices (Gibbs & Coffey, 2004; Ödalen et al., 2019; Hughes et al., 2023). Previous research has shown that the outcomes of phenomenographic research are actively used in planning academic development programs (Åkerlind, 2014; Booth & Ingerman, 2015; Wright & Osman, 2018). Beyond modifying conceptions, such training enhances teachers' professional vision, helping them address misconceptions and appreciate the complexities of teaching and learning (Heinonen et al., 2023; Postareff et al., 2007). While there is consensus on the characteristics of effective teaching (Entwistle & Walker, 2002), there remains a gap in guidance for planning academic development programmes that specifically address teaching problem-solving. Addressing this gap by focusing on teachers' conceptions of PS enables professional development programs to cultivate critical teaching skills and improve students' learning outcomes.

Conceptual framework of conceptions of teaching problem-solving (CoTPS)

Despite the existence of numerous studies on teaching problem-solving, there is still no clear conceptual framework that systematically explores the CoTPS. Previous studies have explored teaching problem-solving from single perspectives, such as how educators categorize problems (Trigwell et al., 2002), defining problem-solving strategies (Siswono et al., 2016), or only addressing the teacher's role (Hendry, 2009). Therefore, we aimed to address this conceptual gap by exploring CoTPS through three critical dimensions that have

emerged after the critical analysis of literature on problem-centred instruction (Bendeliani, 2024). These dimensions are conceptions of the problem, conceptions of the problem-solving process, and conceptions of the tutor's role.

The first key feature that distinguishes problem-centered instruction from other teaching approaches is its emphasis on the nature of the problem. Various theories and models of problem-solving emphasize that the nature of the problem plays a crucial role in achieving learning goals (Jonassen, 1997; Merrill, 2002). There are numerous studies on how to design and structure problems and what constitutes a "good" problem (Biggs &Tang, 2007; Qvist, 2004). This body of research underscores the importance of the problem's nature in problem-solving instruction. For instance, well-structured problems, often used in case-based learning, have clear solutions and defined paths, promoting skills such as procedural knowledge and algorithmic thinking. In contrast, ill-structured problems, typical of PBL, are open-ended and complex, encouraging higher-order thinking skills such as analysis, synthesis, and evaluation (Jonassen & Hung 2008). By focusing on this dimension, we aim to understand PBL tutors' awareness and understanding of the role of problem in problem-solving instruction.

The second dimension that might provide critical information about tutors' understanding is the conception of the problem-solving process. The process of problem-solving in problem-centered instruction is grounded in several theories, such as information processing theory (Simon, 1981), Cognitive load theory (Sweller,1988), and Merrill's First Principles of Instruction (Merrill, 2002). The Design Theory of Problem-Solving (Jonassen, 1997) provides a structured approach to solving problems, highlighting steps such as problem identification, solution generation, testing, implementation, and reflection. Each step in this process is crucial for developing problem-solving capabilities. Although there are slight differences between different problem-centred instructional models, the main phases of problem-solving align with the cognitive process of problem-solving. Understanding how tutors perceive and conceptualize this process will provide insights into the importance of steps or the significance of the structured problem-solving process.

Finally, the role of the tutor in problem-centered instruction is a fundamental aspect that differentiates it from traditional teacher-centered instruction. Problem-centered instruction aims to enhance student autonomy and self-directed learning (Savery, 2006). Consequently, the teacher's role as a facilitator has gained considerable attention. Many studies have explored what constitutes the tutor's role in the process of facilitating tutorial groups and it remains a debatable issue in PBL research (Schmidt & Moust, 2000; Dolmans et al., 2002; Chng et al., 2011; Groves et al., 2005). Therefore, we consider this

dimension crucial for our inquiry into HE teachers' conceptions of problem-solving instruction.

Aims

The aim of this qualitative research is to explore the varying ways in which teachers in Problem-Based Learning environments (PBL tutors) conceptualize key aspects of teaching problem-solving and to identify commonalities within these variations. Specifically, it seeks to understand:

1. How do PBL tutors conceptualize the role of problems in PBL?
2. How do PBL tutors conceptualize the problem-solving process in PBL?
3. How do PBL tutors conceptualize their role as facilitators in the PBL tutorial groups?

The study aims to establish a model illustrating how these conceptions relate to each other and evolve, providing insights into the hierarchical inclusiveness of these conceptions and contributing to a deeper understanding and refinement of teaching practice in problem-centred pedagogy.

Research Design

Understanding and interpreting phenomenographic research outcomes

Phenomenographic research aims to explore and map qualitatively different ways of experiencing a phenomenon, resulting in a structured representation known as the outcome space (Marton & Pong, 2005). This outcome space organizes findings into categories of description, which embody qualitatively different but interrelated ways of understanding. These categories are arranged in a hierarchical structure where more advanced ways of experiencing a phenomenon include and expand upon simpler ones. This hierarchy reflects an inclusive complexity, where each following category adds a new critical aspect of awareness while encompassing the ones from previous levels, which creates inclusively expanding levels of awareness (Stenfors-Hayes et al., 2013).

The hierarchical organization is fundamental to phenomenographic research because it illustrates how human awareness progresses (Green, 2005). Understanding is not static but develops through the discernment of additional critical aspects, which are the key features of a phenomenon that differentiate one way of experiencing it from another. This non-dualistic perspective justifies the expectation that different ways of experiencing the same phenomenon will

be related because, according to phenomenography, all conceptions of a phenomenon share a connection through the object being experienced (Green & Bowden, 2009). While people may perceive the phenomenon in qualitatively different ways, their experiences are still linked by the common object—the phenomenon itself—which provides a common ground for comparison. This progression underscores how inclusivity in awareness builds collective understanding, moving beyond individual perspectives to create a broader, shared framework.

The concept of collective awareness is central to phenomenography, as the method seeks to capture the sum of variation in human experience (Bowden, 2000). This focus allows researchers to identify what could constitute a complete understanding of a phenomenon and, by that, it moves beyond identifying generic "right" and "wrong" answers (Åkerlind, 2005). In practice, this helps individuals situate their own conceptions within a broader context, enabling them to recognize gaps in their awareness and discern what is needed to develop a more comprehensive and sophisticated understanding.

Context

The study was conducted among PBL tutors at Linköping University in Sweden. In 1986, the Faculty of Medicine and Health Sciences at this university became the first faculty in Sweden to implement PBL within its medical training and healthcare programs. Apart from the medical faculty, PBL is used as a primary educational approach in several programmes across four faculties. PBL tutors at the university utilize two specific models— the PBL Wheel and the Lifebuoy (within the Faculty of Medicine and Health Sciences)—to guide students through the problem-solving process. Along with PBL tutorials, which usually take place once a week and consist of 6-7 members of students, they participate in lectures and seminar activities.

Participants

The sample consisted of 15 participants. According to the recommendation given for collecting phenomenographic data, 10-20 participants is the adequate number to achieve saturation (Åkerlind, 2005). A purposive sampling method was employed to ensure the inclusion of participants from different disciplinary backgrounds, which is crucial for study design (Han & Ellis, 2019; Stenfors-Hayes et al., 2013). Participants in this study are members of Didacticum, the university's centre for pedagogic excellence, which supports academic development; the majority of participants have taken the PBL course at least once.

Characteristics	Frequency
Gender	
Male	6
Female	9
Year of teaching experience	
< 10	1
10 to < 20	4
20 to < 30	10
Academic qualification	
Professor	5
Senior professor	1
Associate professor	6
Senior associate professor	1
Associate professor, docent	2
Academic field	
Biomedical and Clinical Sciences	5
Computer and Information Sciences	1
Behavioural Sciences and Learning	6
Health, Medicine and Caring Sciences	3

Figure 1. Profile of Participants.

Data collection

Semi-structured interviews were conducted to explore participants' conceptions of teaching problem-solving. After a trial interview, three main questions were retained, allowing flexibility for additional follow-ups based on participants' responses. The overarching questions included: 'How do you define the problem-solving process?' 'What is your definition of a problem?' and 'How do you perceive your role in this process?'. Drawing on the recommendations (Åkerlind et al., 2005), follow-up questions (such as, why do you think it constitutes problem-solving, Why do you design it this way, etc.) were asked.

Method of Analysis

Given the lack of a standardised procedure for phenomenographic analysis, we experimented with various approaches to handle the data. Ultimately, we found the "whole transcript" method the most suitable. This approach, as described by Bowden (2000), involves analysing the entire interview transcript

without separating chunks responding to specific questions. This method proved more effective because it preserved the context, making it easier to identify underlying conceptions.

The analysis process involved multiple iterative cycles of re-reading the data. Our data analysis steps included familiarisation, condensation, comparison, grouping, and labelling (Cope, 2004; Åkerlind et al., 2005). To make final judgments about the categories of description and determine the conceptions characterized in the interviews, we employed the framework suggested by Sjöström and Dahlgren (2002). This framework guided us in evaluating the data based on how frequently certain views were highlighted in the transcript (frequency), the position of these views within the responses, because significant aspects are often articulated early in the response, and the explicit emphasis participants placed on specific beliefs or opinions (Pregnancy).

To ensure the reliability of our results, we conducted dialogic reliability checks. Feedback was sought from two researchers who were experienced in phenomenographic analysis and had no vested interest in this project. We also presented our findings at conferences to ensure pragmatic validity.

Results

This analysis has led to the development of a hierarchical structure of conceptions of teaching problem-solving (CoTPS), where each category represents a progressively more inclusive and complex understanding of problem-solving within the PBL framework. The round model was chosen to illustrate the outcome space because it effectively demonstrates how each layer of conceptions builds upon the previous one, progressing from less complex to more comprehensive understandings of the phenomena. This aligns with the essence of phenomenography, which seeks to explore the hierarchy of understanding, moving from basic to more sophisticated conceptions (Green, 2005). The circular structure highlights the layered nature of the conceptions and shows how they collectively contribute to a holistic understanding. By visually illustrating how the first layer is less complex than subsequent layers and how each layer enhances the previous one, the round model captures the completeness growth of the conceptions. Furthermore, since this study examines conceptions of problem, problem-solving, and the role of the tutor across three dimensions, the round model facilitates the exploration of their interactions and alignments. The dotted lines connecting the dimensions reinforce their interaction and shared aspects which are discussed further in the discussion section.

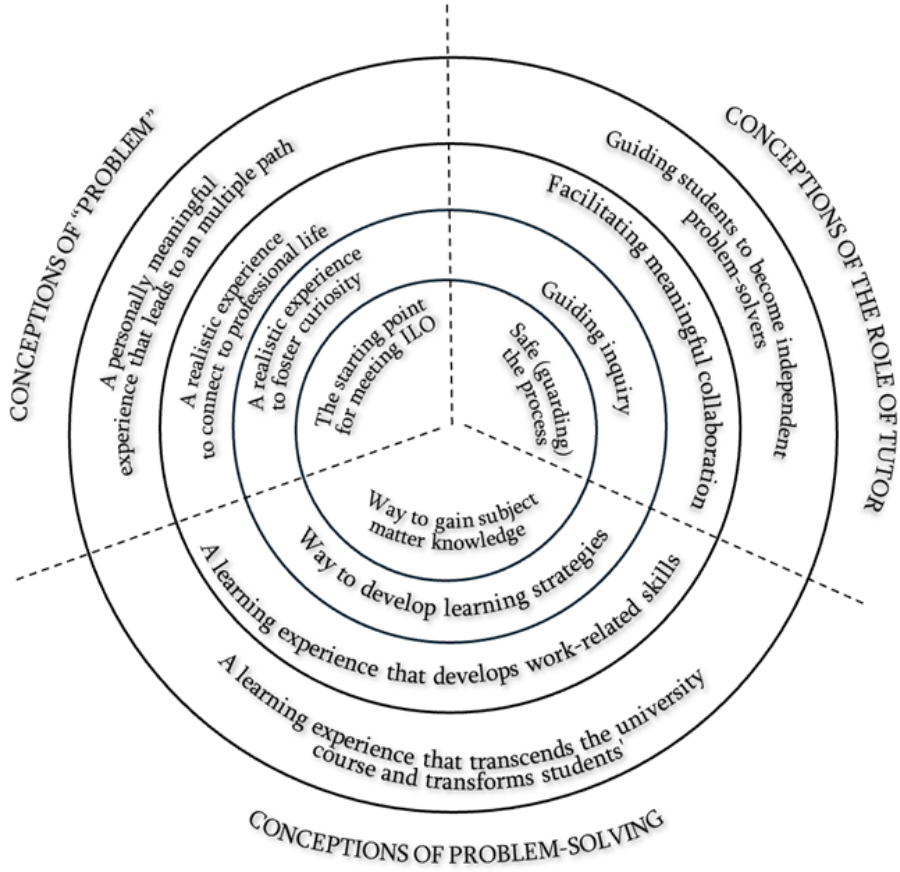

Figure 2. Outcome Space, Conceptions of Teaching Problem-Solving.

PBL tutors' conceptions of 'Problem'

Four qualitatively different conceptions of the problem have been exhibited, where the problem is seen as 1) a starting point to meet ILO 2) a realistic experience to foster curiosity 3) a realistic experience to connect to professional life 4) a personally meaningful experience that leads to a multiple path. In the appendix, you can find extended quotes where the inclusiveness of awareness is clearly illustrated.

Categories & Quotes
C1) "Well, of course, you don't give the students direct questions because they phrased their questions themselves based on the scenario. So, you can only do as much as you can. You can't make errors, so they learn exactly what they're supposed to learn. But you should aim to make a good scenario as possible. Hopefully, it will help students achieve their intended learning outcomes." (N14)
C2) "You shouldn't post the questions itself. It's important that the questions and what is required from the students are not given to them. One thing is that it should probably also be engaging, so it shouldn't be trivial. It should be something that is emotionally engaging and that some students need, that is, some trouble to engage in finding the problem (awareness 2)..." (N1)
C3) "… So, what I want with that case is that the students both should read about mourning and dying (awareness 1), but they should also try to have some self-reflection of what they think is important by death and dying because, in their future profession, they will meet people that believe in God or life after death, stuff like that because they need to do that (awareness 3)." (N4)
C4) "Sometimes, when we give them vignettes, it's like, oh, here's a vignette, and it's all about social influence (awareness 1). So, it should stimulate curiosity (awareness 2). It should be ambiguous in terms of what is to be done, but also multiple ways in which they can go with it. So, maybe one group might go off in one direction, and another group might go off in a different direction, so they should be open to different ways of solving it (awareness 4)." (N6)

Table 1. Conceptions of 'Problem', please visit the appendix for extended quotes.

The first category under this dimension sees problems as a starting point to meet the ILO, which is a fundamental but least complex view. In this conception, the problem serves as an entry point into the learning process, guiding students towards the predetermined goals of the course. According to tutors, problems should inform students about the topic of the week or semester. As one of the tutors emphasized, a problem is a means to ensure that "they learn what they are supposed to learn". Conceiving the main role of the problem as a covering ILO, might encourage academics to be more straightforward in designing the scenarios, meaning they might be too specific, or the clue of the problem might be too obvious for students.

In the second category, the problem is viewed as a realistic experience which should trigger curiosity. It is more complex than the first category because it acknowledges the importance of stimulating the intellectual curiosity of students to engage in the learning process. It adds complexity by bringing the components of curiosity, stimulus, trigger, and provocation. This category discerns the importance of the suitability of the problem with course content but extends the complexity of the first category by placing a strong emphasis on gaining students' attention. Tutors who see the value of the problem as a trigger for learning might design problems which are more provocative, puzzling, and unknown to students, given their understanding of certain concepts.

The third category sees the problem as an experience which connects students to the professional world. Here, problems are designed to show students the relevance and applicability of learning for their profession. This category of description is considered more complex because it transcends the educational purpose of the problem and shows students the importance of the knowledge they acquire for their future. Although all the problems in PBL are authentic and replicate the real world, tutors who hold this conception might value more dysfunctional, wicked problems, which are not oriented to the solution but changing the outcomes of the situations, or as one tutor describes, "creating the environment where living is possible".

The fourth and most complex category conceives the problem as a personally meaningful experience that leads to a multiple path. Several important components are included in this category. First, it shows that a problem can be multidimensional and open to having multiple solutions, or not even a solution, as the main goal of the problem, according to tutors, is not solving it but guiding learners to explore more about it. Second, it shows that it is not driven by the course content, but students are free to explore and dive into the areas they are interested in. This category emphasises personalization, ensuring that each student can engage with the problem in a way that is meaningful and relevant to them.

PBL tutors' conceptions of problem-solving

Analysing teachers' conceptions of problem-solving required a thorough examination of their responses to various follow-up questions. The question "How do you define problem-solving?" often did not reveal their full understanding of the process. Therefore, we had to look at multiple aspects of their responses, including how they view the meaningfulness of the problem-solving process, the outcomes they expect from it, and how they define knowledge within the PBL framework. This comprehensive analysis led to the development of four distinct categories, where problem-solving is seen as 1) a

way to gain subject matter content knowledge 2) a way to develop learning strategies, 3) a learning experience that develops work-related skills, and 4) a learning experience that transcends the university course and transforms students' lives.

Categories & Quotes
C1) "Well, of course, you don't give the students direct questions 'cause they will phrase their questions based on the scenario. So you can only do, I mean as much as you can. You can't make errors; it is all complete for them, so they learn exactly what they're supposed to learn…" (N14)
C2) "I mean, what we try to achieve is basically for the students to look at the scenario. They should find out what they already know and what they need to know and then try to formulate distance in some good way of what they need to know so that they can read about that and then discuss it the next time (awareness 1- 2). yeah, but that's not enough. I've realised that I need to talk with my students also about why we're doing this. So in order to try to motivate them to understand. Why? Why do they do this?... (awareness 2)." (N12)
C3) "...So they have the same tutoring groups for a semester, and then they switch for the next semester. So they have a different group. And I think that it is really good for them to practice working in different group constellations with people that they would never have collaborated with if we hadn't forced them into different types of group process, how to solve conflicts and so on, is a good teaching outcome that is not necessarily about solving problems (awareness 3)." (N9)
C4) "Students are different. But I think that problem-based learning is a way of thinking. It's a style of life. It's something that you engage with, and then you learn in that way, and you operate in that way (awareness 4). I hope that you can use it in many situations in life, not only when you try to learn materials for the course (awareness 1)..." (N7)

Table 2. Conceptions of Problem-Solving, please visit the appendix for extended quotes.

In the first foundational category, the problem-solving process in PBL is viewed as a means to acquire subject matter content knowledge. The focus is on ensuring that students learn specific concepts that align with the curriculum.

The PS process is seen as an interesting way to acquire knowledge. Presumably, tutors' practice might focus on ensuring students understand and retain the subject matter through problem-solving. They might use problems that require the application of specific theories or concepts covered in the curriculum, assessing students' knowledge and understanding.

The second category of the second dimension sees the PS process as a possibility to help students develop effective learning strategies. It emphasises not only the acquisition of conceptual knowledge but also the development of academic skills such as self-reflection, learning to learn, and the ability to structure and organise their learning process. We can assume that tutors who hold this conception focus more on developing students' metacognitive strategies and encouraging self-directed learning and group work skills.

The hierarchical relationship of the conception gets more complex when PS problem-solving is conceived as closely mirroring real-life problem-solving processes. As tutors highlighted the PS process in PBL tutors should not only encourage them to read more about certain topics, but collaborate with different group members in different phases of the problem-solving process enabling them to gain work-related skills, like conflict resolution, coming to a consensus, decision -making, etc. The focus is on applying academic knowledge in practical scenarios and preparing students for professional practice by fostering critical thinking and adaptability. Tutors who value collaboration the most in the PS process might focus on the success of the group rather than the individual level, ensuring that they work together and putting more emphasis on group dynamics.

In the most complex category, problem-solving is viewed as a process that transcends the university course and transforms students' lives. It encompasses all aspects of the first three categories but extends further by emphasizing PBL as a lifelong thinking and operating process. It promotes not only content knowledge and metacognitive abilities but also personal growth and the ability to address real-world issues in both professional and personal contexts. As tutors state, the purpose of the problem-solving process in PBL should not be to complete steps but to teach students how to operate in their lives, and this is the way they will deal with problems in the workplace or in life.

PBL tutors' conceptions about their role

Before we delve into the specific categories of description, it's important to note that no tutors described their role using a single descriptor. Instead, all tutors mentioned multiple roles. Therefore, in conceptualizing their awareness, we focused on the roles they emphasized and prioritized repeatedly. This approach allowed us to capture the most salient aspects of their self-perceived

responsibilities. Analysis has revealed four categories of description, where tutors' roles are seen as 1) safe (guarding) the process 2) guiding inquiry 3) facilitating meaningful collaboration, and 4) guiding students to become individual learners.

Categories & Quotes
C1) "… I'm much more like making the structure. If I notice that they need a lot of guidance and structure because some people in the group will need that, otherwise they will get paralysed…This is the structure of the day. Today, we are going to start with this, and then we will continue like this. And then I will act at the beginning, like a structure maker, like an "informator"…(awareness 1)." (N7)
C2) "… I guess, on the one hand, sort of guiding them through the stages and showing them why it's important, (awareness 1) but also sort of modelling in a way the kinds of questions they can ask. So, when I'm tutoring in a PBL group, I might ask questions and show the kinds of things I want to get them to think about and look at things in a different way (awareness 2). So, it is partly modelling, partly guiding, supporting, and encouraging." (N6)
C3) "It's a lot about just learning PBL structure and working in a group(awareness 1). A lot of the students have bad experiences with group work. I think my part is to make sure that they just don't tell each other what they have read. I read this article. I read this article. That's not okay for me. There should be a discussion. They should deepen the discussion (awareness 3). They ask questions, and if they don't ask questions, I ask questions. I want to challenge them in what they have read (awareness 2)." (N5)
C4) ".... I don't want to hear your poor version of retelling it, but I want to hear your thoughts based on what you've learned and with other people's, we can kind of create new knowledge. I hope for them back to knowledge is that even if they don't know it, even if they don't have the answer, when they get out in the work life and they see a problem they don't know the answer to, they will find a way to find the answer on their own (awareness 4)". (N9)

Table 3. Conceptions of tutors' role, please visit the appendix for extended quotes.

This foundational first category represents the most basic level of tutor involvement in the PBL process. Tutors in this role focus on establishing a safe

environment where students feel secure and confident in their learning journey. The primary objective is to ensure that students understand the expectations and procedures of PBL, thereby reducing anxiety and creating a conducive learning atmosphere. Thus, the expectation is that tutors with this conception act as facilitators who provide clear guidelines, set agendas, and maintain the overall structure of the sessions.

Building on the primary role of providing structure, the second category involves tutors actively engaging students in the inquiry process. Tutors in this role stimulate critical thinking by asking probing questions, modelling reflective thinking, and encouraging students to delve deeper into problems. The focus shifts from merely following a structured process to actively exploring and understanding the problems at hand. The complexity increases as tutors now need to possess a deeper understanding of the subject matter and the ability to guide students' thinking processes without providing direct answers to scenarios. This requires a balance of knowledge, pedagogical skills, and the ability to foster an environment where students feel comfortable engaging in open-ended inquiry.

The third category adds another layer of complexity by emphasizing the importance of meaningful collaboration among students. Tutors in this role not only guide inquiry but also ensure that group interactions are productive and that students engage in deep, collaborative discussions. As was mentioned by tutors, the PBL problem-solving process not only involves reporting readings in groups but also helps students learn to work as a team, seeing the need for and power of communication and collaboration. Tutors who hold these conceptions are not only trying to guide students through PBL steps, but making them uncomfortable with questions, asking them to go back several times, asking justifications about their decisions.

And last, the most complex category comprises tutors aiming to guide students to become more individual problem-solvers. This conception is the most complex as it integrates all views about PBL tutors' roles but adds complexity by showing the understanding that facilitating is not only helping students to work well in the group or to comprehend the problem but also showing them that the skills they acquire transcends university context and makes them independent problem-solvers. Tutors who adopt these conceptions encourage students to define problems from different perspectives and not be limited to exploring multiple paths. They don't give answers, "not putting restrictions on what is to be learned", and most importantly, asking them to reflect often on how they are going through the problem-solving process, asking to evaluate their learning process, group work, how they contribute, etc.

Discussion

This study aimed to explore how tutors in a problem-based learning context conceptualise their roles in the process of facilitating PBL tutorials, the nature of problems, and the problem-solving process. The phenomenographic analysis has revealed a nuanced hierarchy of conceptions, providing insights into the complexity of these elements and their potential impact on educational practices. This section discusses findings in light of existing literature and their implications for practice. Although PBL is considered a very student-centred approach and teachers might possess all PBL competencies, previous research showed that they might differ in their ideas of PBL tutoring (Leatemia et al., 2024).

Concerning the categories of conceptions of problems, at the bottom of the hierarchical structure, they are viewed as starting points to achieve intended learning outcomes. This perspective, while not incorrect, reflects a pragmatic concern with aligning teaching practices with institutional goals and assessment requirements. Tutors often feel the pressure to ensure that curriculum objectives are met, which can sometimes seem at odds with the student-centred ideology of PBL (McAlister et al., 2013). The debate over who should formulate learning objectives—tutors or students—remains a significant issue in PBL research (Czabanowska et al., 2012). However, a more advanced conception views problems as real-life experience that triggers curiosity and also connects to professional life, resonating with Barrett (2017), who highlights the potential of PBL problems to facilitate transitions in knowledge, professional action, and identity. As the categories of description of the problem become more complex, the role of the problem perceived by the tutors becomes more sophisticated. As we can see, the function of the problem is not only to acquire knowledge about certain concepts and make students read certain books and articles, but to encourage self-exploration, to strengthen professional links, etc.

The second dimension of our study focuses on how PBL tutors conceive problem-solving. It is important to note that all participants in this research utilise the PBL methodology as practised at Linköping University, specifically the PBL Wheel. Therefore, there is no variation in the procedural steps they follow during the PBL tutorial process. Our primary interest was to understand what tutors perceive as the main value of the problem-solving process and what aspects they emphasise in their instruction. The least advanced conception views problem-solving as a means to gain subject matter knowledge. While this is undoubtedly a crucial educational goal, research suggests that PBL should not merely serve as an appealing method for covering content. Facilitating the

process versus facilitating content acquisition remains a significant challenge in PBL tutoring (Azer, 2005). As conceptions evolve, tutors begin to emphasise the importance of developing learning strategies, enhancing students' work-related skills, and ultimately viewing problem-solving as a transformative learning experience that transcends the university course and significantly impacts students' lives. This advanced conception aligns with research highlighting the complex nature of the facilitation process, which requires a balance of various skills to be effective (Prodan, 2016; Groves et al., 2005).

The hierarchical categories of tutors' roles range from safeguarding the process to supporting students to become independent problem-solvers. Initially, tutors may focus on ensuring a safe and structured learning environment, which is crucial for fostering PBL group dynamics, as highlighted by Azer (2005). Previous studies have shown that the first fundamental step to ensure meaningful interaction in PBL groups and to promote deep learning is for students to be aware of their roles and how the PBL process works (Azer, 2009). However, this is not the only important conception; therefore, we intended to show how complex it is. As their understanding deepens, tutors see their role as guiding inquiry and facilitating meaningful collaboration, which is essential for developing critical thinking and self-directed learning skills (Katsara & De Witte, 2019). At the highest level, tutors view their role as supporting them to become independent problem-solvers, which involves not only guiding and supporting students but also challenging them to reflect on their beliefs, identities, and professional goals (Leatemia et al., 2024). This advanced conception underscores the importance of tutors in shaping a learning environment that promotes continuous personal and professional development, aligning with the principles of dialogic knowing in PBL (Barrett, 2017).

The outcome space developed from these categories provides a comprehensive understanding of teachers' conceptions of teaching problem-solving. Although the categories of descriptions for each dimension have developed independently from each other, we can observe a noticeable alignment across the dimensions. Figure 1. shows that in all dimensions, first, the least complex categories focus on basic educational goals, such as seeing problems as a means to meet ILO, and gaining content knowledge; as for the teacher's role, it is seen as a safeguard of the PBL process. The second category in each dimension emphasises creating a more stimulating and engaging learning experience for students. Here, the main role of the PBL is seen as an instructional way to suggest a more unconventional learning experience to students, as three facets of it focus on stimulating curiosity and helping students develop metacognitive learning strategies. The third category in each dimension shifts focus towards the development of practical, work-related skills. In this perspective, PBL is not

only about acquiring learning strategies but also about cultivating essential workplace skills. Teachers, in this context, are seen as facilitators of collaboration, an important competency in professional settings. The most complex conceptions, represented in the fourth category of each dimension, highlight the importance of fostering independent learning experiences that promote autonomy beyond the university environment. These conceptions emphasise the development of transformative, transversal skills that students can carry into various aspects of their lives.

Limitations

While this study offers valuable insights, there are some limitations to acknowledge. This study relies on the tutor's interview analyses, which might limit the study from fully capturing how tutors implement problem-solving and tutoring strategies in practice. However, it should be noted that the approach we adopted aligns with a phenomenographic focus on conceptions ('what' aspects) rather than actions ('how?' aspects). Future studies could adopt a mixed-method approach, combining interviews with classroom observations. Furthermore, one of the limitation is the absence of a coder-checking process, which typically involves multiple researchers independently coding the same data transcripts and comparing their categories. Although some researchers view this as a potential drawback due to the possibility of subjective bias, solo research, such as doctoral papers, yields reliable and meaningful data (Åkerlind, 2005). Although it is less likely and unnecessary for different researchers to replicate the outcomes space (Cope, 2004), it would be interesting to see if similar findings emerge in different educational settings.

Application of the study

First of all, this paper highlights the value of phenomenography, as it offers a unique perspective to learn PBL tutors' awareness in a very layered and profound way, which can enrich our understanding of their professional development needs, and, at the same time, show us what are the most complete understanding one can hold regarding different aspects of teaching problem-solving in PBL context. Although this study is dedicated to the PBL context, higher education teachers whose institutions do not formally adopt PBL but are willing to incorporate problem-solving pedagogy can use it as a self-guiding tool.

The present model offers immediate utility by providing a structured framework for reflection and dialogue among PBL tutors. Individual PBL tutors

can use this framework as a reflective tool to evaluate and refine their teaching practices. It enables tutors to recognize their current conceptual focus and explore pathways toward broader, more impactful perspectives. For instance, tutors who see that the only purpose of the problem is to introduce topics of the week can expand their approach by acknowledging and designing problems that connect students to the profession in a way that stimulates their curiosity and also enables them to see personal meaningfulness and multiple paths within it.

From an academic development perspective, our findings suggest that the CoTPS framework, combined with the four-component model suggested earlier (Åkerlind, 2018), can design workshops and training sessions that emphasize variation and hierarchy in understanding. For example, by applying some of the patterns of 4 components model and addressing one of the dimensions of CoTPS, academic developers can direct teachers' attention to the variation of conceptions of the problem, enabling them to identify their existing conceptions and explore distinctions (contrast). They can enable tutors to create problems that address all categories of understanding, such as meeting ILO, fostering curiosity, building professional skills and leading students to have multiple paths (fusion).

Looking ahead, as researchers, we recognize the need to collaborate with academic developers to design programs for tutors aimed at broadening their awareness of diverse aspects of teaching problem-solving. There is an opportunity to create more practical, hands-on resources that PBL tutors and higher education teachers can readily apply in their teaching practices.

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Appendix

Conceptions of Problem, extended quotes

Category 1) "Well, of course, you don't give the students direct questions because they will phrase their questions themselves based on the scenario. So, you can only do as much as you can. You can't make errors… so they learn exactly what they're supposed to learn. But you should aim to make a good scenario as possible. Hopefully, it will help students achieve their intended learning outcomes [Category 1 awareness]." (Response N14).

Category 2) "You shouldn't post the questions itself. It's important that the questions and what is required from the students are not given to them… One thing is that it should probably also be engaging, so it shouldn't be trivial. It should be something that is emotionally engaging, and that some students need, that is, some trouble to engage in finding the problem [Category 2 awareness]. Another thing, of course, is that the PBL tutorials are also kind of artificial because you know what the students are studying for that term. So, you kind of know that now it's physiology. Oh, it's someone with a problem with 'mixed turtian'. And of course, then you think, oh, it might be that they have a problem with the blood pressure and then the students know that they should read about the kidneys…[Category 1 awareness]." (Response N1).

Category 3)" I like cases that do not necessarily bring the most learning outcomes. I like cases that are provocative in some way, that it could be that they are wrong…[Category 2 awareness]. It's provocative because I think that psychologists still need to meet people who believe in things that they don't themselves believe in. So, what I want with that case is that the students both should read about mourning and dying [Category 1 awareness], but they should also try to have some self-reflection of what they think is important by death and dying because in their future profession, they will meet people that believe in God or life after death, stuff like that because they need to do that [Category 3 awareness]." Response (N4).

Category 4) Sometimes, when we give them vignettes, it's like, oh, here's a vignette, and it's all about social influence [Category 1 awareness]. So, it should stimulate curiosity [Category 2 awareness]. It should be ambiguous in terms of what is to be done, but also multiple ways in which they can go with it. So, maybe one group might go off in one direction, and another group might go off in a different direction, so they should be open to different ways of solving it [Category 4 awareness]. Because if it just leads you down one path and it feels very fixed, formulaic, and teacher-driven, and if it's going to be student-driven, It should be something that the students can say, no, I'm actually interested in

this. Can we explore? …If I see a student and if I see them looking at a problem and thinking we can go this way, we can go that way, then I'm thinking, yeah, they've done really well here… Especially with psychology students. You want them to understand the world in different ways and see variability and flexibility and not just to see, oh, you're that kind of person [Category 3 awareness]. You're going to be like that, do you know what I mean? To see a bit more open-minded." (Response N6).

Conceptions of Problem-Solving, extended quotes

Category 1) "Well, of course, you don't give the students direct questions because they phrased their questions themselves based on the scenario. So, you can only do, I mean as much as you can. You can't make errors, it is all complete for them so they learn exactly what they're supposed to learn. But aiming to make a good scenario as possible. Hopefully, it will help students achieve their intended learning outcomes. And of course, the students also know their intended learning outcomes for the course because they have access to the syllabus, and often they also look at the intended learning outcomes when they try to formulate the questions to the scenarios." (Response N14).

Category 2) "I mean what we try to achieve is basically that the students should look at the scenario they should find out what they already know and what they need to know and then try distance from it and reflect on what they need to know so that they can read about that and then discuss it the next time [Category 1-2 awareness]. Yeah, but that's not enough. I've realised that I need to talk with my students also about why we're doing this. So, in order to try to motivate them to understand. Why? Why do they do this? [Category 2 awareness]." (Response N12).

Category 3) **"…**Students are given more freedom to structure their teaching and their learning themselves than compared to other psychology programs in Sweden [Category 2 awareness]. So, when they are done with the psychology program here, they are more self-running academics, psychologists who really do stuff by themselves without anyone telling them what to do. But then we have the idea that from working in the PBL group, students will be forced to individually read more literature than they would have done individually and they will learn more things based on that group context [Category 2 Awareness]. So, they have the same tutoring groups for a semester, and then they switch to the next semester. So, they have a different group. And I think that it is really good for them to practice working in different group constellations with people that they would never have collaborated with if we hadn't forced them into different types of group processes, how to solve conflicts and so on, is a good teaching outcome that is not necessarily about solving problems [Category 3 awareness]." (Response N9).

Category 4) "Students are different. But I think that problem-based learning is like a way of thinking. It's a style of life. It's something that you engage with, and then you learn in that way, and you operate in that way [Category 4 awareness]. I hope that you can use it in many situations in life, not only when you try to learn materials for the course [Category 1 awareness]. It will be a tool for the way you think and the way you solve problems in the future. It will be like a way of approaching problems in the future, a way of also interacting with others and trying to find solutions, not by yourself, but with the help of other people and getting richer solutions. [Category 3 awareness]. A way of learning how to formulate questions and where the questions come from because the questions are very important [Category 2 awareness]. So, if you don't have a good question, you won't get a good outcome." (Response N7).

Conceptions of tutors' role, extended quotes

Category 1) "I'm much more like making the structure. If I notice that they need a lot of guidance and structure because some people in the group will need that, otherwise they will get paralysed…This is the structure of the day. Today, we are going to start with this, and then we will continue like this. And then I will act at the beginning, like a structure maker, like an "informator"…[Category 1 awareness]."(Response N7).

Category 2) "I guess, on the one hand, sort of guiding them through the stages and showing them why it's important, [Category 1 awareness] but also sort of modelling in a way the kinds of questions they can ask. So, when I'm tutoring in a PBL group, I might ask questions and show the kinds of things I want to get them to think about and look at things in a different way [Category 2 Awareness]. So, it is partly modelling, partly guiding, supporting, and encouraging". (Response N6).

Category 3) "It's a lot about just learning PBL structure and working in a group [Category 1 awareness]. A lot of the students have bad experiences with group work. I think my part is to make sure that they just don't tell each other what they have read. I read this article. I read this article. That's not okay for me. There should be a discussion. They should deepen the discussion [Category 3 awareness]. They ask questions, and if they don't ask questions, I ask questions, I want to challenge them in what they have read [Category 2 awareness]." (Response N5).

Category 4) " I want to kind of rock the world a bit, just nudge them and make them a bit uncomfortable by asking questions and make them feel like we have power over our own learning [Category 2 awareness]. And I think the tutor sets the tone for that because I know from my students that most PBL tutors will kind of just ask: Okay, what step are you on now? Have you forgotten anything?

How many studies have you read [Category 1 awareness]. And I'm like, I don't care. I don't care if you've read that many studies. I want you to have studied, but I want the discussion to be meaningful [Category 3 awareness]. I don't want to hear your poor version of retelling it, but I want to hear your thoughts based on what you've learned and with other people's, we can create new knowledge. I hope in the future, even if they don't know it, even if they don't have the answer, when they get out of work life and they see a problem they don't know the answer to, they will find a way to find the answer on their own [Category 4 awareness]."(Response N9).