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Research Report 1936

Problem-Based Learning: Instructor Characteristics, Competencies, and Professional Development

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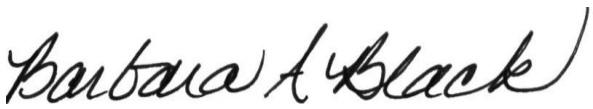


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14. ABSTRACT *(Maximum 200 words)*:
Preparing Soldiers to learn from problem-solving experiences requires that Army instructional practices become more responsive to individual student need, better attuned to operational requirements, and more representative of social learning contexts. To help instructors achieve this goal, the principles for facilitating problem-based learning must be investigated and their implications for professional development explicated. In this research, the instructor characteristics and competencies required to implement problem-based learning were explored. Techniques for instructor professional development in civilian and military contexts then were examined to identify best practices. The Army environment was assessed for its readiness to employ these best practices, and recommendations were developed. The findings suggest that the Army environment partially supports the development of problem-based learning facilitators. Recommendations emphasize transforming basic instructor preparation to be more outcomes-based and student-centered given the time, personnel, and resource constraints of the current Army environment. Ultimately, a comprehensive preparatory approach is needed that targets all implementers of Army education.

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PROBLEM-BASED LEARNING: INSTRUCTOR CHARACTERISTICS, COMPETENCIES, AND PROFESSIONAL DEVELOPMENT

EXECUTIVE SUMMARY

Research Requirement:

Problem-solving skill and lifelong learning ability are imperative learning objectives for the Army professional. Preparing Soldiers to learn from problem-solving experiences requires instructional methods founded on the recognition that learning, individual experience, and collective action are inextricably linked. To implement such methods, Army instructional practices must become more responsive to individual student need, better attuned to operational requirements, and more representative of social learning contexts. The *Army Learning Concept for 2015* challenges institutional educators to immediately ~~-c~~onvert most classroom experiences into collaborative problem solving events led by facilitators (vs. instructors) who engage learners to think and understand the relevance and context of what they learn" (p. 4). To help instructors achieve this vision, relative to the Army environment, the principles for facilitating problem-based learning must be investigated and their implications for professional development explicated.

Procedure:

The instructor characteristics and competencies required to implement problem-based learning (PBL) were explored via a combination of literature review and discussion with Army education providers. First, the defining characteristics of PBL were identified and compared to other student-centered learning approaches. Next, the characteristics and competencies of instructors who successfully implement student-centered learning (and PBL in particular) were investigated. Techniques for instructor selection and development then were examined to identify potential best practices. The Army environment was assessed for its readiness to employ these best practices and implement PBL, and recommendations for instructor professional development were developed.

Findings:

Implementing student-centered instruction, including PBL, requires that Army instructors possess domain knowledge, problem-solving skill, conscientious work habits, and beliefs and personality traits that promote lifelong learning and developing others. The placement of personnel with these characteristics into teaching positions is not done systematically, and development opportunities may be the best option for shaping the instructor cadre. Instructor development must grow the classroom management and facilitation competencies that enable instructors to unobtrusively shape classroom events and respond adaptively to student need. These competencies include organizing and role-modeling problem solving as well as facilitating discussion and collaborative learning. Although Army schoolhouses adopt recommended development methods, the ideal approach requires more time and resources than are currently spent on developing facilitators. Methods must be created that can (1) rapidly develop

instructors' actionable knowledge for teaching; (2) leverage the extant methods used by Army educators; and (3) enable the simultaneous execution of multiple professional development ~~l~~lines of operation."

Utilization and Dissemination of Findings:

The goal of this research was to support the implementation of the Army Learning Concept by providing recommendations for instructor development. The findings suggest that using an accelerated apprenticeship model to reform existing instructor preparation practices would produce a more outcomes-based and problem-centered approach that could reduce time to effectiveness in the classroom. It would also support the continuous professional development of current instructors. This report includes a notional lesson plan that could be used to design a basic instructor development course focused on producing problem-based learning facilitators. The report findings were briefed to the Army Training and Doctrine Command G-3/5/7 Army Training and Education Development Forum.

Because many of the characteristics and competencies required for PBL also are required for other student-centered learning methods, the findings should generalize across instructional methods of interest to the Army. Further research is required to determine the resource requirements of an accelerated apprenticeship model.

PROBLEM-BASED LEARNING: INSTRUCTOR CHARACTERISTICS, COMPETENCIES, AND PROFESSIONAL DEVELOPMENT

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PROBLEM-BASED LEARNING: INSTRUCTOR CHARACTERISTICS, COMPETENCIES, AND PROFESSIONAL DEVELOPMENT

INTRODUCTION

High operational tempo, involvement in complex contingencies requiring joint, civil-military, and multinational coordination, and persistent uncertainty regarding enemy tactics and mission requirements demand that Army personnel develop the capability to adapt to sudden, frequent change. Consider the following examples, which are common experiences for Soldiers in the contemporary operating environment:

- To prepare for deployment, a company commander must prioritize, schedule, and achieve numerous training objectives in the face of time, personnel and equipment shortages.
- When a brigade combat team arrives in theater, it falls in on equipment it has never seen before and must determine how best to integrate the new capabilities into its operations.
- A lifetime combat arms officer discovers that to meet his security objectives he must distribute and oversee funds to foreign contractors who will reconstruct the area's public works infrastructure.

Although such examples are diverse, they illustrate a common demand placed on Soldiers to solve problems quickly and effectively. Cognitive psychologists define problem-solving as the process whereby an individual strives to achieve some goal when the method to do so is unknown and a single, correct answer is unavailable (Mayer & Wittrock, 1996). Problems typical of institutional education may be well-specified, characterizing the current and goal states and prescribing an approach to bridging them (e.g., "You are a mechanized infantry platoon leader. Your unit has been tasked with acquiring a high-value target in an urban area. Use Field Manual 3-21.71 and the map provided to specify how you would employ your platoon to conduct a cordon and search."). More commonly in the operational environment, problems are ill-defined, and the Soldier must first determine a goal state, next identify the gap between the current and goal states, and then develop (and continuously refine) a novel method for bridging it. Complex problems characteristic of stability, security, transition, and reconstruction operations must be solved as a group effort in which diverse experts collectively define the current and goal states and construct an integrated solution (Cianciolo, LaVoie, Foltz, & Pierce, 2009).

Individual and group problem-solving skill and their requisite lifelong learning ability must be considered imperative learning objectives for the Army professional. The centrality of these cognitive capabilities to agility is recognized in the *Army Learning Concept for 2015* [U.S. Army Training & Doctrine Command (TRADOC), 2010], which states that "To remain competitive, the [Army] learning model must… allow seasoned professionals to expand and deepen their cognitive, interpersonal, and problem framing skills essential for operational adaptability" (p. 10). Preparing Army personnel to learn from problem-solving experiences requires instructional methods founded on the recognition that learning, individual experience, and collective action are inextricably linked. To implement such methods, Army instructional practices must become more responsive to individual student need, better attuned to operational requirements, and more representative of social learning contexts (TRADOC, 2010). The Army

Learning Concept challenges institutional educators to immediately ―convert most classroom experiences into collaborative problem solving events led by facilitators (vs. instructors) who engage learners to think and understand the relevance and context of what they learn" (p. 4).

Background

Current national education standards acknowledge that the civilian workplace requires graduates to demonstrate the same cognitive capabilities as those just prescribed for Army personnel (e.g., National Council of Teachers of Mathematics, 2000; National Research Council, 1996). Educational theory and practice have co-evolved to account for the fact that human learning is functional and therefore that instruction must foster purposive action. For instance, constructivist philosophies of learning generally posit that (1) knowledge is constructed through personal interaction with specific environmental conditions; (2) learning is triggered by problematic events; and (3) knowledge construction occurs in a social context (Savery & Duffy, 1995). Instructional design principles based on constructivism place students at the center of learning experiences such that learner needs drive developmental objectives, classroom activities, and assessment criteria (e.g., Glasgow, 1997).

Effectively implemented, student-centered learning principles produce the kind of classroom experiences that are central to the Army Learning Concept (Raymer, 2006). For example, in the student-centered method known as problem-based learning (PBL), problems are the focal point for classroom activity, acting as triggers for knowledge acquisition and group learning processes that mirror the occupational environment (Barrows, 1985; Savery, 2009; Savery & Duffy, 1995; Torp & Sage, 2002). However, instructional methods such as PBL are distinctly different from the techniques traditionally used to educate Soldiers, which are characterized as being ―course-based" and ―throughput-centric" (TRADOC, 2010). Rather than being responsive to student need, Army classroom activity often is driven by the requirement to meet organizational objectives for content (i.e., doctrinal task) coverage and graduation rates (e.g., Perry & McEnery, 2009; Vandergriff, 2010). Teaching methods are standardized and direct (Huitt, Monetti, & Hummel, 2009), involving primarily lecture or presentation, demonstration, and, in most cases, practical exercise. It follows, then, that the conversion of Army classroom experiences may be facilitated by adopting the approaches and lessons learned of civilian educators implementing student-centered learning in general and PBL in particular.

Army instructors must play a central role in converting classroom experiences from passive encounters with information to guided problem-solving events and social learning opportunities. Moreover, instructor practices will determine the potency of the Army's new educational policy to enhance warfighter effectiveness (Hawley & Valli, 1999). To help Army instructors achieve the vision laid out in the Army Learning Concept, constructivist principles for leading student-centered classrooms, particularly those implementing PBL, must be investigated and their implications for professional development explicated.

Project Purpose and Goals

The purpose of this research effort was to explore the requirements for producing Army instructors who can effectively implement PBL in the schoolhouse classroom. First, the defining

characteristics of PBL were identified, as well as their similarities and differences to other student-centered learning approaches. Next, the characteristics and competencies of civilian and military instructors who successfully implement student-centered learning (and PBL in particular) were investigated. Techniques for instructor selection and development in civilian and military contexts then were examined to identify best practices. The Army environment was assessed for its readiness to employ these best practices, and recommendations for facilitating instructor professional development were developed.

The goal of this research effort was to support the implementation of Army policy with regard to student-centered instruction (i.e., TRADOC, 2010) and PBL (i.e., TRADOC, 2009) by providing recommendations for instructor development. Toward this end, the present investigation focused on instructor professional development and did not target the organizational factors that influence the implementation of student-centered learning techniques. The implications of organizational factors for the success of instructor professional development were assessed, however, and are presented in this report.

Organization of This Report

This report begins with an overview of the research effort, and then presents in detail the findings with regard to instructor characteristics and competencies, respectively. Next, recommendations for future research are provided. The Conclusions section summarizes the key findings and recommendations.

PROJECT OVERVIEW

Research Method

Given the extant extensive scholarly investigation of student-centered learning and teacher education, a significant element of the present research effort was civilian literature review. The purpose of this literature review was to determine in a top-down fashion the general characteristics and competencies required for PBL as well as the associated professional development practices. To identify instructor characteristics and competencies, academic descriptions of a variety of student-centered instructional methods, including PBL, inquiry-based learning, experiential learning, action learning, and case-based learning were examined. In addition, principles for designing computer-based student-centered learning environments were reviewed because such guidance could reveal important learning-facilitation techniques, such as scaffolding. To determine best practice in instructor selection and development, the academic and professional literature on civilian teacher education was explored. Particular emphasis was placed on inquiries into the effectiveness of various developmental techniques. Because the civilian literature primarily consisted of case studies or small-sample investigations, a ―qualitative consensus" was used to draw conclusions about the topics studied. The literature review did not investigate the effectiveness of PBL as an instructional method.

Where applicable, military professional writing was analyzed in order to gather bottom-up information on the learning environment to which PBL would be applied. In particular, the topics of outcomes-based training and education and the adaptive leader methodology were

explored to identify their implications for instructional design, learner performance assessment, and instructor beliefs about using a student-centered approach. Additional bottom-up information was gathered via discussion with personnel from the Army Training Support Center and with educational leaders who are implementing student-centered instruction at their respective schoolhouses, including the Command and General Staff College, the Maneuver Center of Excellence, the Fires Center of Excellence, the Army Intelligence Center, and the Army Management Staff College. Interviews and focus groups were conducted with military personnel and government civilians serving as instructors, course managers, course developers, and faculty developers. The purpose of this bottom-up data collection was to identify the Army-specific implications for implementing PBL. Of special interest were the ways in which (1) the Army instructor cadre differed from civilian educators; (2) Army students differed from civilian students; and (3) Army instructor professional development opportunities differed from those available to civilian educators.

The Army Learning Environment

The differences between civilian and military learning environments are immediately obvious. Army students are experienced adult professionals with operationally driven learning objectives whereas civilian students typically are children or young adults with limited experience and more general academic learning objectives. Moreover, civilian educators generally devise their own curriculum and learning materials, but Army instructors typically use programs of instruction and associated resources that have been created for them. Teaching in the civilian world is a lifelong profession with years of preparatory and continuing education whereas an instructor position in the Army generally lasts for just a few years with minimal preparation.

Commonalities exist between the two learning environments, however, which make it reasonable to generalize civilian research findings to the Army context. Facilitating the development of problem-solving skill and lifelong learning orientation is challenging in both environments and for similar reasons. First, pressure to cover a lot of content quickly limits the time available to implement in-depth, student-centered lessons (Onosko, 1991; Thompson, 1990). In addition, criteria used to evaluate instructional quality assume the use of teacher-centered methods, rather than student-centered ones (e.g., rote memorization versus actionable knowledge acquisition and cognitive skill development; Thompson, 1990). Educator philosophies of teaching as knowledge transmission also promote the use of traditional teaching methods (Onosko, 1991; Roehrig & Luft, 2004). Even when educators view learning as the development of independent thought, lack of practical experience ―reading" students and problem solving in the classroom makes it difficult to use feedback from students to guide classroom activities (Kagan, 1993). Moreover, the limitations in metacognitive, self-regulatory, and collaboration skills that challenge student-centered learning among young people also challenge such learning among adults (Brush & Saye, 2000; Thompson, 1990).

Understanding the defining characteristics of PBL presents an opportunity to unify civilian and military perspectives and to apply civilian research findings to a military context. That is, across both types of learning environment, the same activities must take place to create problem-centered classrooms. Common challenges fostering these activities, such as those

described above, can serve as targets for instructor professional development. Examining these difficulties reveals what must be done in order to implement PBL (and, more generally, student-centered learning), regardless of who the students are or where the learning occurs.

Defining Characteristics of PBL

As mentioned briefly above, PBL is an instructional method in which problem solving is used as a vehicle for acquiring knowledge, improving problem-solving skill, and stimulating collaborative learning (Hmelo-Silver, 2004; Savery, 2009; Savery & Duffy, 1995). Initially developed to teach medical students (Barrows, 1985; Williams, 1992), PBL involves realistic, multidisciplinary problems that do not have a single correct answer and that require the contribution of diverse experts to solve (Glasgow, 1997; Hmelo & Ferrari, 1997; Hmelo-Silver, 2004; Savery, 2009). When a problem is presented, students are challenged to as a group to:

- Analyze the facts provided and develop a problem statement;
- Generate candidate solutions;
- Identify and fill knowledge gaps necessary to reach a solution;
- Apply new knowledge to solving the problem and assess progress; and
- Reflect to abstract general lessons learned (Hmelo-Silver, 2004; Savery, 2009).

Problem Comes First

Importantly, PBL *begins* with a problem rather than presenting a problem as a capstone exercise following more direct instruction. Rather than a crawl-walk-run progression of activity, PBL features a "run first" approach in which learners encounter a challenging problem in all its complexity and difficulty serves as a trigger for occasional crawl- or walk-phase self-development and social learning. In this way, problems are not so much practical exercises as they are learning opportunities analogous to those encountered in operational environments where knowledge acquisition is instrumental and incidental. Starting the learning process with a problem is also a defining characteristic of the Adaptive Leader Methodology, which uses vignettes to stimulate discovery of tactical principles through small-group discussion (Vandergriff, 2010). Following effective PBL, learners are expected to be more knowledgeable about the problem domain, better problem solvers and collaborators, and more intrinsically motivated and able to learn (Hmelo & Ferrari, 1997; Hmelo-Silver, 2004; Markham, Larmer, & Ravitz, 2003).

Learning is Structured

Although PBL is not structured using a crawl-walk-run progression, advancement through the phases of problem solving are planned and monitored via interim assessment milestones (Markham et al., 2003). As with outcomes-based instruction (Perry & McEnery, 2009), performance assessment in PBL mirrors the demands of the operational environment; successfully achieving problem-based assessment milestones requires an in-depth understanding of the problem, a clearly specified approach to solving the problem, productive individual and collaborative learning processes, and an integrated problem solution that is effectively communicated. Problem-based learning differs from unstructured discovery learning by

scaffolding the development of individual and collective problem-solving skills. In other words, effective PBL accounts for the fact that individuals differ in their unguided ability to learn from everyday experience (Cianciolo, Grigorenko, Jarvin, Gil, Drebot, & Sternberg, 2006) and that people generally learn better with some structure and feedback (Albanese & Mitchell, 1993; Kirschner, Sweller, & Clark, 2006; Schwartz & Bransford, 1998; Weinstein, McDermott, & Roediger, 2010).

Application is Bounded

The primary objectives of PBL are actionable knowledge acquisition, problem-solving skill (individual and collective), and lifelong learning orientation. When these knowledge, skills, and attitudes are not a goal of instruction, different methods may be more efficient and effective. For instance, procedural skills that must be executed only one way or performed in an automatic fashion may be better developed using training-oriented, direct techniques such as explanation of procedures, demonstration, and practical exercise (e.g., Clark, 2004, 2005).

Instruction is Student-Centered

PBL belongs to a family of student-centered instructional methods that includes experiential learning, case-based learning, and inquiry-based learning, among others. This abundance of methods reflects the diversity of higher-order cognitive learning objectives addressed by student-centered instruction. For instance, experiential learning, a variation of which is used at the Army Command and General Staff College to prepare field grade officers for command, has as its primary focus the development of reflective practices that enable learning from experience (Kem, 2006; Lindsey & Berger, 2009). Problems may be triggers for learning, but so may a wide range of concrete experiences. Rather than solving problems, the primary goal of experiential learning is identifying if and when a problem exists. In contrast, case-based learning specifies a problem and related issues, requiring learners to analyze and understand them in detail (Williams, 1992). Practiced in law schools, case-based learning involves a series of critical incidents that have a given resolution (e.g., a court decision) and that include all of the information necessary to arrive at the resolution through analysis (Savery, 2009; Williams, 1992). Variation among the incidents and their associated resolutions are used to develop actionable knowledge by drawing attention to the specific conditions associated with particular judgments (Cianciolo & Evans, in press; Williams, 1992). Inquiry-based learning, the preferred method for civilian science instruction (including doctoral level research training), targets the investigative skills necessary to specify, generate, and evaluate evidence associated with a particular research question (Crawford, 2000; Lotter, Harwood, & Bonner, 2007).

Student-centered teaching methods are unified by the fact that they all require instructors to use information from learners and from the classroom environment as prompts for action. Acting as facilitators, instructors of student-centered learning must use cues of various teachable moments (student struggle or success) to select from a variety of techniques, including questioning and scaffolding to keep learning moving forward (Costa & Garmston, 1985; Hmelo & Ferrari, 1997; Papinczak, Tunny, & Young, 2009; Saye & Brush, 2004). For instance, periodic direct instruction via short lectures or demonstrations, delivered immediately when students begin to struggle unproductively with course material is a general characteristic of effectively

executed student-centered instruction (Handa, 2008; Harris & Graham, 1996; Hmelo-Silver, 2004; though see Savery, 2009 for a dissenting opinion). For this reason, many of the instructor characteristics and competencies identified in the present research could be considered targets for Army instructor professional development regardless of the student-centered instructional method that must be implemented.

INSTRUCTOR CHARACTERISTICS

Required Characteristics

Required instructor characteristics are those properties of the instructor that influence his or her readiness to implement student-centered learning in general and PBL in specific. Characteristics encompass knowledge, cognitive capabilities, beliefs, personality, and work habits. They are either relatively stable characteristics of a person, such as traits, or they change slowly, making them more suitable as targets for personnel selection than for modification via intervention.

Instructor characteristics required for PBL that differ from those underlying other student-centered learning approaches are those that foster individual and collective problem-solving skill development. PBL facilitator characteristics that differ from those required by direct instruction enable students to develop higher-order cognitive skill, a flexible, actionable knowledge base, and lifelong learning orientation. Where extant, these differences are highlighted in the following discussion.

Domain Knowledge

Civilian and military professional development practices reflect the importance of domain knowledge to teaching quality, regardless of whether direct instruction or student-centered learning is implemented. Civilian educators undergo academic subject matter instruction as pre-service teacher candidates, as part of graduate education (e.g., Masters degrees in teaching or doctoral research degrees), and via in-service professional development programs. In the Army, instructor knowledge may serve both andragogical and motivational purposes for adult learners with limited time and a strong, practical need to learn. Soldier demand for instructors that have up-to-date tactical and technical knowledge is very high due to frequent, rapid change in the operational environment and the high stakes nature of military operations.

Conceptual descriptions of student-centered learning and PBL typically highlight the importance of domain knowledge (Crawford, 2000; Sage & Torp, 1997) as do empirical studies (Albanese & Mitchell, 1993), however disagreement exists over whether it is necessary or even helpful (e.g., Hmelo-Silver & Barrows, 2006; Savery, 2009). Concerns about domain experts as problem-based learning facilitators focus on the difficulty such instructors may have (1) suppressing their knowledge in order to allow students to learn on their own; and (2) role-modeling the problem-solving process if they are not themselves problem-solving (i.e., they already know the solution; Hmelo & Ferrari, 1997; Moust, De Grave, & Gijselaers, 1990).

Given that a defining characteristic of student-centered learning is the requirement to read students, diagnose performance issues, and responsively select instructional techniques, a detailed understanding of the subject matter would seem necessary for PBL (e.g., Barrows, 1992; Crawford, 2000). The scholarly literature addresses the domain knowledge requirements unique to student-centered learning by distinguishing between two types of instructor knowledge: knowledge of the latest developments in the field and knowledge of methods for translating and applying domain knowledge for learning purposes (aka "pedagogical content knowledge"), both of which are related to teaching success (Borko & Putnam, 1996; Darling-Hammond, Berry, Haselkorn, & Fideler, 1999). Understanding content knowledge from a teaching perspective enables instructors to model how *learners* understand the domain (Carpenter, Fennema, & Franke, 1996), and to use this knowledge to select educational opportunities (Fennema, Franke, Carpenter, & Carey, 1993) and to improvise when student responses to classroom activity present "teachable moments" (Harlow, 2009). Andragogical content knowledge would seem especially important for facilitating Army student learning, given the wealth and diversity of deployment experience that Soldiers bring to the classroom.

Beliefs

Instructor beliefs encompass conceptions of the subject matter being taught, the nature of learning, the purpose of teaching, and the extent of student capability (Borko & Putnam, 1996; Crawford, 2000; Lotter et al., 2007). Beliefs have long been a topic of special interest in the educational research literature due to their perceived influence on educators' information processing and, ultimately, their adoption of student-centered teaching practices and success in implementing educational reform (Borko & Putnam, 1996; Lotter et al., 2007). The preponderance of research on instructor beliefs has employed qualitative methods (e.g., in-depth case studies) for linking beliefs to practice; it is unknown whether an empirical relation between instructor beliefs, practices, and teaching quality would be demonstrated, given external influences on instructional practice (Lotter et al., 2007; Roehrig & Luft, 2004). Although beliefs may not be sufficient for achieving teaching success, they are widely considered a necessary condition and often serve as a starting point for instructor preparation (e.g., Connolly, 2008; Crawford, 2007).

Subject matter stability. The adoption of student-centered teaching practices, particularly inquiry-based learning, is thought to extend from instructor beliefs that their subject matter is continuously evolving (Lotter et al., 2007; Roehrig & Luft, 2004). Preference for direct instruction, in contrast, is associated with the belief that subject matter represents a stable body of declarative knowledge that must be transferred efficiently from teacher to student (Onosko, 1991). Seeing subject matter as continuously evolving may be necessary for instructors to value higher-order cognitive skill and lifelong learning orientation as learning objectives; such objectives may be seen as essential for gaining expertise and maintaining a flexible knowledge base about a constantly changing field (Borko & Putnam, 1996; Johnston, 1990). In addition, instructors who view the content they teach as an evolving subject may be more likely themselves to possess the cognitive capabilities associated with student-centered learning and PBL (Crawford, 2000; Lotter et al., 2007).

Learning process. Teachers who successfully implement student-centered instruction have been shown to view learning as the development of independent thinking skill and an actionable knowledge base as opposed to the acquisition of a static list of facts or procedures, the latter perspective being more strongly associated with direct instructional practices (Borko & Putnam, 1996; Johnston, 1990). Like seeing subject matter as part of an evolving domain, valuing independent thought may increase the likelihood that instructors prioritize developing higher-order cognitive skill over assimilating basic knowledge of the course topic (Johnston, 1990). This value may also motivate instructors to take on the hard work of planning, implementing, and improving teaching practices whose purpose is to develop thinking skill.

For PBL, the belief that learning is a collaborative process may promote instructor engagement in group learning activities both as a facilitator and as a participant (Hmelo-Silver & Barrows, 2006; Pedersen & Liu, 2003). Group learning with instructor participation challenges the instructor to relinquish some control of the classroom, to admit the limits of his or her subject matter expertise, to role-model problem solving, and to take on the time-consuming task of developing and supervising collaborative learning exercises (Brush & Saye, 2000; Sage & Torp, 1997; Wilkerson, Hafler, & Liu, 1991).

Teaching process. Beliefs about the nature of teaching follow from perspectives on subject matter and learning, and may influence instructors' decisions to persist in student-centered teaching versus falling back on more familiar, direct teaching methods (Johnston, 1990; Roehrig & Luft, 2004). If the course domain is seen as evolving and expertise is viewed as the flexible application of knowledge and thinking skill, teaching is more likely to be seen as an essential opportunity to guide students as they acquire knowledge through thought and struggle. The acceptance of student-centered teaching methods as valid has been associated with the adoption of such practices and often is the focus of civilian and military professional development initiatives (Connolly, 2008; Crawford, 2007).

Educational researchers believe that teaching also must be viewed as a learning profession, as a series of opportunities to encounter and solve the problems of student development in collaboration with a broader professional community (Franke & Kazemi, 2001; Sage & Torp, 1997; Shulman & Shulman, 2004). Viewing teaching in this way is necessary to motivate instructors to continually reflect on classroom experiences and to enhance or update their techniques, a process that is associated with teacher success (Farr, 2010) and implementation of student-centered learning approaches (Blanchard, Southerland, & Granger, 2008).

Student efficacy. For instructors to feel that student-centered learning and PBL will be successful, they must believe that their students are largely responsible for and capable of guiding their own learning (Albanese & Mitchell, 1993; Hmelo-Silver & Barrows, 2006; Roehrig & Luft, 2004). These beliefs are necessary for instructors to release direct control of the classroom, to give their students a chance to struggle with the learning material on their own, to provide a variety of opportunities for students to learn in their own fashion, and to be responsive to student feedback regarding what they already know and need to improve.

Personality

Personality traits that promote student-centered teaching and PBL are those that enable instructors to guide classroom activity via indirect methods, to engage in continuous, collaborative learning with students and peers, and to weather pushback from others with differing perspectives on teaching, learning, and students. Such traits may include tolerance for ambiguity, low need for control, and openness to experience (Bridges & Hallinger, 1996; Johnston, 1990; Onosko, 1991; Papinczak et al., 2009; Saye & Brush, 2004). Perhaps because they are difficult to modify, personality traits associated with quality teaching have been discussed less often in the educational research literature. However, empirical study has shown a relation between teaching success and personal characteristics such as flexibility and creativity (Darling-Hammond et al., 1999; see also Crawford, 2000). Care for students has also been identified as an important instructor quality (Darling-Hammond et al., 1999; Kagan, 1993).

Work Habits

The work habits of successful student-centered instructors are similar to those of more traditional teachers. Instructors must be energetic and hardworking such that they take the necessary time to plan lessons and establish and update classroom routines (Borko & Putnam, 1996). Instructors of student-centered learning must also devote time, ideally continually throughout their careers, to keep their domain knowledge and access to learning resources current and to learn about students and test out alternative teaching approaches (Borko & Putnam, 1996; Franke & Kazemi, 2001; Wilson & Berne, 1999). To implement PBL, instructors must invest time and effort to developing and refining problems and associated curriculum materials, such as assessments (Sage & Torp, 1997; Saye & Brush, 2004).

Cognitive Capabilities

Cognitive capabilities are the thought processes necessary for an instructor to role-model the higher-order cognitive skills that students must develop to succeed in class and in the related operational environment. Conceptual descriptions of PBL highlight the importance of role-modeling problem-solving skill (Hmelo-Silver, 2004; Hmelo-Silver & Barrows, 2006; Savery, 2009). The ability to solve problems and use experiences as learning opportunities also enables the instructor to continually reflect on and update his or her practices, which has been shown to determine teaching success (Farr, 2010) and to influence teachers' willingness to overcome barriers to student-centered learning (Crawford, 2000; Lotter et al., 2007). To the extent that domain knowledge has a motivational effect on adult learning, instructors must be able to demonstrate how recognizing knowledge gaps and solving problems are critical aspects of subject matter expertise.

Selection Methods

Personnel selection is a method by which the instructor cadre can be shaped in order to maximize the likelihood that any one educator will teach successfully. However, in the civilian learning environment, systematic exploration and adoption of selection methods has not occurred. Multiple factors may have promoted this condition, including (1) misalignment

between the objectives of instructor preparation programs and institutional staffing requirements; and (2) substantially greater demand for educators than supply. Civilian teacher education programs seek to graduate as many students as possible, consequently producing many more teachers in popular areas than are needed (e.g., social studies and physical education), and many fewer teachers in high-demand areas (e.g., mathematics and science; Darling-Hammond et al., 1999). In the university setting, a candidate's teaching capability may be a lower priority than his or her ability to win research grants and produce advanced degrees. Shortages in the job candidate pool require hiring practices that are less selective and more likely to fill open positions quickly. In the event that conditions become more conducive to selecting educators, the extensive body of industrial, organizational, and military research on personnel selection has useful implications for how instructor characteristics might be assessed.

Domain Knowledge

Because domain knowledge often is the dominant criterion for selecting educators, evaluation of the available measures is warranted (Wise, Darling-Hammond, & Berry, 1987). The indicators that are typically used, such as teaching certificates, academic transcripts, test scores, and publication record may not accurately reflect the degree to which subject matter knowledge is actionable or predictive of effective teaching (Wise et al., 1987). Measures of actionable knowledge that are useful for instructor selection must (1) capture a candidate's understanding of subject matter from both an academic and teaching standpoint; and (2) be easy to administer. Situational judgment testing (McDaniel & Nguyen, 2001) is an assessment format that could supply such measures.

Briefly, situational judgment tests feature practical problems that may be presented at various levels of fidelity, ranging from written paragraphs to live-action or animated simulations to in-depth case studies (Cianciolo, Cianciolo, Prevou, & Morris, 2007; Cianciolo, Matthew, Wagner, & Sternberg, 2006; Motowidlo, Dunnette, & Carter, 1990; Weekley & Jones, 1997). A set of solution options for each problem is provided and the examinee must indicate how he or she would respond. Situational judgment testing is thought to capture people's experience-based or tacit knowledge, which enables the accurate assessment of environmental conditions and the selection of appropriate courses of action (Cianciolo et al., 2006). Tacit knowledge inventories are a method of assessing actionable knowledge that has been explored extensively by the Army for its applicability in selecting military leaders (Hedlund, Forsythe, Horvath, Williams, Snook, & Sternberg, 2003). They also have been used to supplement measures of basic ability and technical knowledge when predicting success in other domains, including management, accounting, and even school (Tan & Libby, 1997; Wagner & Sternberg, 1985, 1990; Williams, Blythe, White, Li, Gardner, & Sternberg, 2002).

Beliefs

Although not used for teacher selection, measures of beliefs have been developed in order to track change as a result of civilian teacher education programs. Two of these measures are the Teachers' Pedagogical Philosophy Interview (TPPI; Salish I Research Project, 1997) and the Inquiry Teaching Belief Instrument (ITBI; Harwood, Hansen, & Lotter, 2005), both of which have been validated and used in peer-reviewed articles on teacher beliefs. Currently, both

measures require one-on-one administration and are designed to capture beliefs about inquiry-based learning in grade school science or mathematics. However, the measures could be modified to focus on adult PBL (or student-centered learning more generally) in other topics and for automated self-administration in a computer-based format.

The TPPI is a set of two structured interview protocols that address the beliefs about subject matter (science/mathematics), teaching, and learning held by first and second or third year teachers (see Salish I Research Project, 1997 for a detailed description). The interviews are ideally conducted face-to-face in two sessions totaling 1 to 1.5 hours of discussion. Example questions include "Describe a well-organized classroom. When you have your classroom running the way you want it, what is it like?" and "How do you decide what to teach and what not to teach?" Responses to each question are categorized at a high level as being teacher-centered, conceptual, or student-centered. On a lower level, responses are categorized along a continuum of beliefs ranging from Didactic to Inquiry. The coding scheme for each question is complex, and would require trained raters to apply properly, warranting the investigation of simpler measures that could capture the same belief constructs.

The ITBI is a type of card sorting task in which the examinee is asked to place 18 cards labeled with various student activities at different distances from a central "classroom" card in order to convey how strongly each activity is believed to represent or support inquiry-based instruction (see Harwood et al., 2005 for a detailed description). Based on the scholarly literature and national education policy, each of the activities is pre-labeled as "inquiry," "neutral," or "non-inquiry." Example activities include "students using evidence to defend their conclusions" (inquiry), "students asking questions" (neutral), and "students listening to instructor lecture" (non-inquiry). Typically, the ITBI is administered in combination with a structured interview such as the TPPI in order to fully characterize instructor beliefs. Quantitatively, inquiry beliefs are reflected in the ITBI's Inquiry Ratio, which is the average distance of the non-inquiry items from the classroom card divided by the average distance of the inquiry items from this same card. A larger Inquiry Ratio reflects a greater distinction made by the examinee (in a direction consistent with national education policy) between inquiry and non-inquiry classroom activities.

Personality and Work Habits

Where personality and work habits are assessed in civilian teacher hiring, they are assessed through interviews and references, however the validity of these methods is questionable (Wise et al., 1987) and remains untested. Numerous psychometrically validated measures of personality may be used for the selecting instructors, including the Revised NEO Personality Inventory (NEO PI-R; Costa & McCrae, 1992). Empirical evidence suggests that such measures can predict occupational performance above and beyond measures of ability, especially for jobs (such as teaching) that require autonomy and interpersonal skill (e.g., Barrick & Mount, 1993; Day & Silverman, 1989; Mount, Barrick, & Stewart, 1998; Tett, Jackson, & Rothstein, 1991). The NEO PI-R directly assesses some personal characteristics believed to underlie student-centered teaching success, including openness to experience. Facets of conscientiousness as assessed by the NEO PI-R, including order and dutifulness, may also capture some aspects of work habits, and have consistently shown a relation to occupational performance (Barrick & Mount, 1991, 1993; Mount et al., 1998). The use of personality

measures for personnel selection has been thoroughly reviewed and documented (e.g., Barrick & Mount, 1991; Hogan, 1991; Hough & Schneider, 1996) so it is not described in detail here.

Cognitive Capabilities

Assessment of the problem-solving skill necessary to implement PBL requires that individuals demonstrate their ability to achieve some goal when the method to do so is unknown and a single, correct answer is unavailable. Proxy measures of such skill, including performance references or supervisor ratings, may be employed, but they are subject to pressures that may reduce their utility. Army-funded research has validated more direct measures of problem-solving skill, which require examinees to construct responses to complex, ill-defined military leadership problem scenarios (Zaccaro, Mumford, Connelly, Marks, & Gilbert, 2000). Responses may be subjectively scored essays that address various aspects of the problem-solving process, including information encoding and idea evaluation. Responses also may be constructed by assembling selections from a set of pre-determined options.

Army Environment

The Army's success in implementing PBL will depend in part on the correspondence between the requirements of PBL and the characteristics of Army instructors, which are shaped by selection practices. This correspondence has never been systematically evaluated and insufficient archival data existed to perform a detailed, quantitative analysis within the scope of the present research effort. This section presents qualitative findings from interviews and focus groups with Army education providers, which illuminate the differences between the current Army learning environment and one that is ideal for PBL. Army instructor selection processes are addressed first, due to their implications for instructor characteristics.

Instructor Selection

Army instructor selection is not a standardized process in terms of selection criteria or application. The Army currently has no policy regarding instructor selection and no formal selection process. The Army instructor cadre, which comprises military personnel and civilians (government employees or contractors, typically retired military), largely is a product of nominations and contract awards. Nominations of military personnel may be a function of (1) subject matter expertise; (2) availability; or (3) unsuitability for an operational duty position. Contract awards to civilian instructors may be a function of (1) subject matter expertise; and/or (2) contract cost. To the extent that subject matter expertise is evaluated, the available measures (e.g., evaluation reports, course completion, prior service) may be subject to the same validity concerns as those used to reflect civilian teachers' domain knowledge. Perhaps most importantly, the demand for qualified Army instructors outstrips the available supply, so there is a greater need to develop personnel quickly than there is to select them.

One Army institution that does implement a rigorous instructor selection process is the Command and General Staff College (CGSC) at Fort Leavenworth, Kansas. Instructor candidates are selected on the basis of their professional experience, teaching experience, demonstrated scholarship (publications), leadership and joint experience, and educational

credentials. After review, interview, and hiring, instructors at CGSC teach for two years under probation. Performance during the probationary period is developed and evaluated and may lead to termination.

The selection methods described in the previous section could be applied after being modified for both content validity and feasibility purposes. A chief concern is ensuring that assessments of instructor characteristics be (1) matched to the demands of the teaching position; and (2) applied rigorously. For instance, not all teaching positions may require student-centered teaching methods, in which case, subject matter knowledge may matter more than some interpersonal skills. Scores on assessments of belief should be used differently, depending on whether student- or teacher-centered beliefs are more aligned with a particular learning environment. Selection measures must be applied consistently and scores documented so that a database can be created to allow quantitative analysis of instructor characteristic-teaching performance links.

Instructor Characteristics

To the extent that they are a representative sample of the civilian population, there is no reason to believe that Army instructors differ from civilian educators in terms of basic characteristics. Many Army instructors are, in fact, civilians. Regardless, Army instructor and civilian teacher beliefs have been shaped by similar kindergarten through 12th grade (K-12) and college education experiences. In addition, the two populations are unlikely to differ in terms of the basic personality traits associated with student-centered learning. They also have had similar opportunities to develop problem-solving skills and productive work habits as adults. For these reasons, and on the basis of discussions with Army education providers, it seems safe to conclude that, on average, Army instructors resemble civilian educators with regard to subject matter expertise, education-related beliefs, personality, work habits, and problem-solving capability.

Unfortunately, the characteristics of civilian educators generally are inconsistent with the requirements of student-centered learning or PBL (Borko & Putnam, 1996). In general, civilian education (including college undergraduate instruction) been dominated by traditional, teacher-centered instructional methods, producing (1) concepts of subject matter as a static body of facts; (2) philosophies of teaching as knowledge transmission; (3) expectations for students to be passive participants in the learning process; and (4) greater familiarity and comfort with controlled teaching techniques. Because beliefs have been shown to be very difficult to change, one implication of the similarity between Army instructors and civilian educators is that the Army will encounter similar challenges implementing student-centered teaching and PBL. In addition, changes in the nature of warfare and in the operational environment decrease the likelihood that any one instructor will have comprehensive subject matter expertise. As the operational tempo remains high, Army instructors face significant challenges keeping their domain knowledge current and relevant.

One important difference between Army instructors and civilian educators also has implications for Army implementation of PBL. For most Army instructors, teaching positions last a relatively short time, 2-3 years, and are not always seen as an opportunity for professional

advancement (CGSC faculty excepted). Anecdotally, being nominated for an instructor position is seen by some Army personnel as a bad sign regarding career prospects. Yet, seeing teaching as a prestigious, chosen profession worthy of continuous learning is necessary for Army instructors to make the investment in student-centered learning.

Recommendations

To summarize, the successful implementation of PBL as well as other student-centered learning methods requires that Army instructors possess the same characteristics that experts in the complex, continuously evolving field of military operations have. Problem-based instructors specifically must possess the problem-solving skill characteristic of seasoned military leaders (Zaccaro et al., 2000). In addition, instructors must be willing and able to apply their professional knowledge and skill to creating and facilitating learning opportunities for others. Such experts are difficult to develop and operationally valuable in any profession. The placement of such experts into Army teaching positions is not yet a systematic process.

Currently, the characteristics of the average Army instructor can be expected to resemble those of the average civilian educator, which do not meet the requirements of student-centered instruction or PBL. Using selection to shape the instructor cadre and promote PBL is necessary, as is exploring how to make teaching positions more attractive to experts who are rewarded for remaining in the field. However, until the pool of instructor candidates with the necessary characteristics exceeds the number of open positions, there likely is insufficient benefit to be gained from investing in selection than cost incurred. In the current Army environment, developing instructor andragogical content knowledge and beliefs may be the best option for shaping the instructor cadre with regard to characteristics.

Attempts to modify beliefs and, in concert, practices have met with some, albeit very limited, success (Grossman, Smagorinsky, & Valencia, 1999**;** Zeichner & Tabachnik, 1981). Successful attempts have been characterized by their infusion into the ongoing teaching process such that they involve (1) active reflection on events and actions taken in the classroom; and (2) a supportive community of teachers on a similar developmental trajectory (Borko & Putnam, 1996; Borko, 2004). In the Army, the Combat Application Training Course (CATC) contains some of these elements, and anecdotally has had an impact on instructors' openness to using more operationally relevant criteria for designing instruction and assessing student performance (Connolly, 2008). Attempts to modify domain knowledge from a teaching perspective have been shown to increase the sophistication of teachers' understanding of their students (Smith, 2005). Developmental methods targeting andragogical content knowledge are described in more detail in the next section.

INSTRUCTOR COMPETENCIES

Required Competencies

Educational research suggests that students and experienced teachers prefer structured, well-managed, and routinized learning environments (e.g., Albanese & Mitchell, 1993; Brush & Saye, 2000; Kagan, 1993; Land & Zembal-Saul, 2003) and that such environments are more

conducive to learning (Kirschner et al., 2006). Structures and routines may enable instructors facilitating student-centered learning to improvise in response to student progress (Harlow, 2009; Yinger, 1987). However, it can be challenging to strive for a well-managed learning environment without adopting teaching techniques that directly control the classroom (Cornett, 1990; Papinczak et al., 2009). Required instructor competencies for PBL therefore are those functions that a student-centered learning facilitator must perform to simultaneously provide structure and adaptively respond to student need. These competencies fall into two categories: classroom management and learning facilitation. They support indirect shaping of the classroom by promoting assessment, comprehension, and response to student need.

Classroom Management

As the facilitator of problem-based learning, the instructor serves in much the same role as a project manager, ensuring that problem-solvers understand what is expected them and that they have access to the resources they need to succeed (Bridges & Hallinger, 1996; Glasgow, 1997; Hmelo & Ferrari, 1997; Markham et al., 2003). Classroom management activities set the stage for productive problem-based learning by requiring the instructor to prioritize learning objectives, to structure problems and assessment activities, and to anticipate most likely or most damaging areas (to future learning) of student difficulty. Competencies associated with effective classroom management include specifying outcomes, developing problems, and constructing a problem ~~r~~oadmap."

Specify outcomes. Outcomes are the knowledge and skill acquisition objectives for a problem-based course. Additional outcomes may be ~~h~~abits of mind," such as persistence and attention to detail (Markham et al., 2003). Specifying outcomes is necessary to organize the course and to ensure that the problems used to situate learning serve a valid, applicable instructional purpose (Barron, Schwartz, Vye, et al., 1998; Thompson, 1990). For instance, if course outcomes do not require problem-solving skill and collaboration skill, an approach other than PBL should be used (Hmelo & Ferrari, 1997). Outcomes also must match the performance requirements of the environment to which learning is expected to transfer, including standardized tests (e.g., professional certification exams; Thompson, 1990). Specifying outcomes assists instructors in developing problems and prioritizing instructional tasks by making explicit what purpose these activities serve.

Learner outcomes commonly associated with PBL (Hmelo & Ferrari, 1997; Hmelo-Silver, 2004; Markham et al., 2003; Savery, 2009) include:

- An extensive, flexible domain knowledge base;
- Problem-solving skill;
- Self-directed lifelong learning skill / reflective practice;
- Collaboration skill;
- Intrinsic motivation to learn; and
- Self-regulation and metacognitive skill.

To best support classroom management, learner outcomes must be specified in concrete terms with clear evaluation criteria. For example, the instructor must define what collaboration

skill is to be developed and what it ―looksike" when it is happening [e.g., ―group members facilitate each others' participation" could be demonstrated when ―members often encourage other members to share thinking, listen carefully, and effectively manage disruptive behavior" (p. 78, Markham et al., 2003)]. Specifying evaluation criteria that are embedded in the course content may optimally stimulate instructor reflection on what the learning purpose of a problem is and how he or she will know if that purpose has been served. Defining problem-solving skills in terms of a specific problem may reveal the problem's operational relevance and knowledge requirements (Zaccaro et al., 2000). For instance, ―learners identify knowledge gaps" could be demonstrated when they ―specify that traffic flow patterns as a function of time of day must be understood to solve the problem."

Develop problems. Problems must be developed to trigger and situate the learning process. Ideally they are ill-defined, interdisciplinary, complex, and realistic—representative of problems typically encountered in the operational or transfer environment (Bridges & Hallinger, 1996; Hmelo & Ferrari, 1997; Hmelo-Silver, 2004; Savery, 2009). To promote the active involvement of all students, problems must feature interdependent roles for each member of the collaborative-learning group, and problem-solving products must require individual accountability (Barron et al., 1998). The collaboration requirements of a problem should be representative of the transfer environment such that learner roles and the nature of their interdependence is realistic (Glasgow, 1997). Problems must be solvable within the time constraints of the course, presenting a level of complexity that can be addressed with the resources available to learners (Markham et al., 2003). It can be helpful to develop a series of problems ranging in difficulty and complexity such that learners can be sufficiently challenged without being overwhelmed (Barron et al., 1998; Brush & Saye, 2000). Simpler problems can be used as practice events or for targeted remedial instruction. Most importantly, as described previously problems must address the knowledge outcomes of the course (Markham et al., 2003). Problem solving must require students to acquire the same knowledge that they must possess at the end of the course.

Construct a problem "road map." Constructing a problem ―road map" provides structure that guides the assessment and understanding of students and scaffolds learners' development of cognitive skill (Moust et al., 1990; Papinczak et al., 2009; Wilkerson, 1995). Problem road maps do not necessarily have to be developed from scratch, but may be created by critiquing and modifying existing lesson plans to make them more student-centered (Duncan, Pilitsis, & Piegaro, 2010). Constructing a road map constitutes:

- Developing advanced organizers for the course, including an up-front introduction of the problem-based learning process and expectations of students as individuals and collaborators (Bridges & Hallinger, 1996; Brush & Saye, 2000; Hmelo & Ferrari, 1997);
- Specifying assessment milestones and student-centered evaluation criteria (Barron et al., 1998; Brush & Saye, 2000; Glasgow, 1997; Markham et al., 2003; Musial, 1996);
- Specifying when direct instructional techniques (e.g., ―mini lectures") might be needed (Albanese & Mitchell, 1993; Barron et al., 1998; Bridges & Hallinger, 1996); and
- Specifying when other instructional strategies might be useful (Costa & Garmston, 1985)

Several resources provide guidance for structuring problem-based learning via road maps, particularly the specification of assessment milestones and criteria (Glasgow, 1997; Markham et al., 2003; Musial, 1996). In general, it is recommended that instructors require student products at multiple phases of the problem-solving process, including identification of the problem, planning the problem-solving approach, addressing knowledge gaps, synthesizing information, and reaching a final solution. Student products may include research plans, journal entries, databases, and presentations, among many other possibilities. Student-centered evaluation criteria may be applied to these products as well as to other assessment opportunities, including group discussions. Markham et al. (2003) and Musial (1996) provide a wealth of assessment criteria that may be applied to problem-based learning. Quintana, Reiser, Davis, Krajcik, Fretz, Duncan, et al. (2004) describe a learner-centered design method for planning when scaffolding might be needed and what approaches might be used.

Facilitate Learning

Learning facilitation is what instructors do in real time to ensure that students remain active and in charge of their learning while keeping learning on track to meet course requirements (Hmelo-Silver & Barrows, 2006). Here too the instructor acts as a project manager, stepping back to allow students to work on their own yet intervening when students get stuck or venture too far down a counterproductive path.

Monitor student progress and intervene as necessary. Monitoring student progress is an essential component of any student-centered teaching method. Real-time assessment ensures that instructors detect when learning has gotten off track (Barrows, 1992; Moust et al., 1990), when student thinking is faulty (Papinczak et al., 2009), and when student frustration represents unproductive struggle versus a normal response to solving complicated problems (Barrows, 1992). Instructors monitor student activity via formal and informal assessment. Informal assessment includes observation of ongoing classroom events or actively questioning students about their thinking during the problem-solving process (Papinczak et al., 2009). To determine whether or how to intervene, it is believed that instructors compare their informal assessments against a situated model of how problem-solving should be conducted (Carpenter, Fennema, & Franke, 1996; Costa & Garmston, 1985; Harlow, 2009; Yinger, 1987; though see Fennema, Franke, Carpenter, & Carey, 1993). This comparison is facilitated by advance planning and requires an understanding of the problem subject matter from a learning standpoint—how students understand the material and bring their experiences to processing it (e.g., Quintana et al., 2004).

Instructors may intervene to facilitate learning via providing direct instruction (Albanese & Mitchell, 1993; Barrows, 1992; Schwartz & Bransford, 1998; Thompson, 1990), asking questions that challenge learners' assumptions and make faulty thinking explicit (Barrows, 1992; Land & Zembal-Saul, 2003; Papinczak et al., 2009; Wilkerson et al., 1991), drawing students' attention to outside resources that can be used to solve the problem (Brush & Saye, 2000; Moust et al., 1990), and introducing simpler, ~~"p~~ractice" problems (Barron et al., 1998). To optimally challenge learners' to explain and justify their thinking, questions should be open-ended and target thought processes. For example, rather than asking students to state the cause of a regional conflict, the instructor should ask students to specify the evidence they used to determine why

the conflict occurred. To facilitate access to outside resources, instructors must have up-to-date awareness of the key knowledge repositories associated with the subject matter and a current social network of experts working in the problem domain (Barron et al., 1998; Crawford, 2000).

Role-model the problem-solving process. Role-modeling the problem-solving process is essential for students to understand what is expected of them regarding how to solve problems and how to learn from the struggle with complicated situations (Papinczak et al., 2009). In addition to using a problem road map and formal assessment opportunities to structure group activity, instructors can role-model the problem solving process by making students' thinking and depth of understanding explicit at various stages of the problem-solving process (Hmelo-Silver & Barrows, 2006). Methods for making thinking and knowledge explicit include open-ended questioning that pushes for assumptions and explanations, assisting in the development of a public record of progress (e.g., shared visualizations), and making one's own knowledge gaps public as well as the process for bridging them (Hmelo-Silver & Barrows, 2006; Loh, Reiser, Radinsky, Edelson, Gomez, & Marshall, 2001).

It arguably is easier for instructors to role-model the problem-solving process when the problem is new to them and unsolved. Such problems can be community-based such that solving the problem meets some need in a context that matters to students and the instructor alike (e.g., Crawford, 2000). Community-based problems engage students because they are realistic, personally meaningful, and require communication of results to external evaluators (Barron et al., 1998; Crawford, 2000). When the problem emerges from the instructor's professional network, it gives him or her a chance to demonstrate expertise in the subject matter, problem solving, and lifelong learning.

Facilitate discussion and collaboration. Ill-defined, multidisciplinary problems typical of the operational environment require frequent interaction among collaborators to solve effectively (Cohen, 1994). Such interaction requires problem solvers to understand each others' information requirements, to build trusting relationships with one another, to resolve conflict, and to communicate effectively (Cianciolo et al., 2009). In the classroom environment, however, it is important that knowledge acquisition is not stymied by underdeveloped interpersonal skill (Albanese & Mitchell, 1993; Brush & Saye, 2000). Instructors must facilitate group discussion and collaboration in order to support knowledge acquisition and give students a model of successful collective problem solving (Moust et al., 1990; Wilkerson, 1995). To do so, instructors must perceive when disagreement among group members is intractable or, conversely, when agreement has been reached prematurely or is factually wrong (Chazan & Ball, 1999). Instructors must also detect when member contributions are out of balance and engage the less active learners. Questions used to facilitate discussion should be open-ended and instructors should give students time to respond instead of jumping in with an answer (Wilkerson et al., 1991). Instructors model effective collaboration by not interrupting the flow of the discussion (Wilkerson et al., 1991), by fostering tolerance for mistakes (Bridges & Hallinger, 1996), and by facilitating the construction of a shared visual representation of how the group understands the problem (Hmelo-Silver & Barrows, 2006).

Development Methods

Educational researchers have widely investigated the preparation of instructors for facilitating student-centered learning, and numerous methods of teacher education have been proposed and assessed (albeit often qualitatively). Although rigorous, comparative evaluation of various development methods has never been conducted (Borko, 2004), it is generally recognized that high-quality teacher education (1) is long-term, enabling continuous professional development; (2) is learner-centered; (3) addresses domain knowledge from both academic and instructional perspectives; (4) is tied to external standards; (5) involves social learning within a professional community; and (6) is connected to actual classrooms and student performance (Ball & Cohen, 1999; Borko, 2004; Hawley & Valli, 1999; Lotter et al., 2007; Loucks-Horsley, Henson, Love, & Stiles, 1998; Sage & Torp, 1997; Sykes, 1999). Comprehensive instructor professional development should involve multiple methods at different times (Loucks-Horsely et al., 1998), especially given the fact that teachers learn informally throughout their careers and that the failure rate is high for interventions that are narrow in scope (Borko, 2004). Several methods addressed in the literature are described below.

Practice-Based Methods

Practice-based methods provide instructors with an opportunity to exercise and refine their teaching competencies, including classroom management. These methods often are the most time-consuming approach to professional development, but they are also the most representative of actual classroom instruction, which may enhance transfer (Ball & Cohen, 1999; Grossman et al., 1999; Kagan, 1993; Schwartz & Bransford, 1998). Use of these methods with effective supervision and scaffolding promotes learner-centered implementation of instructor professional development, and is preferred by civilian teacher candidates (e.g., Brown & Melear, 2006).

Student teaching. In this method, a common element of teacher preparation programs, instructor candidates teach in actual classrooms under the supervision of a more experienced mentor. Ideally, the supervising instructor is a master (i.e., he or she role-models highly effective, student-centered teaching) and uses learner-centered approaches to help the student teacher reflect on classroom events, update his or her classroom management approach, and refine his or her repertoire of facilitation strategies. Student teaching may last for a semester, academic year, or longer, depending on the need for graduates and the availability of supervisors. Conducting student teaching increases the amount of time between completing coursework and serving as an independent instructor, but may shorten time to competency post-graduation.

Field experiences. Field experiences give teacher candidates a chance to try out the instructional methods they are learning in formal professional development with individuals or small groups of students from actual classrooms. Field experiences expose pre-service instructors to the realities of applying methods to actual student learning, allowing them to experiment in a representative context that is not overwhelming (Danielson, Kuhlman, & Fluckiger, 1998). Supervision of field experiences can be very time consuming when there are multiple teacher candidates, and must ensure that prospective teachers reflect on what happened during their

experience to extract lessons learned for application to a classroom environment (Danielson et al., 1998).

Peer teaching. In peer teaching, pre-service teachers deliver instruction to their fellow instructor candidates (e.g., Luft, 2001). In the absence of opportunities for student teaching or field experiences, peer teaching enables experimentation with instructional strategies. Peer teaching is most effective when peer learners are representative of the actual classrooms in which the instructor candidate will teach. To the extent possible they should be unfamiliar with the subject being taught, similar demographically to actual students, and have similar expectations for learning. Like student teaching and field experiences, peer teaching is most likely to be effective when conducted under the supervision of a master instructor who can guide reflection and transfer of instructional practices.

Social Learning Methods

In social learning, instructors rely on interpersonal networks to learn continuously about students and subject matter and to refine their teaching skills (Blanchard et al., 2008; Borko, 2004; Loucks-Horsely et al., 1998; Sage & Torp, 1997). Social learning occurs outside of formal instructor professional development, and therefore does not require additional investment by educational institutions. The success of social learning assumes, however, that people have the time available to participate, that they feel participation will be useful, and that it is actively and voluntarily led by experts who can productively guide discussion, reflection, and articulation of lessons learned (Loucks-Horsely et al., 1998; Cianciolo & Evans, in press).

Communities of practice. A central feature of communities of practice is voluntary, collegial conversation among educators about students, teachers, and learning (Franke & Kazemi, 2001; Wilson & Berne, 1999). Participation in teacher communities of practice may promote the development of actionable knowledge via improved understanding of students and classrooms (Cianciolo & Evans, in press; Franke & Kazemi, 2001) and may shape instructors' professional identity and beliefs (Franke & Kazemi, 2001). Geographically distributed communities of practice may support the implementation of student-centered approaches by instructors who are immediately surrounded by peers who do not embrace constructivist teaching methods.

Team teaching. In team teaching, multiple instructors are assigned to the same class of students. Ideally, team teachers have complementary strengths and weaknesses, both in terms of subject matter expertise and ability to relate to students. Team teaching fosters social learning by providing a situated context for talking about students, teaching, and learning (Wilson & Berne, 1999). It enables peer observations of teaching with feedback, discussion, and identification of lessons learned (Sage & Torp, 1997). Team teaching is resource intensive, however, graduating fewer students per teacher than individual teaching methods.

Demonstration classrooms. Demonstration classrooms provide an opportunity for teachers to observe and discuss the practices of more experienced peers (Luft & Pizzini, 1998; Pinnell, 1987; Putnam, 1985). Participation in demonstration classrooms can occur as part of teacher preparation or continuing education. Ideally, participants use advance organizers to guide

their observations and then discuss what they saw with the demonstration teacher, a mentor or coach, and other observers. Observers also prefer that the demonstration classroom be as representative of their target classroom as possible, including subject matter and student demographics (Putnam, 1985).

Partnerships. Partnerships with outside organizations help instructors to stay current in the domains they teach and provide opportunities for immersive learning of subject matter (Loucks-Horsely et al., 1998). Partnerships also facilitate the development of problems that are realistic and that can have actual operational impact (Crawford, 2000). As with any cross-organizational effort, however, expectations, roles, and responsibilities must be clearly defined and goals must be shared in order for the partnership to be productive and lasting (Loucks-Horsely et al., 1998).

Activity-Based Methods

Activity-based methods are learning opportunities that are focused on particular knowledge and/or skill. Such methods may be employed in a variety of settings, including classroom instruction (i.e., as part of formal professional development), workshops or seminars, communities of practice, and computer-based instruction. In the context of practice-based professional development methods, activity-based methods may serve as useful interventions to strengthen teacher judgment and performance. For the continuous self-developer, activity-based methods available via professional networks may assist in honing skills or solving particular teaching problems. Activity-based methods vary widely, and may focus on teachers' understanding of students and classrooms, knowledge and selection of instructional strategies, and reflective practice. The activity-based methods described below are not an exhaustive list of the possibilities, but represent those frequently mentioned in the literature.

Cases. Cases feature critical incidents in ongoing classroom instruction and require analysis to identify what happened, why, and the implications of the events for teaching. Analogous to situational judgment tests with a solution provided (described earlier in this report, see also Williams, 1992), cases may be presented in a variety of formats, including brief written summaries, classroom transcripts, live action or 3-D animated films (e.g., Herrington & Oliver, 2000; Rogers, 1972; Smith, 2005; Stein, 2001). The use of cases enhances teachers' perception of ongoing classroom activity and decision making about what to do given particular conditions (e.g., Schwartz & Bransford, 1998). Cases may compliment other professional development activities that are focused on practicing instructional strategies because they draw attention to the ―why" of action instead of just the ―what" of action (Stein, 2001). As part of a blended teacher education environment (e.g., Herrington & Oliver, 2000), computer-based cases can provide more in-depth exposure to course topics without increasing time in the classroom. Used as self-development, computer-based cases could enhance reflection skills and accelerate on-the-job learning (Lampert & Ball, 1999).

Knowledge games. Knowledge games are practical exercises that stimulate pedagogical (or andragogical) content knowledge acquisition. For example, Questioneze (described in Rogers, 1972) is a game that was designed to increase teachers' understanding and use of various questioning strategies. One element of the game asked teachers' to roll a die and then design a

question that belonged to the category associated with the value on the die. Teachers earned points either for designing a question that went unchallenged by others or could successfully defend their design. Games such as these could be computer-administered and may help instructors (1) distinguish between teacher- and student-centered beliefs and teaching methods; (2) recognize teachable moments; or (3) learn the connection between particular instructional strategies and specific student needs.

Journaling / Records of practice. Journaling or records of practice stimulate reflection on classroom events: what the conditions were, what the instructor did, how students responded, how well the event met expectations, and so on. Reflection exercises also may be employed in concert with other activity-based methods, such as cases (e.g., Herrington & Oliver, 2000). In this way, they serve as an experiential learning tool that guides instructor professional development in an anytime / anywhere fashion, and may be used by novice and experienced teachers alike. This reflection is necessary for instructors to modify their practices adaptively to student need (Blanchard et al., 2008; Borko, 2004) and may stimulate change in beliefs (Borko & Putnam, 1996). To the extent that reflection is voluntary, however, it is subject to the beliefs and work habits of the individual instructor. It may be that the instructors who would benefit most from reflection are the least likely to engage in it.

Curriculum critique and modification. Curriculum critique and modification involves providing guidance on student-centered learning principles and then giving instructors the opportunity to review and change a real curriculum to make it more consistent with these principles (e.g., Duncan et al., 2010). Curriculum critique could include lesson structure and assessment criteria, as well as planned classroom activities. This method may increase the sophistication of teachers' understanding of student-centered learning and can directly guide them in revising their own lesson plans (Duncan et al., 2010; Loucks-Horsely et al., 1998).

Job Aids

Not explicitly a professional development method, teacher job aids include handbooks (e.g., Marham et al., 2003), tutorials (Hmelo & Ferrari, 1997), tips or rules of thumb (e.g., Musial, 1996), teaching kits that include structure, problems, and assessment tools (e.g., the Science Education for Public Understanding Program), and templates (e.g., general learner assessment rubrics; Markham et al., 2003). Job aids do not remove the instructor from the classroom; instead they provide a situated method for enhancing classroom management, saving preparation time, and improving rigor. Because the adoption of job aids is voluntary, it depends upon instructor awareness that an aid is necessary and available and his or her belief that the aid will be useful. Online communities of practice can be a valuable source for job aids, providing explanation and contextualization for their use (Cianciolo & Evans, in press).

Army Environment

The degree to which Army instructors possess the required competencies for facilitating student-centered learning and PBL has never been formally assessed, and insufficient archival data exist to perform a quantitative evaluation within the scope of the current effort. The present assessment is based on qualitative findings from interviews and focus groups with Army

education providers. Instructor development methods are discussed first to highlight their implications for instructor competencies. Because it was not a purpose of this project to evaluate specific programs, this assessment addresses Army instructor development as a whole wherever possible, using examples only to provide context or illustrate key points.

Instructor Development

Most nominated instructors must complete the Army Basic Instructor Course (ABIC) prior to assuming a teaching position. Currently under modification, the ABIC addresses basic concepts (e.g., roles and strategies), lesson plans, learning theory, classroom management, learner assessment and evaluation, and instructional media and technology. As educational leaders at Army schoolhouses have recognized the importance of student-centered learning for enhancing Soldiers' readiness, they have developed their own approaches to preparing instructors to facilitate it (e.g., Connolly, 2008; Kem, 2006; Perry & McEnery, 2009; Raymer, 2006). Where applicable, these grassroots efforts have modified or augmented the ABIC to include instruction on particular advanced methods, including (but not limited to) outcomes-based instruction, the Adaptive Leader Methodology, and PBL. Some institutions, such as CGSC and the Army Management Staff College (AMSC), have their own faculty preparation programs focused on implementing experiential and inquiry-based learning, respectively.

As stated earlier in this report, the generally recognized criteria of quality instructor professional development indicate that such programs should be (1) long-term and sustained via social development opportunities; (2) aligned with external standards such that developmental objectives are instrumental; and (3) representative of actual classrooms, strengthening domain knowledge from both a content and teaching perspective. Current Army instructor professional development opportunities are described below in terms of these criteria.

Duration. In general, the duration of Army instructor development is shorter than recommended and there is limited opportunity for instructors to sustain their skills via social learning. High operational tempo requires Army schoolhouses to produce many instructors quickly. Initial preparation typically is very short-term in nature, lasting approximately one to two weeks before an instructor begins teaching independently. In addition, instructor tenures usually are short (2-3 years), precluding self-identification as professional educator and advanced development as such. To meet high throughput demands, most of an instructor's time is spent in the classroom, so it can be difficult to find time for continued professional development even when it is desired. However, there exist opportunities for activity-based continued development, including attending a small-group instructors' course or a 2-3 day workshop on advanced methods (e.g., Connolly, 2008). Social learning methods that promote continuous development are applied at the discretion of instructor cadres and are subject to time and personnel constraints. For instance, instructors of the Army Reconnaissance Course (ARC) at Fort Knox have adopted social learning methods, including team teaching. However, these instructors acknowledged that social learning is too time- and resource-intensive to be sustained without formal organizational support.

An Army exception to the rule of truncated instructor development is CGSC, where faculty self-identify (and typically have professional background) as instructors, serve longer

tenures (usually 5-10 years, but as many as 15 years), go through five phases of continuous professional development, and actively participate in social learning methods supported by the schoolhouse, including team teaching and the *Instructor Net* online discussion forum. Outside the Army, the Instructor and Staff Development Plan for the U.S. Marine Corps Basic School includes phased professional development and features a mentorship program to facilitate social learning. This approach could serve as a model for implementing continuous learning in Army schoolhouses that teach foundational courses, such as Advanced Individual Training.

Alignment. The alignment of external standards with instructor preparation objectives is accomplished by close coordination between policy makers and implementers. Coordination with policy makers ensures that instructors are prepared to teach in a way that meets organizational expectations and, by extension, that a reward structure is in place to promote the sustainment of desired practices. In the Army, curriculum development and implementation roles often are distributed across organizations (CGSC and the Army Management Staff College excepted). Curriculum materials usually are not created by instructors; thus two different types of implementer must coordinate with policy makers: course developers and instructors. Course developers must produce curriculum materials that both meet policy standards and the criteria for effective, student-centered classroom management described earlier in this report, including problem development. In addition, the programs of instruction designed by course developers are used by Army quality assurance officers to evaluate instructor performance. The assessment criteria they use must be aligned with policy, programs of instruction, and instructor development objectives. Aligning instructor preparation with policy therefore requires that three groups of people with different reporting structures all receive preparation in student-centered learning methods. The focus of the present research effort reflects the Army's current focus on instructors alone, which reflects suboptimal alignment, however recent working groups have identified the need for a more comprehensive approach to Army educational reform (William Bickley, personal communication).

Representativeness. The representativeness of an instructor development program is reflected in the degree to which it employs practice-based methods. The short timeframe in which Army instructors currently are developed, combined with short teaching tenures and limited opportunities for social learning, generally has precluded the use of such methods. With the exception of the CGSC faculty development program and the conduct of ARC, both of which involve forms of student teaching and team teaching, Army instructor preparation does not currently support the ideal implementation practice-based methods. All initial instructor preparation courses reviewed as part of the present research did include multiple activity-based methods, however, some of which involved peer teaching and work with actual course materials (e.g., development of assessment criteria and practical exercises). In general, these activity-based methods target curriculum design, instructional strategies, and learner performance assessment. Andragogical content knowledge, specifically an understanding of how adult students view the subject being taught and how material should be framed to promote learning, is not systematically addressed. Activity-based development methods focused on this aspect of domain knowledge could potentially shorten the time to instructor efficacy in the classroom.

Instructor Competencies

The status of Army instructor PBL competencies is unknown. Given the short duration and limited scope of instructor preparation, it seems reasonable to conclude that the competencies of Army instructors on average resemble those of civilian educators. Unfortunately, civilian educator competencies usually are found to be insufficient for implementing student-centered learning effectively. For instance, instructors often have trouble planning and managing classrooms (Borko & Putnam, 1996; Calderhead, 1996; Kagan, 1993; Thompson, 1990), designing student-centered curriculum materials including problems (Duncan et al., 2010; Sage & Torp, 1997), and defining student-centered learning objectives and performance criteria (Saye & Brush, 2004; Thompson, 1990). In the Army, the preponderance of classroom management is addressed by programs of instruction, which tend to promote direct instruction and feature assessment criteria that target process (e.g., throughput, time on task) rather than operationally relevant criteria (National Security Analysis Department, 2009).

Student-centered learning facilitation is especially difficult for civilian educators to acquire (Grossman et al., 1999). Not knowing how to shape classroom activity via indirect means, teachers (including college professors) are reluctant to use less directive approaches to instruction (Albanese & Mitchell, 1993; Kagan, 1993; Sage & Torp, 1997). For instance, they have difficulty keeping knowledge to themselves (Moust et al., 1990; Sage & Torp, 1997) and letting students make mistakes (Blanchard et al., 2008). They also tend to ask content-focused questions with a single right answer versus metacognitive, process-focused questions (Hmelo & Ferrari, 1997; Saye & Brush, 2004) and they interrupt student discussion (Wilkerson et al., 1991). Lacking pedagogical domain knowledge (Barron et al., 1998; Kagan, 1993), civilian educators typically fail to use methods that scaffold problem solving (Brush & Saye, 2000; Land & Zembal-Saul, 2003; Oliver, 1996; Saye & Brush, 2004), group discussion (Chazan & Ball, 1999; Hmelo & Ferrari, 1997), and reflection (Loh et al., 2001; Saye & Brush, 2004).

Recommendations

To summarize, instructor development for student-centered learning and PBL must grow the classroom management and facilitation competencies that enable instructors to indirectly shape classroom events and respond adaptively to student need. Although recommended instructor development methods are adopted by Army schoolhouses, the ideal development approach requires more time and resources than are currently spent on developing facilitators. In addition, a comprehensive approach that also prepares curriculum developers and quality assurance officers is needed for investment in instructor development to have an impact. Given this context, methods must be created that can (1) rapidly develop instructors' actionable knowledge for teaching; (2) leverage the existing development methods currently in use by Army educators; and (3) enable the simultaneous execution of multiple professional development ―lines of operation" (e.g., practice-based methods and social learning).

Activity-based methods that target andragogical content knowledge and are tied to actual classrooms and students could meet these objectives and reduce new instructors' time to effectiveness once they begin teaching independently (Ball & Cohen, 1999). Using an accelerated apprenticeship model, situated activity-based methods could include:

- Focused observations of actual/demonstration classrooms

- Critique and modification of actual curriculum materials in collaboration with current instructors
- Deliberate practice on high-payoff instructor competencies via a combination of cases and journaling
- Field experiences that allow instructor candidates to practice strategies and learn about students while assisting current instructors with remediation

Rather than addressing a list of tasks or competencies, instructor preparation *designed around* situated activity-based methods could be more outcome-focused and problem-centered. In the accelerated apprenticeship model, instructor development would (1) begin by exposing instructor candidates to teaching problems presented in an actual or demonstration classroom (carefully selected to address specific professional development objectives); (2) stimulate knowledge development and reflective practice through supporting activities (e.g., curriculum critique and modification, journaling), direct instruction, and group discussion; and (3) exercise teaching competencies via field experiences. Using this model of professional development, assessment criteria would target outcomes (i.e., ~~"t~~eaching mission accomplishment," such as reading students and selecting an appropriate intervention) versus process (e.g., number of required competencies covered via direct instruction).

The general architecture of a professional development lesson plan based on the accelerated apprenticeship model is illustrated below (Figure 1) in comparison to the architecture characteristic of a typical, competency-driven lesson plan. On the left side of the figure, illustrating the competency-driven approach, instructional segments are each linked to a competency, which is addressed via a sequence of introductory example, lecture, and practical exercise. Analogous to the task-based approach to operational training, the coverage of competencies is used as a proxy for the acquisition of competencies (National Security Analysis Department, 2009). On the right side of the figure, a single instructional segment addresses multiple competencies in a situated, naturalistic context via a sequence of classroom observation, after action review, follow-up direct instruction, deliberate practice activities, and field experiences. In this approach, demonstration of competency directly reflects its acquisition.

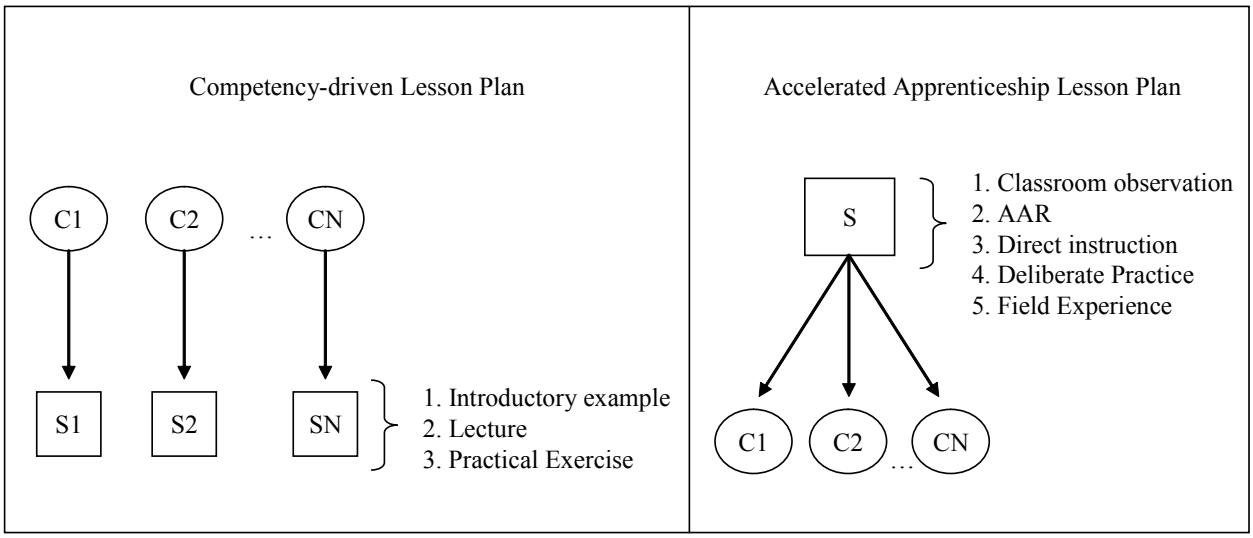

Figure 1. Competency-driven lesson plan versus accelerated apprenticeship lesson plan.

A notional lesson plan for a 10-day, basic PBL facilitator course using the accelerated apprenticeship model is shown below in Table 1. It is not meant to serve as a single ―right answer" to instructor preparation, but to illustrate at a high-level a focus that is shifted away from covering required competencies and toward fostering actionable knowledge. To execute professional development in a manner consistent with the notional lesson plan, close coordination between instructor developers and instructor cadres is essential. In addition, the Army standards for professional development objectives must be consistent with those for facilitating student-centered learning as described in this report. The notional lesson plan places less emphasis on classroom management activities that are primarily associated with course development, however an analogous lesson plan for developers (and instructor evaluators) could be created. The specific resource demands of implementing the accelerated apprenticeship model require further research, but the model (1) does not necessitate more faculty developers or longer instructor preparation courses; (2) can involve some of the lecture materials and practical exercises already used for instructor preparation; (3) can leverage classroom experiences for the development of learning activities; and (4) attempts to reduce the resource requirements of team teaching through the employment of student teachers and field experiences.

Table 1.
Notional lesson plan for PBL facilitator course

Day	Topic	Development Method
1	Introduction (Course Overview, Instructor Roles, Introduction to Student-Centered Learning)	Direct Instruction, Knowledge Games
2	Reading Students - Monitor & Intervene - Facilitate Collaboration	Classroom Observation #1, After Action Review (AAR), Follow-up Direct Instruction
3		Activities – Cases, Journaling
4	Questioning Strategies - Monitor & Intervene - Facilitate Discussion - Model Problem Solving	Classroom Observation #2, AAR, Follow-up Direct Instruction
5		Activities – Cases, Journaling
6	Facilitate Learning	Field Experience, AAR, Follow-up
7		Field Experience, AAR, Follow-up
8	Specify outcomes Develop problems	Classroom Observation #3, AAR, Follow-up Direct Instruction
9		Activities – Curriculum critique and modification
10	Wrap-up (Future Course Planning)	One-on-one mentoring

Employing activity-based methods as the foundation for instructor preparation would be a natural extension of the practical exercises widely used in Army instructor preparation as conducted by the Army Training Support Center, the Army Intelligence Center, and the Fires Center of Excellence. It also could aid in the development of job aids and professional self-development tools that could be made available Army-wide, online (e.g., in a professional forum such as *Instructor Net*). Moreover, using a situated approach could promote initial and continuous learning by providing feedback to current instructors in a non-evaluative context who in turn would guide instructor candidates. Models of this approach can be found at CGSC and in the current conduct of the ARC. Finally, as has been demonstrated with the CATC, a situated, activity-based approach is among the strongest venues for changing traditional beliefs about teaching, learning, and students as instructor candidates discover the means, accessibility, and utility of student-centered teaching techniques (Borko & Putnam, 1996; Connolly, 2008).

FUTURE RESEARCH

Although comprehensive curriculum reform is possible, it is very difficult, requiring strong leadership and creative approaches that leverage existing resources to make change without increasing costs (Des Marchais, Bureau, Dumais, & Pigeon, 1992). Future research should support the Army's efforts to enhance instructor preparation over the short-term, but also should facilitate lasting change that will have a greater impact on educational quality and achieve the vision laid out in the Army Learning Concept. Research to support short-term improvements should focus on designing activity-based instructor development methods. Research to facilitate lasting change should investigate in depth the organizational factors that influence instructor effectiveness and the impact of investment in institutional education.

Designing Activity-Based Instructor Development Methods

To effectively design activity-based instructor development methods, research must be conducted to elicit and codify instructor domain knowledge as it relates to learning (i.e., andragogical content knowledge). Teacher knowledge elicitation is not new, and a variety of methods may be used, including simulation, commentaries and narratives, concept mapping, and ethnographic studies (Calderhead, 1996). Perhaps the strongest knowledge elicitation method is simulation because it directly assesses situated, actionable knowledge; it does not require instructors to self-report their thinking, does not impose a structure onto teacher thought processes, and is less subject than other methods to the unconscious influence of researcher perspectives. In this method, expert instructors are presented with a series of classroom vignettes that are systematically varied along dimensions believed to influence teacher situational assessment (e.g., student behaviors, classroom features, etc.). For each vignette, the teacher indicates how they perceive the situation and/or what they would do. Variability in teacher responses to each vignette reveals the strength of each manipulated dimension in influencing their behavior.

Aggregated over multiple expert instructors, simulation results can be used as the learning objectives and foundational design specifications for most activity-based methods. For example, if simulations revealed that experienced teachers use student discussion that cycles over and over as a cue for unproductive struggle, student discussions representing varying degrees of this behavior should be featured in cases for instructor candidates to compare, discuss, and reflect upon. To produce valid cues, expert instructors would have to be carefully selected using evaluation criteria that are consistent with student-centered learning and PBL. Where an insufficient number of Army instructors is available, it may be possible to begin with expert civilian instructors whose classrooms best match typical Army learning environments.

To create activity-based methods for PBL, simulations could be designed to reveal cues of student cognitive functioning and group activity in each phase of collaborative problem-solving. As shown in Table 2 below, the actionable knowledge of expert instructors could be examined at each phase, revealing the classroom conditions and instructor actions associated with successful facilitation. To optimally foster actionable knowledge acquisition, simulations should be conducted for each course such that their results are related to the domain knowledge the instructor will use to teach. To manage scope, generalities can be explored after expert knowledge has been elicited over a representative sample of courses. Further research is required to fully define the framework, construct and conduct simulations, and compile results for activity design implications.

Table 2.
Notional Framework for Eliciting Instructors' Actionable Knowledge

Student Behaviors	Phases of Problem Solving				
	Analyze facts, state problem	Generate candidate solutions	Identify and fill knowledge gaps	Apply new knowledge and evaluate	Reflect and abstract lessons learned
Unproductive struggle	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*
Poor organization	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*
Surface-level thinking	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*
Ineffective collaboration	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*	*Conditions / Actions*

Examining Organizational Change Requirements to Support Student-Centered Learning

Although this report provides recommendations for strengthening instructor preparation under current conditions, a comprehensive investigation of the organizational change requirements for supporting student-centered learning should be conducted. Such an investigation should produce a logic model linking the investment of resources to outcomes through the activities and outputs of Army educators (Cianciolo, 2007; McLaughlin & Jordan, 2004). The model should produce a plan for executing multiple, simultaneous "lines of operation" for initial and continuous educator professional development, including instructors, course developers, and instructor evaluators. A notional causal model to frame this kind of research is shown below in Figure 2.

Initiating logic model development by defining outcomes and outputs ensures that the professional development plan enacts Army policy and that activities and resources support policy implementation. Outcomes must be defined such that they can be linked meaningfully to changes in classroom instruction as laid out in the Army Learning Concept. That is, the agility and mission readiness of Soldiers must be conceptualized (and therefore measurable) in a manner that is within the sphere of influence of institutional education. The output represented in the logic model should be Army education as prescribed by the Army Learning Concept such that measures of output reflect the type of classrooms and instruction that are necessary for student-centered learning (e.g., as described in this report).

Activities specified in the logic model should relate directly to producing the desired output, i.e., student-centered learning. They should include selection practices and development methods for instructors, course developers, and instructor evaluators that meet the generally recognized criteria for high-quality professional development. To optimize return on investment in personnel selection, it is necessary to identify the organizational changes required to generate a sufficient pool of recruits to warrant selection practices. Such organizational changes would

include methods for making teaching positions more attractive and rewarding to operational experts. To optimize return on investment in development, it is necessary to identify the organizational changes required to ensure that development is of sufficient duration and scale to enable the use of practice-based and social learning methods.

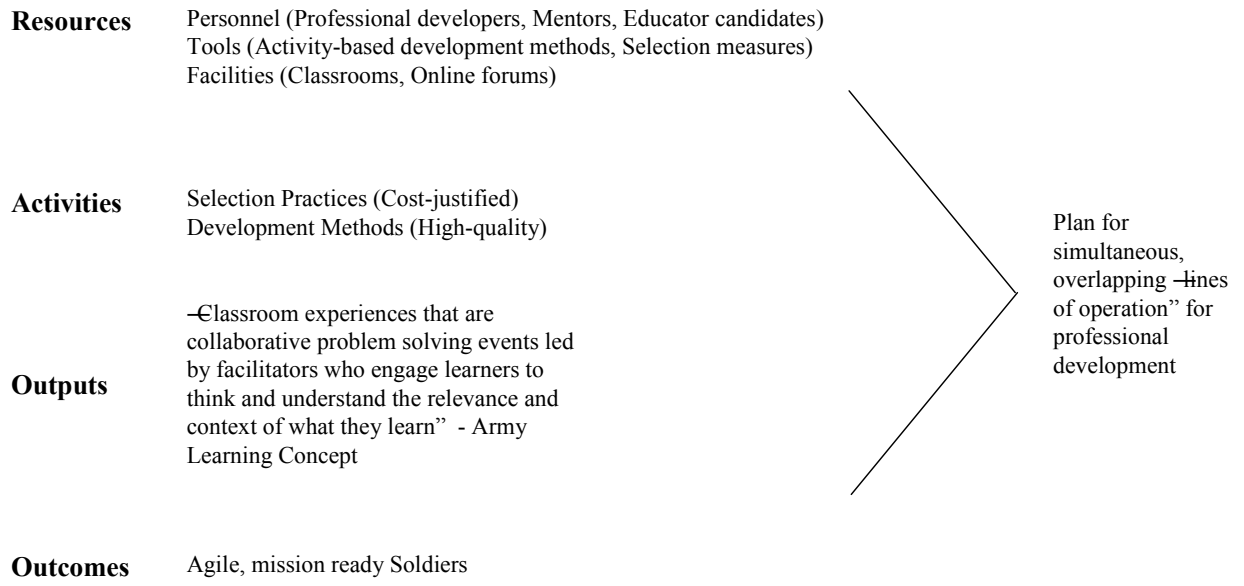

Figure 2. Notional logic model for investigating organizational change requirements.

Defining the necessary organizational changes to implement professional development activities reveals the resources required to achieve desired policy outcomes. The resources that should be investigated include, but are not limited to, personnel, tools, and facilities. Personnel and associated cost requirements should address the requirement to enable (a) supervision of practice-based methods as part of initial instructor preparation; (b) integrated preparatory courses for instructors, course developers, and instructor evaluators; (c) student and team teaching implemented in most Army courses; and (d) a sufficient pool of educator candidates to justify the cost of personnel selection. Tools should include activity-based development methods as well as selection measures and the associated cost of their development. Facilities should include the classroom requirements of providing comprehensive development, including student teaching and field experiences. Facilities also should include online forums used to provide individual and social self-development opportunities. If online forums are provided, the personnel and cost of operating them should be included in the analysis.

Investigating the Operational Need for Changes to Instruction

Although it appeals to common sense that institutional instruction must change to meet the demands of the operational environment, the relation between schoolhouse educational achievement and operational performance metrics has never been investigated. Such an

investigation would determine the metrics necessary to link outcomes to outputs in the logic model used to generate a comprehensive professional development plan. It is possible to expect a relatively weak relation given that (1) operationally relevant learning is done on the job or handled by combat training centers; (2) non-educational initiatives (e.g., synchronizing the Reset and Train phases of the Army Force Generation process) may have a more direct impact on mission readiness; and (3) operational success is most often quantified using global pass/fail metrics. Figure 3 shows four possible relations between schoolhouse educational achievement and operational performance. Although not an exhaustive representation of the possibilities, each of these relations has different implications for (a) the expected organizational return on investment in Army institutional education; (b) the operational performance metrics most likely to demonstrate return on investment in educator professional development; and (c) the knowledge gaps that need to be addressed in order to develop a plan for educator professional development. Each panel is explained in turn.

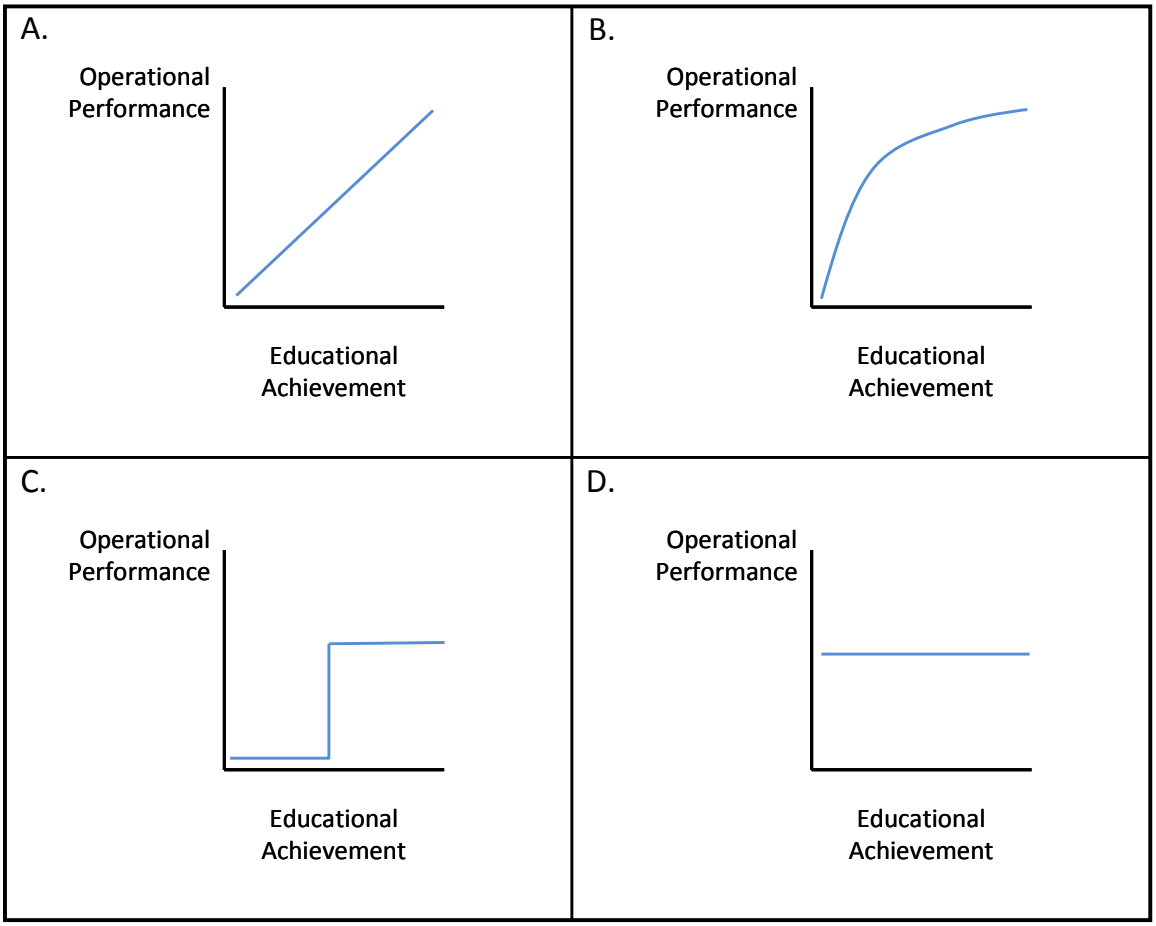

Figure 3. Possible relations between educational achievement and operational performance.

Panel A

The line in this panel indicates that every increment in educational achievement leads to an equal increment in operational performance; operational performance objectives and educational goals are perfectly aligned. This relation is unlikely if measures of operational performance are reliably stable (i.e., generally insensitive to changes in conditions on the ground). This relation also is unlikely if the link between educational outcomes and operational outcomes is indirect. To produce a relation between operational performance and educational achievement as shown in Panel A, operational performance metrics must be defined very precisely in terms of institutional learning objectives, which may limit their utility.

Panel B

The negatively accelerating curve in this panel indicates that relatively minimal educational achievement has a large impact on operational performance and that increased investment in education continues to positively affect performance. There is, however, a point of diminishing returns, suggesting that investment primarily in foundational education would produce the greatest return. The curve in this panel may be more plausible than the line in Panel A, however, the size of the impact of educational achievement may be overestimated (i.e., the curve could be ―shorter" on the y axis).

Panel C

The broken line in this panel indicates that a moderate level of educational achievement is necessary to influence operational performance, but that further investment in education would not affect performance. Investment in reaching moderate levels of educational achievement would produce the greatest return, however peak operational performance is determined by factors besides educational achievement (e.g., materiel, unit cohesion, etc.).

Panel D

The horizontal line in this panel indicates that operational performance is unrelated to educational achievement. Rather, operational performance is entirely determined by other factors, including pressure to report high levels success, materiel readiness, on-the-job training, and chance. In this panel, operational and educational goals are completely out of alignment. If this relation is true, investigation is required to determine how operational performance should be measured and what link it should have to institutional education in order to justify further investment.

CONCLUSIONS

As outlined in the *Army Learning Concept for 2015*, preparing Soldiers to learn from problem-solving experiences requires that Army instructional practices become more responsive to individual student need, better attuned to operational requirements, and more representative of social learning contexts. Army instructors are gatekeepers to the achievement of this vision. Directly involved in classroom conduct, instructors must be prepared to facilitate PBL. The

present research effort investigated the instructor characteristics and competencies required for facilitating PBL, examined best practices in instructor professional development, and assessed the readiness of the Army environment to implement these best practices. Because many of the characteristics and competencies required for PBL also are required for other student-centered learning methods, the findings of this research should generalize across constructivist instructional methods of interest to the Army.

Implementing student-centered instruction, including PBL, requires that Army instructors possess the same characteristics that experts in the complex, continuously evolving field of military operations have. These characteristics include domain knowledge, problem-solving skill, conscientious work habits, and beliefs and personality traits that promote lifelong learning and developing others. Instructor development must grow the classroom management and facilitation competencies that enable instructors to indirectly shape classroom events and respond adaptively to student need. These competencies include organizing and role-modeling problem solving as well as facilitating discussion and collaborative learning. Preparing instructors to facilitate student-centered learning is difficult, and after decades of effort, wide-ranging success remains elusive in civilian learning environments. The Army is poised to demonstrate "what right looks like" with regard to comprehensive educational reform, provided that significant, coordinated changes are made across multiple organizations involved in institutional education.

The current Army environment partially supports instructor professional development and the successful implementation of student-centered learning. It is unknown exactly which courses require student-centered instruction or PBL, and the placement of instructors with the required characteristics into teaching positions currently is not done systematically. Moreover, the current pool of instructor candidates is much smaller than the number of positions available and rigorous selection methods remain to be developed. For these reasons, professional development opportunities other than selection may be the best option for shaping the instructor cadre. Army schoolhouses adopt some recommended development methods, but the ideal approach requires more time and resources than are currently spent on developing facilitators. Consequently, instructor characteristics and competencies cannot yet be expected to meet the requirements for facilitating student-centered learning or PBL.

To promote PBL within the time, personnel, and resource constraints of the current Army environment, basic instructor preparation should be more outcomes-based and student-centered. Methods must be created that can (1) rapidly develop instructors' actionable knowledge for teaching; (2) leverage extant methods used by Army educators; and (3) enable the simultaneous execution of multiple professional development "lines of operation." An accelerated apprenticeship model could reduce time to effectiveness in the classroom and would support the continuous professional development of current instructors. Although not expected to exceed current instructor professional development costs, the resource requirements to implement the accelerated apprenticeship model are unknown. Moreover, the extensive use of activity-based development methods for deliberate practice would require the identification and participation of a limited number of expert instructors to develop instructional materials.

Ultimately, a comprehensive approach to Army educational reform is needed. All implementers of Army education must be prepared to develop, facilitate, and evaluate student-

centered instruction and PBL. Future research that can support the successful, lasting implementation of the Army Learning Concept must include an in-depth investigation of the required resources to execute comprehensive educational reform as well as the likely return on investment in changing Army institutional education.

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APPENDIX A: ACRONYMS

AAR	after action review
ABIC	Army Basic Instructor Course
AMSC	Army Management Staff College
ARC	Army Reconnaissance Course
CATC	Combat Application Training Course
CGSC	Command and General Staff College
ITBI	Inquiry Teaching Belief Instrument
K-12	kindergarten through 12th grade
NEO PI-R	Revised NEO Personality Inventory
PBL	problem-based learning
TPPI	Teachers' Pedagogical Philosophy Interview
TRADOC	U.S. Army Training & Doctrine Command