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ARTICLE

A Multilevel Analysis of Problem-Based Learning Design Characteristics

Kimberly S. Scott (Northwestern University)

The increasing use of experience-centered approaches like problem-based learning (PBL) by learning and development practitioners and management educators has raised interest in how to design, implement, and evaluate PBL in that field. Of particular interest is how to evaluate the relative impact of design characteristics that exist at the individual and team levels of analysis. This study proposes and tests a multilevel model of PBL design characteristics. Participant perceptions of PBL design characteristics are used to examine PBL reactions and perceived learning outcomes. Findings reinforce the importance of problem design characteristics and effective team facilitation while raising new questions about team-level characteristics such as goal orientation diversity.

Keywords: PBL, design, multilevel, management, HLM

Introduction

Management educators currently are facing many of the same challenges that existed when problem-based learning (PBL) was first introduced by the medical faculty at McMaster University to improve medical students' development of diagnostic skills (Barrows & Tamblyn, 1980; Barrows & Mitchell, 1975; Neufeld & Barrows, 1974). Educators are searching for ways to engage future managers and leaders in deeper levels of learning and problem solving required for professional practice rather than focusing on teaching functional-specific, factual knowledge. A few studies have reported results of using PBL in management programs (Bigelow, 2004; Brownell & Jameson, 2004; Chaharbaghi & Cox, 1995; Goltz, Hietapelto, Reinsch, & Tyrell, 2008; Hallinger & Lu, 2011; Sherwood, 2004; Smith, 2005), but PBL has not been used as widely or tested as rigorously in this context as it has in medical education where PBL has become a prominent pedagogical approach since its introduction in the 1960s (Hung, Jonassen, & Liu, 2007; Schmidt, 1983).

In a recent meta-analysis of research comparing the learning outcomes from PBL versus lecture-based course designs, Walker and Leary (2009) found five controlled experiments from the field of business that showed significant, positive effects for PBL compared to traditional teaching methods. More recently, Hallinger and Lu (2011) found support for the effectiveness of PBL in management education. Studies also have revealed positive relationships between PBL and improvements in professional skills, including social skills, critical thinking, and problem solving (Hmelo-Silver, 2004; Hung et al., 2007; Loyens, Kirschner, & Paas, 2012; Schmidt, Rotgans, & Yew, 2011; Schmidt, van der Molen, te Winkel, & Wijnen, 2009). These studies and others showing promising outcomes continue to fuel interest in and support for PBL. However, for management educators and human resource development practitioners, existing research does not answer questions that often arise during PBL design and implementation.

When presented with the opportunity to use PBL for leadership development, instructional designers naturally begin with a battery of questions about how to effectively design for PBL in this context. How will the team-based learning environment influence learning outcomes for experienced managers compared to new managers? What is the role of the facilitators and how do they influence the PBL process and outcomes? And, driving most of these questions, where should we focus our limited resources to create the best learning opportunities for our students? Fortunately, the PBL literature is rich with research that can be applied to offer recommendations, but one area where research is needed to improve PBL implementation is examining the combination of PBL design characteristics that engage participants and contribute to learning outcomes. Designing and implementing PBL requires attention to both the characteristics of individual participants, such as their intrinsic motivation or past experiences, and the characteristics of the team, such as the level of team collaboration or diversity. These variables

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can directly impact individual learning outcomes, and the variables are likely to interact with each other such that the effects of individual-level variables are strengthened or diminished based on the effects of team-level variables.

Answering these questions requires an approach, *multilevel modeling*, that has not yet been widely adopted in PBL research. Multilevel modeling, also referred to as hierarchical linear modeling, provides a statistical technique for examining questions that involve hierarchical data structures, which occur regularly in PBL where the effects of individual and team characteristics are believed to have an impact on individual outcomes (Raudenbush & Bryk, 2002). The purpose of this paper is to explore the construction and use of a multilevel PBL model to examine the effects of both individual- and team-level design characteristics. As a preliminary investigation of my multilevel hypotheses and to illustrate the application of multilevel modeling for PBL, I use hierarchical linear modeling to analyze data gathered during the implementation of PBL in a professional master's degree program. Because the graduate program focused on educating experienced practitioners to develop leadership, teamwork, and management consulting skills, this study also contributes to the literature extending PBL into management education.

The primary goal of this paper is to illustrate the use of a multilevel model for PBL in examining the effects of design characteristics, thereby setting the stage for future research to address more complex questions that exist due to the hierarchical structures and units of analysis in PBL research. I begin by reviewing some of the issues that surface when placing the PBL features and design characteristics into a multilevel framework. To develop specific hypotheses for an empirical study, I elaborate on some of the design characteristics supported by prior research and their proposed relationships with learner outcomes. I then use data from a PBL implementation to offer a preliminary examination of what this evaluation approach reveals.

Multilevel Model of PBL Design Characteristics

Studies that have sought to define and explain the process of PBL (e.g., Barrows & Tamblyn, 1980; Hmelo-Silver, 2004; Hung et al., 2007; Schmidt, 1983; Schmidt et al., 2011) typically identify five features that collectively differentiate PBL from other experiential learning techniques and form the core levers for achieving PBL objectives: (1) starting the process with the problem, (2) requiring student-directed learning throughout the process, (3) reflection about problem solving and learning, (4) small group collaboration, and (5) facilitation to guide learning. These features are necessary in combination for effective PBL design; so to the extent possible they should be represented in a multilevel model evaluating PBL effectiveness. However, examining a model for the presence or absence of each feature is not sufficient to fully understand how PBL works because each feature can be designed and implemented in many different ways. For example, problems can range in complexity and type, participants can engage in reflection and self-directed learning to varying degrees, and facilitators can provide different types and amounts of support. As noted previously, few studies have examined which combination of PBL characteristics are essential to produce desired outcomes, and the complexity of PBL design, with its numerous design variables, has made it difficult to make progress in this area (Hung, 2011; Mamede, Schmidt, & Norman, 2006; Sockalingam, Rotgans, & Schmidt, 2011). A multilevel model of PBL can attempt to capture these variables so that combinations can be compared and evaluated for their effects on learning outcomes.

To create variables for multilevel analysis, it is important to be explicit about the units of analysis used to represent these variables. As noted by other PBL researchers, several design characteristics may be evaluated more effectively if they are defined and measured from the learner's point of view (Hung, 2009; Sockalingam & Schmidt, 2011). For example, problems may be authentic and challenging only to the extent that they are judged as such by the participants based on their prior experiences. An instructor might present a problem that is likely to be encountered in the student's professional role, but if the student or the learning team does not believe that the problem is realistic, the expected levels of student engagement in problem solving might not appear. Similarly, facilitators can think they are providing individuals and teams much autonomy to pursue problem solving, but students may not perceive the same degree of autonomy. Therefore, the perceived affordances of PBL design characteristics may influence desired outcomes and engagement in the learning process, and these perceptions can vary between individuals in the same PBL intervention. A multilevel model of PBL can address this challenge by examining these variables from the learner's point of view while accounting for the specific context (e.g., team, class) in which the problem was solved.

Scholars have repeatedly emphasized the need to be explicit about the nature of the levels represented in theoretical and statistical models, particularly when constructs are measured at one level and specified at another level (Breugst, Patzelt, Shepherd, & Aguinis, 2012; Garavan, McGuire, & O'Donnell, 2004; Hofmann, 1997; House, Rousseau, & Thomas-Hunt, 1995; Raudenbush & Bryk, 2002). For example, facilitator effectiveness is a design characteristic that can be measured at the individual level (e.g., learner perceptions of facilitator effectiveness) and then aggregated to create a measure of facilitator effectiveness for the team and specified in the model as a team-level variable. When learners are assigned to teams with different facilitators, analyzing PBL data only at the individual level of analysis (e.g., examining the relationship between perceived facilitator effectiveness and learner satisfaction) overlooks the nested nature of data gathered from participants working in these teams, and it obstructs our ability to understand team-level effects relative to individual-level effects (Raudenbush & Bryk, 2002).

To construct a multilevel model of PBL design, it is necessary to first specify the most appropriate theoretical and statistical levels of analysis for the design variables under investigation. Personal characteristics of the learner, such as motivation, age, self-directed learning skills, and experience, are properly defined and measured at the individual level of analysis. As described previously, PBL design characteristics that are measured by individual perceptions, such as perceived facilitator effectiveness, team collaboration, or team autonomy, may be measured at the individual level of analysis but theoretically it makes more sense to specify them as team-level variables. When the design characteristic is an attribute of a group, or when the characteristic represents an experience shared by members of the same group that may be different between groups, then the design characteristic is properly defined at the team level of analysis. Table 1 shows the PBL design characteristics and features examined in the empirical study described in this paper. The characteristics are grouped according to whether the variable is an individual-level or team-level concept. This table does not provide a comprehensive list of all PBL variables that could be included in a multilevel framework, but rather focuses on the variables that are used to illustrate this approach in the current study. Each of the design characteristics used in this study and their hypothesized main effects for learning outcomes and engagement in PBL are described briefly in the next section.

Individual-Level PBL Design Characteristics

Engagement in Self-Directed Learning and Reflection.

In a review of the studies that have examined relationships between PBL and self-directed learning, Loyens, Magda, and Rikers (2008) found mixed support for the hypothesis that PBL develops these skills. However, studies have used limited measures of self-directed learning (e.g., time spent in self-study) when examining PBL's effectiveness, and the extent to which students have the ability and opportunity to use these skills may directly affect learning outcomes. Faculty can make many different design and implementation choices for fostering self-directed learning and reflection through their coaching and by using assignments like learning journals, blogs, or diaries. Similarly, students can choose to engage in a variety of self-directed learning (SDL) activities, which can include selecting learning issues; deciding which learning resources and strategies to use; and engaging in self-study, monitoring, and evaluation (Loyens et al., 2012; Loyens et al., 2008). While reflection is recognized as an important process to facilitate learning in PBL, sometimes it is described as an aspect of

Table 1. Multilevel PBL Design Characteristics

Variables	Variable Features
Individual Level	
Engagement in Self-Directed Learning and Reflection	• Selecting learning issues and strategies • Initiating planning and feedback • Monitoring learning progress • Reflecting about experiences and new/dissonant ideas • Questioning beliefs and assumptions
Problem Authenticity	• Importance of the problem to students • Practical relevance—based on "real work" • Provides a meaningful context for knowledge transfer
Problem Familiarity	• Prior understanding and knowledge of the problem • Context and content familiarity
Learner Characteristics	• Learning vs. performance goal orientation • Learning preferences
Team Level	
Facilitator Effectiveness	• Supporting teamwork and learning activities • Stimulating questioning, elaboration, knowledge integration • Encouraging interaction and accountability for SDL • Modeling feedback, questioning, and reflection
Team Autonomy	• Perceived control over learning, problem solving • Climate supportive of team autonomy
Diversity	• Goal orientation diversity
Learning Team Collaboration	• Sharing responsibility for learning and action • Questioning and challenging ideas • Climate of openness, trust, and encouragement

SDL. Reflection is a student-directed process that involves questioning and sense making. Research suggests that it is a key metacognitive skill for PBL (Hmelo-Silver, 2004; Hmelo & Lin, 2000; Hung, 2009; Kek & Huijser, 2011; Loyens et al., 2008; Pease & Kuhn, 2011). To monitor whether SDL and reflection interventions are producing their intended effects, instructors need to gauge how often students engage in these activities during PBL. To the extent that students do so, we can expect positive effects on PBL outcomes.

Hypothesis 1: Student Engagement in Self-Directed Learning and Reflection will be positively associated with PBL outcomes.

Problem Characteristics

Selecting the "right" problem is a critical design step because PBL is constructed around problems, but few empirical studies exist to guide design or evaluation. Proposed characteristics have included problem clarity, authenticity, challenge, suitability, complexity, and familiarity (Schmidt & Moust, 2000; van Berkel & Schmidt, 2000). For this study, I focus on two problem design characteristics that appear to be particularly important for management education: Authenticity and Familiarity.

Problem Authenticity

Research suggests that learning transfer will be more successful and students will be more cognitively and affectively engaged in problem solving if problems are authentic and meaningful within their profession, defined as the kind of problem they will encounter beyond an academic context (Hung, 2006; Innes, 2006; Loyens et al., 2008; Schmidt et al., 2009; Wirkala & Kuhn, 2011). Hallinger and Lu (2011) demonstrated that authentic problems can be designed for business students with careful consideration of students' work environments and with instructor collaboration to develop performance-based assessments of project outcomes. By measuring perceived Problem Authenticity from the student's point of view, researchers can explore the extent to which this design characteristic is associated with PBL engagement and effectiveness.

Problem Familiarity

Prior research in PBL has found that unfamiliar problems may be less effective because students are unable to relate to them and, therefore, have less productive group discussions (Loyens et al., 2012; Schmidt et al., 2011). This is consistent with theory suggesting that group members need some task familiarity to provide the scaffolding necessary for successful learning and performance (Hmelo-Silver, Duncan, & Chinn, 2007; Loyens et al., 2012; Reiser, 2004; Schmidt et al., 2011; Sockalingam & Schmidt, 2011). Therefore, the level of perceived Problem Familiarity also should be associated with Student Engagement in PBL.

Hypothesis 2: Perceived problem characteristics (i.e., Authenticity and Familiarity) will be positively associated with PBL outcomes.

Hypothesis 3: Perceived problem characteristics (i.e., Authenticity and Familiarity) will be positively associated with Student Engagement in SDL and Reflection.

Learner Characteristics

Learner characteristics and their effects on the PBL process and outcomes have received little attention within PBL research (Hung et al., 2007; Loyens et al., 2012). Although learner beliefs and preferences influence learner behaviors regardless of the learning environment, individual differences may be especially important for PBL researchers and designers to consider. One reason is because of PBL's heavy reliance on self-directed learning, reflection, and collaborative discourse to draw meaning from problem-solving experiences. Scholars have suggested that self-efficacy, perceived control, and personality characteristics like openness are particularly relevant for experiential learning (Araz & Sungur, 2007; DeGeest & Brown, 2011; DeRue & Wellman, 2009; Raelin, 1997). Research about learning styles suggests that congruence between learning style and environment leads to better learning achievements, thus it may be easier for some individuals to learn from PBL (Armstrong & Mahmud, 2008; Kolb & Kolb, 2005). Learners who are less inclined to engage in questioning and reflection may need additional instruction and support to prepare them for PBL, and they may require more scaffolding during the process to have a successful experience.

Furthermore, PBL creates a performance-oriented environment as learners are given authentic problems to solve, particularly when the problem requires a solution for a real client or organization. Research examining individual differences in goal orientation has revealed that goal orientation influences how learners perceive tasks and process information, how they respond to feedback, and the subsequent actions they take to accomplish tasks (Button, Mathieu, & Zajac, 1996; Dweck & Leggett, 1988; Phan, 2009; Senko, Hulleman, & Harackiewicz, 2011). Achievement goal theory suggests two orientations that individuals can adopt when faced with a challenge: a "mastery," or learning goal orientation (LGO), is characterized by a desire to engage in challenging activities, self-improvement, and the belief that capabilities can be developed, whereas a performance goal orientation (PGO) emphasizes avoiding mistakes, a preference for nonchallenging activities, and demonstrating performance relative to others (Button et al., 1996; Dweck, 1986; Dweck & Leggett, 1988). Therefore, LGO may be positively associated with Engagement in Self-Directed Learning and Reflection in PBL environments. However, because research shows that both goal orientations may be associated with learning achievement, each orientation may be significantly associated with PBL outcomes.

Hypothesis 4: Goal Orientation will be significantly associated with PBL outcomes.

Hypothesis 5: Goal Orientation will be significantly associated with Student Engagement in SDL and Reflection.

Team-Level PBL Design Characteristics

The design variables to be examined at the team level of analysis are Facilitator Effectiveness, Team Autonomy, Team Diversity, and Collaboration. All of these variables are conceptualized at a group level because they represent shared effects across members within a team. Prior research suggests that these PBL design characteristics will have an effect on learning outcomes and Student Engagement in SDL and Reflection. I briefly explain the proposed relationships between these variables next to set up the team-level hypotheses.

Facilitator Effectiveness

The role of the facilitator is one of the most thoroughly researched PBL design characteristics. Studies have defined Facilitator Effectiveness to include using questions to support reflection, metacognitive skill development, and collaborative knowledge building; encouraging members to share and elaborate on their knowledge; fostering individual and team ownership of their learning; helping teams create a climate and structure that encourages collaboration; and scaffolding problem-solving and learning strategies by modeling effective behaviors (Hmelo-Silver, 2004; Hmelo-Silver & Barrows, 2008). These facilitator practices are intended to directly affect Student Engagement in SDL and Reflection and improve learning outcomes without being overly directive or delivering too much instruction. Effective facilitators provide sufficient scaffolding to help learners build skills, but they gradually reduce such scaffolding as learners develop (Hmelo-Silver, 2004; Hmelo-Silver et al., 2007).

Effective Facilitation is hypothesized here as a group-level variable because facilitators provide a set of routines and tools for teams to use based on their learning goals, resulting in interactions and shared social experiences among team members that may be different between teams—even between those teams that have the same facilitators. Facilitation practices also can widely vary across programs based on their learning philosophies, and no single approach has emerged as the "best practice" for PBL. Given that facilitators can create relatively homogeneous experiences for members within teams and teams can be exposed to different but equally effective Facilitation techniques, the research approach adopted here is to measure Facilitator Effectiveness the same way that climate measures are employed by aggregating individual-level perceptions to represent this group-level variable (see Seibert, Silver, & Randolph, 2004).

Team Autonomy

Much like individual autonomy is necessary to give learners opportunities to engage in self-directed learning, Team Autonomy is an important group-level input to collaborative learning (Hmelo-Silver & Barrows, 2008). Building from studies on self-determination theory, research suggests that group members are more engaged when they can decide which actions to take, have responsibility for their learning and performance, and work in a climate that supports team autonomy (Liu & Fu, 2011; Rotgans & Schmidt, 2011). As such, individual member judgments about the level of team authority can be aggregated to create a group-level variable to examine whether shared perceptions of autonomy affect SDL engagement and learning outcomes.

Team Diversity

Given the prominence of social interaction in theoretical accounts of PBL, it is surprising that little research has examined the impact of Team Diversity on PBL outcomes. Descriptions of the McMaster program note the importance of having a heterogeneous student body, in terms of academic training, experience, personality, and perspective, to provide a rich forum for problem solving (Neufeld & Barrows, 1974). Work group diversity theories suggest that diversity increases the pool of resources, knowledge, and skills that members can draw from for learning and problem solving (van Knippenberg & Schippers, 2007).

Research on team goal orientation diversity also raises interesting implications for PBL design. Goal orientation diversity has been conceptualized as a dimension of deep-level diversity involving stable individual differences that influence mental representations of tasks and how to perform them (Pieterse, van Knippenberg, & van Ginkel, 2011). Diversity in goal orientation could interfere with group collaboration and performance because individual differences in task representations disrupt coordination and communication between members. However, evidence also suggests that engaging teams in reflective practice to help them establish shared mental models may counteract the negative effects of goal orientation diversity (Pieterse et al., 2011), so PBL's emphasis on questioning and reflection may diminish these effects.

Team Collaboration

As discussed earlier, the team's learning environment forms what many scholars believe to be the essential group-level process for achieving PBL outcomes and encouraging self-directed learning and reflection (Dolmans & Schmidt, 2006;

Gijselaers & Schmidt, 1990; Hmelo-Silver & Barrows, 2008; Hmelo-Silver et al., 2007; van den Hurk, Dolmans, Wolfhagen, & van der Vleuten, 2001). I use the general term *collaboration* here to refer to these collective team-learning activities and norms, although it is still characterized as the "black box" of PBL because much less research has examined how Collaboration influences PBL outcomes (Schmidt et al., 2011). A "snapshot" of an effective PBL group should reveal students engaged in open, nonmanipulative two-way dialogue, working together toward a common goal while questioning each other's ideas and supporting members in the learning process (Innes, 2006). However, Innes (2006) contends that such dialogic communication is difficult to achieve because students may opt for the *divide-and-conquer* method of problem solving to improve project efficiency. Research suggests that a team's commitment to learning, or the shared norms of taking responsibility for learning and sharing expertise, is an important factor contributing to PBL effectiveness (Hmelo-Silver & Barrows, 2008). To the extent that these norms can be encouraged and reinforced by instructors, we can expect positive effects on Student Engagement in SDL and on PBL outcomes.

Hypothesis 6: Team-level design characteristics (i.e., Facilitator Effectiveness, Team Autonomy, Team Diversity, and Collaboration) will be positively associated with PBL outcomes.

Hypothesis 7: Team-level design characteristics (i.e., Facilitator Effectiveness, Team Autonomy, Team Diversity, and Collaboration) will be positively associated with Student Engagement in SDL and Reflection.

In the study described below, I explore whether these hypotheses can be examined using a multilevel approach to reveal insights that might be missed by analyses only conducted at the individual level of analysis. The main purpose is to illustrate the use of a multilevel model for PBL evaluation.

Methods

Sample

Data were gathered from surveys administered to three classes (one class each year) within a master's degree program that incorporated problem-based learning into a required course for students who were in their first year of the program. Approval from the Institutional Review Board was granted for this study. Students were experienced practitioners, managers, and senior leaders who typically held positions in the fields of organizational development, human capital, and change management. The three online surveys administered for each course were part of the program's overall curriculum and course evaluation procedures used to monitor student learning and engagement in the program. Items from these surveys were extracted to measure the variables included in this study. One survey was administered during the first week of the course, gathering information about students' backgrounds, preferences, and skill self-assessments. The second survey, administered one week before the project deadline, gathered team learning and collaboration evaluations. The final survey, administered as the course ended, contained items about perceived learning, facilitator effectiveness, and reactions to the course overall. Of the 84 students who completed these courses, 80 participants completed all instruments. Students were distributed across 14 teams and had an average of 12 years of work experience (ranging from 3 to 38 years), and they were primarily Caucasian (75%), female (78%), part-time students (76%) working in corporate settings (67%).

PBL Design

The PBL experience was central to the course design, which focused on developing leadership self-awareness, teamwork, and management consulting skills. Students were required to identify specific learning goals and complete reflection assignments to share their learning achievements with the instructors. Teams ranging in size from 5–8 students were formed to maximize diversity in experience (i.e., the years of work experience for individuals on the teams) and background (i.e., industry and role).

Each class was presented with an ill-structured problem that was an actual performance challenge for a nonprofit "client organization." Although the client organizations were different each year, the instructors worked with the clients to construct problem statements that were similar in scope and that required assessing, diagnosing, and proposing a solution for the organization, and then prototyping the approved solution with members of the client organization. Within each class, teams conducted their own organization needs assessments and crafted unique solution proposals to address the stated problem. The problems were ill-structured and complex, with no "right answers" predetermined by the clients or the instructors, resulting in different solutions proposed and prototyped by the teams. All of the problems involved changing individual behaviors in organizations (e.g., attending organization events, increasing knowledge sharing among members, etc.) and improving the overall performance of the organization (e.g., increased community awareness of the organization's purpose, improved organization reputation), as defined by the client. For example, one client wished to increase the level of "member engagement" within the organization, making explicit the desired outcomes of engaged membership but leaving it to the students to help discover and define what "engagement" meant for that organization. The following are examples of the solutions created by the teams: an event designed for organization members to teach them about the desired behaviors; the design and implementation of a survey to understand member behaviors; a web site prototype for the client organization; and toolkits to educate, inform, and motivate organization members in behavior change.

An experienced facilitator was assigned to each team to support individual student learning and to help the teams engage in collaborative learning. All of the facilitators had advanced degrees (master's or PhD) and over 10 years of experience in consulting and facilitating team learning with managers and professionals, allowing them to coach the students on their learning processes, teamwork, and consulting skills. The facilitators met with each other and the instructors several times throughout the project to discuss their teams' progress, challenges, and the support they were providing to help the teams or individual students. The facilitators often shared ideas with each other, but they were not required to use the same facilitation tools or techniques with their teams.

Measures

Measures were created to represent the PBL design components described in the literature review, and learning outcomes were measured using items from the final survey administered to the students at the end of the course. The measures described below for the Problem Characteristics, Student Engagement, Collaboration, Team Autonomy, Facilitation, and Perceived Learning and Performance were ad-

Table 2. Design Characteristics, Scale Items and Factor Loadings

Design Variable	Design Scale Items	Item Factor Loadings
Problem Authenticity (*authenticity*)	1. This project required me to stretch beyond the skills and abilities I started with 9 months ago.	0.42
	2. I was very interested in the challenge we were asked to address.	0.70
	3. The challenge of [name of problem] is a very important issue.	0.85
	4. This project was a realistic consulting experience.	0.54
Problem Familiarity (*familiarity*)	1. Responding to a request for proposals.	0.77
	2. Consulting for a leadership team.	0.67
	3. Conducting an organization assessment.	0.71
	4. Designing and implementing the specific type of intervention that your team proposed.	0.47
	5. Managing the implementation of a project.	0.70
Engagement in SDL and Reflection (*SDL*)	1. Reflecting about my emotional reactions.	0.78
	2. Reflecting about what I was learning.	0.83
	3. Asking others for feedback about my behaviors.	0.68
	4. Trying out new behaviors that I wanted to practice.	0.58
Facilitator Effectiveness *(facilitation)*	1. Guided us effectively in reflecting.	0.79
	2. Helped us establish a climate conducive to learning.	0.88
	3. Intervened in a timely and appropriate manner.	0.84
	4. Made sure that every member of our team was given the time and encouragement to express their thoughts.	0.89
	5. Was a good model for effective questioning and listening skills.	0.88
	6. Provided accurate, frank and helpful feedback.	0.82
	7. Provided timely feedback.	0.84
	8. Was committed to helping us learn and develop.	0.92
	9. Took a nonjudgmental approach toward our team's decisions and actions.	0.68
	10. Coached in a tolerant and patient manner.	0.74
	11. Helped me improve my teamwork skills.	0.85
	12. Helped me become a better leader.	0.81
Learning Team Collaboration (*collaboration*)	1. We have been strongly committed to our task.	0.61
	2. Our team communicates with openness and honesty during our team meetings.	0.90
	3. Team members regularly challenge and question each other's assumptions.	0.77
	4. Our team focuses equally on learning and performance.	0.78
	5. Our team created an environment where all members feel comfortable trying out new ideas, approaches and behaviors.	0.87

opted from metrics created and administered by the program department to monitor student learning and engagement. As such, these measures used different Likert scales. To examine whether the available PBL design measures could be used to represent the variables in this study, I conducted an exploratory factor analysis with principal axis extraction and Varimax rotation. The Kaiser-Meyer-Olkin measure indicated sampling adequacy for this analysis (KMO = 0.81), and a satisfactory five-factor solution emerged, corresponding to the desired variables. The measures, their items, and factor loadings are displayed in Table 2.

Individual-Level Variables

The items for Problem Familiarity used a 6-point Likert scale ranging from "very unfamiliar" to "very familiar." This measure had a reliability coefficient α = 0.79. The items for Problem Authenticity used a 6-point Likert scale ranging from "strongly disagree" to "strongly agree," with the final measure reliability α = 0.80. The measure for Student Engagement in Self-Directed Learning and Reflection (SDL) used a 5-point frequency scale ranging from "never" to "always." The SDL coefficient α = 0.83. Finally, individual-level scores for Performance Goal Orientation and Learning Goal Orientation were created from the 8-item measures established by Button et al. (1996) that identifies two unique dimensions for goal orientation. These measures used a 7-point Likert scale ranging from "strongly disagree" to "strongly agree." Items were averaged to create composite scores, with reliabilities α = 0.83 for PGO and α = 0.86 for LGO.

Team-Level Variables

I measured three of the team-level characteristics using the mean of team members' responses on items reflecting these variables (see Table 2). Using mean responses to represent group-level variables is justified if there is a high degree of consensus among member perceptions of these characteristics. The Collaboration measure (α = 0.90) employed a 7-point Likert scale ranging from "strongly disagree" to "strongly agree." The Team Autonomy (α = 0.72) and Facilitation (α = 0.97) measures used 6-point "strongly disagree" to "strongly agree" Likert scales. Standard deviations of the goal orientation measures among students on each team were used to represent Performance- and Learning-Goal Orientation Diversity (Pieterse et al., 2011).

PBL Outcomes

The two outcome measures for this study, reactions to the PBL experience and perceived improvement in learning, were based on students' self-assessments of their learning experiences. Students' reactions to their PBL experiences (Student Reactions) were measured using Wexley and Baldwin's (1986) 5-item measure (α = 0.90). The items used a 5-point bipolar scale to capture reactions to the following dimensions: chaotic/organized, unstimulating/stimulating, irrelevant/relevant, impractical/practical, and unapplicable/applicable.

Consistent with other studies that have examined learning achievement (Liu & Fu, 2011; Molleman, Nauta, & Buunk, 2007), the perceived improvement in learning outcome measure used student judgments about their achievement of learning objectives. The Perceived Learning composite score used items with a 4-point Likert scale ranging from "not at all" to "very much" in response to a question about how much the student improved as a result of the PBL experience. Students rated their improvement in 15 competencies related to leadership (e.g., influencing, negotiating, listening, decision making, relationship building, collaboration), consulting (e.g., analytical skills, assessment, diagnosis, project management, problem solving), and learning agility (e.g., self-awareness, self-management, comfort with ambiguity, adaptability). To create the composite measure, I first conducted an exploratory factor analysis on the 15 competency ratings using principal axis extraction and Varimax rotation. The Kaiser-Meyer-Olkin measure indicated sampling adequacy for this analysis (KMO = 0.89). Although three factors emerged corresponding to the leadership, consulting, and learning agility dimensions described above, a few of the items were moderately associated with more than one factor. Because the focus of this study is Perceived Learning overall, an average composite score was calculated using the combined averages of the items from the three factors (α = 0.84).

Control Variables

An individual-level variable that could influence students' PBL reactions is perceptions of project performance for the client organization. As such, I included a three-item scale for Perceived Task Performance which used a 7-point "strongly agree" to "strongly disagree" Likert scale to assess how well the students thought they performed overall, how pleased they were with the results they produced, and whether they successfully accomplished the tasks that they set out to achieve for the client. The coefficient α = 0.82 for this measure. For the team-level analyses, average team LGO and PGO were examined as control variables because LGO and PGO Diversity measures were of primary interest in this study. Finally, because the client problems presented to the teams were different for each class and the team sizes varied, I also included these as control variables in the first step of level 2 modeling, as described below, to make sure there were no significant differences that could affect the overall modeling results.

Results

Preliminary Analyses

Table 3 presents the means, standard deviations, correlations, and alpha reliability coefficients for the measures. To check for common method variance, I used a Harman's one-factor test (Harman, 1976) with principal component analysis and Varimax rotation for all independent and dependent variables. No single major factor emerged to account for the majority of variance in the model.

I also examined whether the data empirically justified aggregating the team-level design measures for Collaboration, Facilitation, and Team Autonomy. I computed the $r^*_{wg(j)}$ for each variable per team as an index of within-group agreement (James, Demaree, & Wolf, 1984, 1993; Lindell, Brandt, & Whitney, 1999), and I used a one-way analysis of variance (ANOVA) to examine between-group variation. The mean $r^*_{wg(j)}$ statistics were 0.84 for Collaboration, 0.62 for Facilitation, and 0.64 for Team Autonomy. The ANOVA indicated significant between-team variances for Collaboration ($F[13, 66] = 12.94$, $p < 0.01$, $\eta^2 = 0.70$) and Facilitation ($F[13, 66] = 8.63$, $p < 0.01$, $\eta^2 = 0.68$), but not for Team Autonomy ($F[13, 66] = 1.67$, $p > 0.05$, $\eta^2 = 0.10$). These results provide acceptable support for including the first two as team-level variables, but Team Autonomy was excluded from further modeling.

Hypothesis Testing

To test the cross-level hypotheses and account for effects of the nested data, I used hierarchical linear modeling (HLM) with group-mean-centered individual-level (level 1) predictors (Raudenbush & Bryk, 2002), following Hofmann's (1997) three-step guidelines. The first step was to test whether there was a significant amount of between-team variance in the Student Reactions and Perceived Learning outcome variables and the Self-Directed Learning (SDL) engagement variable by examining their null models and intraclass correlation coefficients. As shown in Table 4, the analyses revealed that 38% ($\tau_{00} = 0.32$, $\chi^2 = 52.75$, $p < 0.001$, ICC1 = 0.38) of the variance in Student Reactions resides between teams (to be explained by level 2 variables). For Perceived Learning, 15% ($\tau_{00} = 0.06$, $\chi^2 = 26.61$, $p < 0.01$, ICC1 = 0.15) of the variance lies between teams, as shown in Table 5. For SDL, 11% of the variance resides between teams ($\tau_{00} = 0.05$, $\chi^2 = 20.51$, $p = 0.08$, ICC1 = 0.11), which is not significant, and, therefore, Hypothesis 7 cannot be examined in this study. Ordinary least squares regression, therefore, was used to test the individual-level hypotheses (i.e., Hypotheses 3 and 5) for the predictors of SDL.

Thus having established that HLM is warranted to examine the two outcome variables in this study, I added the individual-level variables to their level 1 models first. In the last step, team-level design characteristics were added to cre-

Table 3. Means, Standard Deviations, and Intercorrelations Between Study Variables

Variables	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
Familiarity	3.99	1.13	(0.79)												
Authenticity	4.21	1.10	-0.30**	(0.80)											
SDL	3.08	0.69	0.02	0.15	(0.83)										
Performance Orientation (PGO)	5.20	0.74	-0.07	-0.08	0.09	(0.83)									
Learning Orientation (LGO)	6.15	0.57	0.25*	0.19	0.35**	0.03	(0.86)								
Perceived Task Performance	5.04	0.79	-0.06	0.42**	0.35**	-0.08	0.26*	(0.82)							
Student Reactions	3.48	0.89	-0.26*	0.76**	0.28*	-0.09	0.15	0.44**	(0.90)						
PGO Diversity	0.77	0.12	0.00	-0.32**	0.10	-0.05	-0.08	-0.08	-0.29**						
LGO Diversity	0.49	0.20	-0.11	0.06	-0.15	-0.08	-0.24*	-0.16	0.06	0.00					
Facilitation	4.95	1.07	-0.15	0.48**	0.40**	0.02	0.08	0.42**	0.59**	0.05	0.03	(0.97)			
Collaboration	4.57	0.99	-0.13	0.05	0.26*	0.06	0.17	0.34**	0.08	0.42**	-0.08	0.17	(0.90)		
Team Autonomy	4.71	0.95	0.01	0.34**	0.17	0.02	0.22	0.39**	0.40**	-0.09	0.15	0.08	0.24*	(.72)	
Perceived Learning	2.48	0.63	-0.45**	0.55**	0.30**	-0.10	-0.02	0.33**	0.55**	-0.23*	-0.01	0.37**	0.11	.21	(.84)

N = 80; * $p < 0.05$ ** $p < 0.01$, two-tailed tests.

ate level 2 models to test Hypothesis 6. Because the level 2 sample size was limited, prior to adding the team-level design predictors, I examined whether any of the potential level 2 control variables were significant (i.e., class, team size, and average team LGO and PGO). None of the control variables were significant, and the model variances did not change significantly when they were included, so the level 2 control variables were excluded from the final models described below. As a final test to examine whether omitting the control variables biased the coefficient estimates, I conducted a sensitivity analysis on the level 2 coefficients which revealed negligible effects from their removal.

Individual-Level Design Characteristics

The first test of Hypotheses 1, 2, and 4 was conducted using a level 1 model that included all of the individual-level variables (i.e., SDL, Familiarity, Authenticity, PGO, and LGO) predicting Student Reactions to PBL. The results are shown in the second section of Table 4, which reveals that the control variable Perceived Task Performance was not significant. Hypothesis 1 was supported with SDL ($\gamma = 0.21$, $p < 0.05$) showing a significant, positive relationship with Student Reactions. In partial support of Hypothesis 2, Problem Authenticity ($\gamma = 0.50$, $p < 0.01$) had a significant relationship with Student Reactions, but Familiarity did not. Finally, neither of the learner characteristics (LGO or PGO) had a significant relationship with Student Reactions, thus there was no support for Hypothesis 4. Overall, 47% of the within-team variance in Student Reactions was accounted for by the individual-level variables in this model.

The second test of these hypotheses used the outcome variable Perceived Improvement in learning. In this set of analyses, the Student Reactions measure was included as an additional level 1 control variable to account for the possibility that Perceived Improvement is influenced by overall reactions to the course. The level 1 results in the first section of Table 5 show that the two control variables, Student Reactions and Perceived Task Performance, were not significant. Once again, there was support for Hypothesis 1 with a significant relationship between SDL ($\gamma = 0.24$, $p < 0.05$) and Perceived Learning. Hypothesis 2 was not supported, although Familiarity ($\gamma = -0.21$, $p < 0.01$) had a significant, negative relationship with Perceived Improvement. Again, none of the learner characteristics were significant, providing no support for Hypothesis 4. This model explained 35% of the within-team variance in perceived improvement in learning.

Table 4. Results of Hierarchical Linear Modeling for Effects on Student Reactions to the Learning Experience[a]

Variable	Coefficient	SE	t	χ^2	σ^2	τ_{00}	Model Deviance	R^{2b}	Total R^{2c}
Null model									
Intercept	3.45**	0.17	19.84**	52.75**	0.53	0.32	196.26		
Level 1 variables									
Intercept	3.44**	0.18	19.30**	101.47**	0.28	0.39	165.54	0.47	
Task Performance	0.18	0.11	1.63						
SDL	0.21*	0.11	2.02*						
Familiarity	-0.03	0.07	-0.44						
Authenticity	0.50**	0.09	5.42**						
PGO	-0.01	0.09	-0.14						
LGO	-0.09	0.13	-0.71						
Level 2 variables				34.78**	0.28	0.15	152.49	0.62	0.53
PGO Diversity	-2.99*	1.14	-2.62*						
LGO Diversity	0.49	0.60	0.81						
Facilitation	0.48**	0.15	3.31**						
Collaboration	0.07	0.16	0.45						

[a] Students' N = 80, teams' N = 14; [b] Indicates the proportion of variance explained at each level, i.e., Level 1 within-team variance, Level 2 between-team variance; [c] Indicates R2 within-group x (1 – ICC1) + R2 between-groups x ICC1; * p < 0.05 ** p < 0.01, two-tailed tests.

Table 5. Results of Hierarchical Linear Modeling for Effects on Perceived Improvement in Learning

Variable	Coefficient	SE	t	χ^2	σ^2	τ_{00}	Model Deviance	R^{2b}	Total R^{2c}
Null model									
Intercept	2.48**	0.09	26.46**	26.61**	0.34	0.06	150.31		
Level 1 variables									
Intercept	2.47**	0.09	26.33**	40.19**	0.22	0.08	139.47	0.35	
Task Performance	0.03	0.10	0.34						
Student Reactions	0.08	0.12	0.65						
SDL	0.24*	0.10	2.43*						
Familiarity	-0.21**	0.06	-3.61**						
Authenticity	0.10	0.10	0.99						
PGO	-0.12	0.08	-1.49						
LGO	-0.20	0.12	-1.70						
Level 2 variables				19.81*	0.22	0.05	134.76	0.38	0.36
PGO Diversity	-1.73*	0.75	-2.29*						
LGO Diversity	0.06	0.40	0.14						
Facilitation	0.21	0.10	2.20						
Collaboration	0.09	0.11	0.82						

a Students' N = 80, teams' N = 14; b Indicates the proportion of variance explained at each level, i.e., Level 1 within-team variance, Level 2 between-team variance; c Indicates R2 within-group x (1 – ICC1) + R2 between-groups x ICC1; * $p < 0.05$ ** $p < 0.01$, two-tailed tests.

Hypotheses 3 and 5 were tested using multiple regression to examine the effects of the individual-level variables on Student Engagement in SDL and Reflection. The results are shown in Table 6. The first model showed no support for Hypothesis 3 ($R^2 = 0.03$, $F = 1.05$, *ns*), with neither of the problem characteristics significantly predicting SDL. Results from the second model did support Hypothesis 5 ($R^2 = 0.13$, $F = 5.77$, $p < 0.01$), affirming the notion that learner characteristics are related to SDL. To examine the individual regression coefficients, I used a full model that included all of the individual-level predictors. Only LGO ($\beta = 0.35$, $p < 0.01$) had a significant, positive relationship with SDL.

Team-Level Design Characteristics

The first test of Hypothesis 6 was conducted by adding the level 2 predictors to the model for Student Reactions. The results in the lower section of Table 4 show partial support for this hypothesis. There was a significant positive effect for Facilitation ($\gamma = 0.48$, $p < 0.01$), but Collaboration was not significant. Also, Performance Orientation Diversity ($\gamma = -2.99$, $p < 0.05$) had a significant, negative relationship with Student Reactions. The team-level design characteristics explained 62% of the between-team variance, and, overall, the full model explained 53% of the total variance in Student Reactions to their learning experiences.

The results for the second test of Hypothesis 6 are shown in the lower section of Table 5. Results show a similar pattern of partial support with Perceived Learning negatively related to Performance Orientation Diversity ($\gamma = -1.73^*$, $p < 0.05$). While Facilitation is positively associated with Perceived Learning, it is not statistically significant ($\gamma = 0.21$, $p = 0.06$), nor were the other level 2 predictors. This level 2 model explained 38% of the between-team variance, and the full model explained 36% of the variance overall in Perceived Learning.

Discussion

The purpose of this study was to apply multilevel analysis to investigate the effects of individual-level and team-level PBL characteristics. Following a review of the literature to identify PBL design variables, this study examined the utility of a multilevel approach by exploring some of the design characteristics that may influence student engagement in PBL and Perceived Learning. The significant amount of between-team

Table 6. Multiple Regression Results Predicting Student Engagement in Self-Directed Learning

	Model 1	Model 2	Full Model		
Variables	Coefficients	Coefficients	Coefficients	SE	*t*
Problem Characteristics					
Familiarity	0.07		-0.04	0.07	-0.36
Authenticity	0.17		0.08	0.07	0.68
Learner Characteristics					
PGO		0.08	0.08	0.10	0.77
LGO		0.35**	0.35	0.14	2.98**
Total R^2	0.03	0.13	0.14		
F	1.05	5.77**	3.06*		

N = 80; * p < 0.05 ** p < 0.01, two-tailed tests; Standardized regression coefficients are shown.

variance in the outcome variables, combined with the significant variance explained by the team-level predictors, supports the value of taking a multilevel approach and the need to conceptualize several important PBL design characteristics at the team level of analysis. Before I discuss implications for future research, I will highlight the key findings from this study and implications for PBL design.

First, the results confirm the importance of Student Engagement in SDL and Reflection to achieve desirable PBL outcomes. Student Engagement was positively related to Student Reactions and Perceived Learning, suggesting that the more students actually engage in self-directed learning and reflection, the more likely they are to report positive outcomes from their PBL experiences. The PBL design that the students experienced in this study followed the core features suggested in the literature, including the use of an ill-structured problem at the start of the course to frame student learning, reflection assignments (i.e., papers and journal entries), individual learning plans (e.g., setting goals for the learning experience), and facilitation that supported self-directed learning, questioning, and reflection. All of these mechanisms may have served to promote student engagement in self-directed learning, but the analyses used in this study examined just a few selected predictors.

When examining the variables predicted to influence self-directed learning and reflection, the only significant characteristic detected in this study was learning goal orientation (LGO). The positive relationship between LGO and SDL is consistent with achievement goal theory predictions that individuals who are focused on mastery goals will engage in more self-directed learning activities. This is an important finding because prior research has not included learner characteristics as a design consideration, and students with low LGO may need additional support to benefit from PBL interventions. Unfortunately, there was not enough between-team variance in SDL to examine relationships between the team-level design variables and Engagement in SDL and Reflection. However, the significant, positive correlations between SDL and Facilitation ($r = 0.40$, $p < 0.01$), and Collaboration ($r = 0.26$, $p < 0.05$) lend some support to the notion that effective Facilitation and Team Collaboration foster higher levels of Student Engagement in Self-Directed Learning and Reflection.

Consistent with previous studies, results showed that problem characteristics are associated with PBL outcomes. Students who perceived the problems to be authentic reported more positive learning experiences, and, in this study, there was a significant negative relationship between Familiarity and Perceived Learning. This finding supports claims from action learning research that students working on unfamiliar problems in unfamiliar contexts will "gain broader knowledge and a greater systems perspective" (Marquardt, 1999, p. 27). However, this study cannot explain why the problem characteristics had these effects because they were not significantly associated with Student Engagement in Self-Directed Learning and Reflection.

Examining the effects of the team-level design variables, the significant characteristics found in this study were Facilitation and PGO Diversity. This investigation confirms prior research that emphasizes the role of effective Facilitation throughout the PBL process (Hmelo-Silver & Barrows, 2008). In this study, facilitators served as models for questioning and reflection, provided feedback, and supported both individuals and teams with their self-directed learning, as evidenced by the significant correlation between Facilitation and SDL Engagement. Additionally, a significant contribution of this study is the introduction of goal orientation diversity as an important characteristic in PBL design. The significance of PGO Diversity elevates the need for educators and researchers to consider how to design the composition of PBL teams to maximize the benefits of Team Diversity for student learning while minimizing potentially negative effects.

Given that PBL is designed to foster collaboration and reflexivity, it is remarkable that PGO Diversity had a negative effect on PBL outcomes in this study. The significant, positive correlation between the Collaboration measure and PGO Diversity ($r = 0.42$, $p < 0.01$) suggest that there were benefits of Team Diversity in establishing team norms and expectations for balancing learning and performance behaviors. So why was there a negative relationship between PGO Diversity and the perceived outcome variables? There is evidence that PGO can negatively impact the quality and amount of information exchanged between people working on complex tasks in achievement-oriented situations, and that PGO Diversity may cause lower group process efficiency and poor team performance (Pieterse et al., 2011; Poortvliet, Janssen, van Yperen, & van de Vliert, 2007). PGO Diversity might have created a more competitive and less open context for information sharing, resulting in negative reactions to PBL. Because the Collaboration measure used in this study did not include items that measured degree of information exchange or group process efficiency, it is impossible to say whether diminished levels of information sharing occurred during problem solving and learning tasks in teams with higher PGO Diversity. Future research needs to examine the team process effects of PGO Diversity in PBL and whether other team or individual characteristics can moderate these effects.

Implications for PBL Design

Although it is necessary to be cautious about drawing conclusions from this study due to the sample size and measurement limitations described in the next section, I will discuss three implications for PBL design. First, PBL designers should work with a multilevel evaluation framework in mind as they create their courses and implementation processes. This includes knowing which design characteristics are individual-level versus team-level and anticipating the impact on PBL assessment procedures. For example, to include variables such as Facilitator Effectiveness or Team Autonomy in a multilevel framework, individual student evaluations need to be collected and aggregated to create measures that can represent group-level effects using HLM. Thinking about the measures that are required to conduct a multilevel analysis will introduce more steps to the design and implementation process, but it also may spark new opportunities for design innovation. In the present study, problem characteristics were measured and analyzed at the individual level, which allowed me to explore how perceived problem characteristics influenced individual learning outcomes. Measuring characteristics like the degree of problem familiarity or difficulty ideally should occur before students begin PBL to capture their initial understanding of the problem. Knowing students' perceived problem familiarity or difficulty before the course begins also can help designers adjust the level of challenge and the solution expectations that are established, help instructors guide students in creating appropriate goals for the learning experience, and inform facilitators about student needs for scaffolding. This is particularly important in graduate management education programs where students may enter the program with many years of work experience. Finding authentic problems that are equally unfamiliar or challenging to experienced practitioners is difficult, so designers will need to consider ways to calibrate the problem for students with varying degrees of experience. After the implementation, a multilevel analysis can be applied to understand how problem familiarity interacted with the degree of team experience diversity, the facilitation provided to the team, or other team context effects. Such cross-level interactions are possible to examine using HLM.

Second, when it comes to designing with a "level 2 model" in mind, learning team composition deserves heightened attention. Team-level variables overall accounted for a significant amount of variance in both of the individual-level outcomes examined in this study, underscoring the point that team context matters in PBL design effectiveness. Of these team-level variables, PGO Diversity was a significant predictor in both models. If additional research confirms that higher levels of PGO Diversity decreases learning outcomes, designers will need to consider ways to mitigate these effects, perhaps by informing facilitators about the goal orientation diversity in their teams. Facilitators may need to be more vigilant about the level and quality of information sharing that is happening in teams with high PGO and work with team members to tailor their project management tactics. For example, teams with high levels of PGO Diversity might benefit from exercises at the start of the project to develop a shared mental model for effective teamwork. For the master's program examined in this study, one PBL design adjustment was to establish a new assignment for all teams to complete a structured team charter at the beginning of the course. This assignment requires students to share their individual preferences for project work and collaboration using the results of their self-assessments, and then to make explicit, within their team charters, the practices they will adopt to achieve their individual (and team) learning and performance goals.

When assigning students to PBL teams, instructors should consider the overall learning objectives for the students and how the combination of members on a team will impact learning outcomes. For example, when the PBL design was created for the master's program examined in this research, the instructors focused on creating teams that had a mix of work experience levels. The intent, which was explained to the students, was for the more experienced students to share their knowledge about problem solving and consulting but to avoid dominating the activities of the team so that less experienced members had opportunities to practice these skills. PBL designers need to find the right balance in team composition given the program's objectives, and then provide facilitation that affords teams the opportunities to learn from working in diverse teams while avoiding the potentially negative impact on individual learning.

Finally, this study affirms the importance of preparing students to engage in PBL, with individual differences in goal orientation introduced here as another factor that may influence learner readiness. It is a mistake to assume that participants new to PBL, regardless of their age or work experience, will have sufficient motivation, metacognitive skills, learning strategies, and collaboration skills to successfully engage in PBL. Rather, PBL is an approach that should be interlaced throughout a management development program designed to achieve the cumulative effects of PBL over time. Several studies suggest that PBL is an intervention that is most effective when used with students throughout multiple courses in a curriculum (Brownell & Jameson, 2004; Hung, 2011; Miflin, Campbell, & Price, 2000; Schmidt et al., 2011). In other words, successive iterations of PBL will gradually develop the skills necessary to engage in PBL while building leadership, problem-solving skills, and practical knowledge in a management education program. For example, students might begin with a PBL experience that highlights learning objectives focused on setting learning goals; developing critical reflection skills; and awareness of goal orientation, learning strategies, and self-monitoring techniques. Beginning PBL with a focus on developing learning skills is supported by research showing that teams whose members had higher levels of metacognitive and self-regulation skills experienced higher team cooperation and demonstrated better decision making (Dierdorff & Ellington, 2012), both of which are necessary for successful PBL.

Limitations and Future Research

This study relied on survey methodology to investigate a multilevel model for PBL design, thus there are several limitations associated with this approach. First, all of the data were extracted from surveys that were used by the program to understand students' expectations, experiences prior to starting the course, their PBL experiences and their reactions to the course. While using student-assessed measures of design characteristics introduces a way to compare PBL implementations, these measures combined with the self-reported outcome measures introduce the potential for common method variance bias. I attempted to reduce these effects by using survey measures that were distributed across different time periods during PBL. The problem and learner characteristics were measured at the beginning of the course, and the SDL Engagement, Collaboration, Facilitation, and outcome variables were distributed across two surveys toward the end of the course. A Harman's single-factor test indicated that the variance among the measures was not attributed to one factor, thus the findings are unlikely to result from common method variance. Nonetheless, future research that uses perceived affordances of the design variables should seek outcome variables from alternative sources. Furthermore, in light of research suggesting that self-reported measures of learning reflect affective outcomes (e.g., satisfaction, motivation to learn) rather than cognitive outcomes, such as improved understanding and knowledge (Sitzmann, Ely, Brown, & Bauer, 2010), the results from this study should be interpreted cautiously as evidence in favor of positive student reactions about their learning rather than knowledge and skill development.

A second limitation is that a measure for intrinsic motivation was not available for this study which would have provided information about the underlying processes that affected Student Engagement in Self-Directed Learning and Reflection. Because motivation is a process and outcome variable in PBL, ideally it should be measured several times throughout the course. Similarly, separate measures could be used to examine engagement in self-directed learning and engagement in reflection. Although these two learning processes are closely related, it may be possible to differentiate the effects of each of these processes with more extensive measures.

Third, there are limitations with the sample used for this study. While the number of students assigned to each learning team was optimal for PBL (between 5 and 8 students per team is ideal) and sufficient to conduct limited team-level analyses, only 14 teams were available for this study. This restricted my ability to propose and test additional multilevel hypotheses about the team variable effects, and it introduced the possibility that significant team-level effects were undetected. Examining mediation hypotheses and interactions between PGO diversity, individual characteristics, and PBL outcomes would provide answers to questions about how team diversity influences outcomes. Additional research in these areas is needed, particularly in light of research showing significant interactions between goal orientation diversity and reflexivity (Pieterse et al., 2011). Studies that include more level 2 variables and a greater number of teams can provide valuable insights into why and under what conditions these effects occur.

Furthermore, the study participants were predominantly Caucasian women, many of whom were either currently employed in or pursuing occupations in human resources development and human capital fields. Not only did this prevent tests of other demographic diversity variables, it restricts the generalizability of these results to a broader population of students. Similarly, the high level of learning goal orientation for this sample suggests that these students may have been more receptive overall to the PBL experience. Multiple studies have reported that students initially respond to PBL with frustration and anxiety, and that an environment that fosters collaborative learning, risk taking, and learning from mistakes is critical for effective implementation (Barrows & Mitchell, 1975; Hung et al., 2007; Miflin et al., 2000). The culture and selection criteria for the program in this study contributed to a learning environment for these students that may not be typical of other management education programs. While this study did not address these institution-level effects, it is possible they played a role in student reactions to their learning experiences.

And last, future research should continue to examine measures for Facilitator Effectiveness, Team Collaboration, and Team Autonomy based on group mean judgments of these concepts. The high level of within-group agreement and between-group differences in the Facilitation and Collaboration measures suggests that these concepts can be represented by shared perceptions of the team's learning environment. Scholars have called for evaluation approaches that allow for comparisons between PBL implementations (Mamede et al., 2006; Newman, 2006), and this approach provides researchers with a way to do so while offering a potentially more accurate representation of these concepts. Research also should focus on establishing more extensive, valid measures of PBL design perceptions so these results can be confirmed and additional team-level concepts can be examined using this approach.

Conclusion

Benjamin and O'Reilly (2011) recently called for learning interventions that are built from a solid understanding of students' cognitive processes and that will improve the relevance and rigor of leadership development in business school contexts. This study provides an example of using hierarchical linear modeling to examine PBL, which can be applied in business schools to help management educators achieve relevance and rigor in their experiential learning designs. The purpose of this article was to illustrate the use of a multilevel model that design researchers can expand upon to advance their research and practice of PBL. The results provide preliminary support for the multilevel nature of the design characteristics, offering new directions for PBL evaluation. Additionally, this study makes a significant contribution to the PBL literature by introducing goal orientation and goal orientation diversity as important variables that can have direct and indirect effects on PBL outcomes. The potential to extend the multilevel hypotheses to include cross-level interactions should encourage scholars to expand research into these new areas and answer more questions about how to develop managers who can solve complex problems and lead in diverse contexts.

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