TEACHING LINGUISTICS

Problem-based learning in introductory linguistics

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This study proposes a design for and examines the effects of a PROBLEM-BASED LEARNING approach to the promotion and assessment of deep learning in undergraduate linguistics education. Specifically, it reports on how the higher-order learning outcomes are achieved by students through a semester-long problem-solving task in an introductory Spanish linguistics course. Specific teaching strategies are described, and achievement is measured by student grades, self-evaluations, and reflections. This approach has proven effective for stimulating such higher-order thinking skills as (i) applying knowledge of the material to solving linguistic problems, (ii) developing skills in research and critical analysis, and (iii) developing a professional work ethic.*

Keywords: problem-based learning, pedagogy, introduction to linguistics, forensic linguistics, higher-order thinking

1. INTRODUCTION. The focus of this research is a novel problem-based approach to teaching an introduction to linguistics course to undergraduate students at advanced levels of Spanish. As is well known to the readership, because linguistics is studied from formal, cognitive, and social perspectives, it represents an intersection between humanities and social sciences (see e.g. Spring et al. 2000). Experience shows that common learning outcomes in introductory linguistics courses are recognition and understanding of concepts and phenomena at the various levels of language structure (i.e. sound, word, sentence, etc.). These skills, however, are considered to be at the lower end of cognitive difficulty and depth of learning (Bloom 1956), leaving the higher-end potential largely untapped. An important part of this reality is due to the fact that linguistics is a relatively young discipline, not normally taught at the high-school level and not required of nonlinguistics majors in college, with the exception of language education majors and laterally related careers such as anthropology and speech pathology. Yet because linguistics is a data-driven, research-based, and highly analytical discipline, it offers many opportunities for development of higher-order thinking skills, including critical thinking, scientific reasoning, and interdisciplinary research and reporting.

The pedagogical innovation presented in this article addresses this issue by proposing a design of the curriculum for and reporting on the incorporation of a PROBLEM-BASED LEARNING (PBL[1]) component into this course, with the purpose of developing precisely these higher-order skills and fostering deeper learning in students of all majors. Specifi-

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[1] 'Project-based learning' and 'problem-based learning' are both abbreviated as PBL and share student-centered and multidisciplinary problem orientation, self-direction, and collaboration as their fundamental aspects (Perrenet, Bouhuijs, & Smits 2000). The distinction is said to be in that project-based learning is focused on application, while problem-based learning is more concerned with the acquisition of knowledge. Thus, project-based learning usually leads to a concrete final product through a more defined series of steps that must be followed. Problem-based learning, by contrast, may lead to multiple possible solutions, some more effective than others, emphasizing instead skill development and critical thinking in the process.

cally, the article presents a semester-long multistep forensic problem, which builds on different pieces of linguistic evidence, and describes its integration into and effect on the progression of the course, from its design to implementation to evaluation. On the one hand, this study addresses the growing interest in innovative and effective pedagogy for teaching linguistics by illustrating and supporting one such method with evidence of student success. On the other hand, it also proposes solutions to some assessment limitations of previous PBL research by focusing on problem solving and deep content learning, together with the more general goals of improved scientific reasoning and professional development as part of the overall mission of higher education.

With these goals in mind, the article is structured in the following way. The background section (§2) defines and situates PBL in the theoretical and historical context, offering an overview of pedagogical evidence on PBL in various disciplines, along with its strengths and limitations, and leads to the motivations and objectives of the present research. The methods section (§3) introduces the course and its objectives, as well as the design, implementation, and assessment of the PBL component. The analysis and results (§4) report on the quantitative grade data and the qualitative student reflections and self-evaluations. The article concludes with a reflection on the importance of such evidence-based pedagogical innovations, with due consideration of issues to take into account in future research and some possible directions for innovations in teaching linguistics, for which there is growing momentum.

2. Background.

2.1. Theoretical background on PBL. Problem-based learning refers to a range of problem-solving and interdisciplinary approaches to teaching, aimed at students' self-directed discovery of knowledge through analyzing and tackling complex, real-world problems with more than one solution (Dochy et al. 2003, Sipes 2017, Stentoft 2017, Walker & Leary 2009). It is a relatively new approach for most disciplines, housed under the larger umbrella of active learning and based on the constructivist theory of learning (e.g. Fosnot & Perry 1996, Savery & Duffy 1995).

Constructivism is an influential learning theory stemming from Piaget's (1955) and Vygotsky's (1978) research into children's cognitive development. Its principles lie in the process of knowledge construction by learners through active cognitive and social engagement (Schcolnik, Kol, & Abarbanel 2006, Yilmaz 2008). Savery and Duffy (1995:31) summarize constructivist principles of learning as (i) interactions with the environment or context (ii) stimulated by cognitive conflict or puzzlement (Piaget 1977) and (iii) evolving through social negotiations (Vygotsky 1978). These principles also define what has come to be known as deep approaches to learning (Baeten et al. 2010). They have further informed the multiple active-learning pedagogical approaches and methods that are in existence today: learner-centered teaching (e.g. Blumberg 2009), self-directed learning (e.g. Garrison 1997), collaborative learning (e.g. Bruffee 1993), project-based learning (Krajcik & Blumenfeld 2006), and problem-based learning (e.g. Savery & Duffy 1995), among others. The motivation behind all of these teaching models is the movement away from the basic conceptual learning (i.e. surface learning) toward higher-order learning processes (i.e. deep learning), such as analysis and critical evaluation, outlined by the influential Bloom's taxonomy (Bloom 1956, Krathwohl 2002).

Active learning has become the definition of good teaching and learning across disciplines, because it deepens and reinforces knowledge by turning concepts into measurable products and outcomes. It defines learning by doing. The advantage of active-learning

pedagogies is further supported by benefits that are independent of content, such as improved academic achievement, interpersonal relationships among the students, perceptions of greater social support, self-esteem, and student attitudes (Prince 2004).

These interdisciplinary benefits are easily translated into general CAREER READINESS for graduating college students. According to the National Association of Colleges and Employers (NACE), eight core competencies define a competitive modern-day professional across most career paths, as summarized in 1.

(1) Core competencies (NACE 2018)
   a. critical thinking and problem solving
   b. oral/written communication
   c. teamwork/collaboration
   d. information-technology application
   e. leadership
   f. professionalism/work ethic
   g. career management
   h. global/intercultural fluency

Development of some of these skills is often an implicit part of various active-learning pedagogies. The PBL approach described in this study aims to improve most of these competencies to a significant extent.

2.2. PEDAGOGICAL BACKGROUND ON PBL: APPLICATIONS AND IMPLEMENTATIONS. PBL was first envisioned and implemented in Canada in the 1950s and 1960s in medical education (Barrows & Tamblyn 1980) and has now become a common teaching method in medicine (e.g. Boud & Feletti 1997, Chakravarthi, Judson, & Vijayan 2009, Solomon & Crowe 2001), engineering (e.g. Lima et al. 2007, Woods 1996), sciences (Arámbula-Greenfield 1996), and economics (e.g. Koromyslova & Garry 2016), and it is currently gaining ground in social and cognitive sciences (e.g. Gallagher & Stepien 1996, Willis 2002). Multiple individual and meta-analysis studies advocate for PBL effectiveness as opposed to traditional lecture-based instruction with respect to long-term retention of knowledge, development of transferable skills, overall satisfaction (Dochy et al. 2003, Harris & Kloubec 2014, Strobel & van Barneveld 2009), interpersonal skills, and rates of graduation and program completion (Schmidt et al. 2009).

In MEDICAL EDUCATION, Solomon and Crowe (2001) conducted a study on student perceptions of a peer-led problem-based physiotherapy course at a Canadian university. During this course, students alternated as group peer tutors in leading content discovery, questioning, and analysis. A qualitative analysis of fifty-six reflective journals revealed that students struggled with taking on these deeper approaches to learning while also developing as independent and responsible group leaders. The personal challenges were nevertheless accompanied by a sense of accomplishment and better preparation for real work in the medical field toward the end of the course. Similarly, Nardi and Cremer (2003) assessed the level of student success in achieving higher-order learning outcomes in an introduction to nursing course. This was done through critical reflective inquiry to promote not only deep learning but also mindful practice essential in the field. A multivariate analysis of sixty-four students' reflexive practice scores and their final grades in the course revealed a strong correlation. Higher-order learning objectives achieved included competent provision of health care, as well as critical thinking, cultural competency, effective communication, and professional role modeling.

In ENGINEERING, PBL has been identified as an ideal teaching method to promote all eleven of the ABET (2013) outcomes that engineering students must achieve, among

which are the ability to apply knowledge, conduct experiments, design a product, function on multidisciplinary teams, solve problems, and more (Felder & Brent 2003). Woods (1996) is an avid promoter of PBL in the chemical engineering program at McMaster University, boasting of the high effectiveness and competitiveness of the program's graduating students due to their highly developed problem-solving skills and adaptability to demanding work environments. Lima, Carvalho, Flores, and van Hattum-Janssen (2007) were specifically interested in student and professor perceptions of the benefits of project and problem components of engineering courses in Portugal. Specifically, they found that students perceived the content of the course to be more easily relatable to other disciplines and skill sets gained from other major-required courses, and that students' motivation increased, their soft skills of collaboration and critical thinking improved, and teacher satisfaction also generally grew.

In SCIENCE, Cheaney and Ingebritsen (2005) explored the use of PBL in an online biotechnology course for a mixed undergraduate and graduate student audience. The study focused on a redesigned five-week unit on genetic diseases and ethical, legal, social, and human issues related to DNA testing. The PBL component was a fictional but realistic case study in which students had to consider medical history and a range of other background factors in order to cooperatively come to a decision to advise a fictitious person on whether to undergo DNA testing. The assessment consisted of a series of inquiry-based assignments and group work, exams, and student evaluations of the unit and self-evaluations of the learning objectives. In this study, the post-unit exam scores were somewhat lower for the PBL instruction than for the lecture-based format, although there were no significant differences in the overall course grades. This was interpreted as due to the inconsistency of assessing lower-level thinking as opposed to the actual problem-solving skills that were practiced. In the final evaluations, these skills were rated between good and excellent in terms of achievement of course outcomes.

In SOCIAL SCIENCE, Gallagher and Stepien (1996) conducted a comparison between traditional lecture-based instruction and PBL-based instruction of American Studies at a high-school level. A total of 167 students were randomly distributed among eight sections of American Studies taught during the same year. Two of the sections, taught by one of the four instructors of the course, were PBL-based. While the other sections continued using traditional instruction, the curriculum of the PBL sections consisted of about 50% dilemmas and inquiry-based activities that had been inserted into the regular curriculum. All eight sections took the same multiple-choice test at the end of the year. The gain scores for conceptual knowledge on the test were either significantly higher or the same for the PBL sections as compared to the control sections, showing potential benefits for long-term retention and no loss of opportunity to learn conceptual knowledge.

The wide variability in implementation of PBL-based approaches is summarized in Sipes's (2017) PBL matrix for data collection and calls for caution regarding different assessment techniques when interpreting its effectiveness (Gijbels et al. 2005, Walker & Leary 2009). Sipes (2017) classifies PBL ENVIRONMENTS as a matrix of various combinations of the curriculum-design variable and the problem-type variable.

- CURRICULUM-DESIGN TYPES (Barrows 1986): lecture-based, case-based lectures, case methods, simulation of an authentic problem, and closed-loop authentic problems
- PROBLEM TYPES (Jonassen 2000): story problems, rule-using problems, decision making, troubleshooting, strategic performance, policy, design problems, and dilemmas

According to this matrix, PBL-based courses can range from low PBL-environment indices (e.g. lecture-based curriculum using story and rule-based problems) to very high indices (e.g. closed-loop authentic problems framed as design problems and dilemmas). This points to multiple possibilities for incorporating PBL into almost any course depending on the discipline's practice and required skill sets at various levels of undergraduate, graduate, and professional education.

2.3. Limitations and practical considerations of PBL. Some PBL implementations have been met with criticism of the imbalance between direct instruction and student self-regulation, especially in disciplines like science and engineering (Kirschner, Sweller, & Clark 2006). Successful problem solving involves a certain skill set that is usually still being developed in students new to the discipline and requires a fair amount of modeling and scaffolding on the part of the instructor (see Hung, Bailey, & Jonassen 2003). Rather than simplify the learning outcomes, Schmidt (1993) addresses the cognitive demands of PBL that stimulate learning and that must be attended to in its implementation, as in 2.

(2) Cognitive demands of PBL (Schmidt 1993)
   a. activation of prior knowledge
   b. active processing and elaboration on prior knowledge through discussion
   c. restructuring of knowledge and construction of an appropriate semantic network
   d. learning in the scaffolding context of a real-world problem
   e. emergence of epistemic curiosity due to real-world relevance

Additionally, there has often been a mismatch between the applied focus of instruction and a contrastively conceptual assessment (e.g. traditional multiple-choice tests), making it difficult to assess the real effect of PBL on deeper learning and resulting in some conflicting literature on its benefits (Belland, French, & Ertmer 2009). While there are often various administrative constraints on the type of assessment used, it is important to keep in mind that if problem solving is the skill being taught, as often is the case in linguistics, an effective assessment should be problem-based as well. In general, however, in spite of some contradictory reports on the effects of PBL on short-term knowledge retention, there is a fair amount of promising evidence of long-term knowledge retention (Dochy et al. 2003, Strobel & van Barneveld 2009). Specifically, even when students in traditional learning environments end up performing better than PBL students on immediate tests, their retention of conceptual knowledge and skills levels out with time (Coulson 1983, Eisenstaedt, Barry, & Glanz 1990). This finding is useful for introductory-level linguistics, where developing strong conceptual knowledge is often the main goal of the course.

Finally, from the student perspective, the ambiguous and ill-structured format of real-world problems commonly results in both a feeling of uncertainty and discomfort with taking on more responsibility for individual learning (Alessio 2004, Hung et al. 2003), on the one hand, and excitement to try something new and different (e.g. Harris & Kloubec 2014), on the other. These conflicting perceptions have added to the criticism of PBL in the literature and to the uncertainty that still exists regarding its effectiveness. There is no doubt that PBL offers considerable promise due to its strong foundation in the science of learning, and it is equally true that its implementation has not yet been mastered. In particular, the issues of scaffolding and assessment must be consciously and effectively addressed at the teaching end of its implementation, and the present study intends to illustrate this for an introductory linguistics course.

2.4. Research motivation and objective. At the moment, no research exists on the PBL approach to teaching linguistics, though outreach efforts involving college linguistics students (e.g. Fitzgerald 2010, McKee et al. 2015) and project-based curricula (Bateman 2019) are likely to provide students with some of the same benefits. Turning a content-heavy survey of several subfields of linguistics into a cohesive active-learning environment presents its challenges, and best practices are still emerging. One logical reason for this is that introductory courses are traditionally designed as general surveys of basic concepts that are critical for continued study in upper-level courses. The goal of simply understanding and remembering such concepts for future application is therefore consistent with lower-level thinking skills and objectives (Bloom 1956, Krathwohl 2002). Introducing higher-order objectives, such as application and critical analysis, into an introductory course is not common but is not actually contradictory to this goal. First of all, application and analysis strengthen understanding of the concepts by necessarily putting them into practice and showing their potential for future applications. These future applications, in turn, also vary. Introductory courses in general are exploratory for many students in search of a major, so an introductory linguistics course may either remain a student's only experience with the field or turn into a stepping stone for further career development. Linguistics as a science offers valuable life and research tools to both types of students, majors and nonmajors, which makes the introductory course even more important.

With these considerations in mind, it is the position of this researcher that it is neither enough nor desirable that linguistics students finish an introductory course with only basic familiarity with an array of concepts that are not readily connected to each other, to other courses, to students' varied career paths, or to the problems of the real world. In the spirit of promoting linguistics education as general education, linguistic outreach possibilities, and active-learning pedagogies, the present study attempts to fill the gap by offering a design of a PBL-based introductory linguistics course. Additionally, it addresses some of the assessment limitations of previous PBL research by focusing on problem solving and deep content learning specifically, together with the more general development of scientific reasoning and professional development.

3. Method: PBL applied to introductory Spanish linguistics.

3.1. Introduction to Hispanic linguistics. The pedagogical innovation of incorporating PBL into introductory linguistics is illustrated with an advanced, third/fourth-year undergraduate course in Spanish linguistics at a large US Midwestern university. The course is a requirement for Spanish majors and minors, to be chosen from three content-based courses on literature, culture, and linguistics. It is taken after students have completed intensive grammar training in the first two years. While these students are at the advanced levels of their language education, most of them do not have any linguistics training, making this an introductory course in terms of content.[2] The following course description has been adapted to the course under investigation, with the highlighted elements unique to the sections designed and taught by the author and referring to the incorporated PBL component:

[2] At the institution under investigation, this course is taught by a large number of graduate students and faculty, resulting in a fair amount of variation in teaching styles and curricular implementation, as well as varying assessments. The unifying factor is a relatively general course description that guides the curricular and assessment decisions in order to ensure that the courses are comparable in quality. The particular course objectives, however, may vary slightly, as is shown for the PBL sections in §3.2.

> This general introduction to Hispanic linguistics has as its objective to help students understand and appreciate the linguistic system that we use to codify the world around us and to communicate among each other. The course is designed to introduce basic concepts of linguistic theory and methodology and to put them into practice in **various projects that linguists use in real life**. The class time will be divided among presentation of information, practical exercises and discussion while homework will include reading, videos, and **written projects** to reinforce and advance learning. [my translation, emphasis added]

While there is some variability in the branches of linguistics covered in course sections taught by different instructors, those covered in the present curriculum include pragmatics, morphology, syntax, phonetics, phonology, and sociolinguistics—in this order. The present study focuses on this particular course structure as illustrative of a PBL curriculum and does not explicitly compare it to other sections that are typically taught at this or other institutions.

3.2. Course objectives. The course description has been translated into a set of seven learning outcomes for the PBL-based sections, summarized in 3, ranging from lower-order to higher-order cognitive mastery.

(3) Learning outcomes for PBL-based course sections
   a. Distinguish among different levels of linguistic analysis (word, sound, etc.)
   b. Understand basic concepts of pragmatics, morphology, syntax, phonetics, and phonology
   c. Understand regional and social variation in the Spanish-speaking world
   d. Apply knowledge of the material to solving linguistic problems
   e. Develop basic skills in research and critical analysis
   f. Develop professional ethics related to scientific work
   g. Prepare for other courses in Spanish, linguistics, or Hispanic linguistics and your professional career

Learning outcomes 3d–f, added to the author's sections of the course specifically to foster PBL, correspond to the higher cognitive processes of applying, analyzing, and evaluating from the revised Bloom's taxonomy (Anderson & Krathwohl 2001), as well as procedural and metacognitive dimensions of knowledge. It is at these levels that learning becomes deep and turns into transferable knowledge and skills, and PBL pedagogy is an effective way to promote it.

3.3. The PBL component in introductory linguistics.

Design. The PBL component of the course takes the shape of a semester-long case study modeled on an authentic problem in modern-day forensic linguistics. Forensic linguistics is a practice of 'applying rigorous, scientifically accepted principles of linguistic analysis to legal evidence' that is at least in part language-based in nature; this includes plagiarism, contracts, confessions, anonymous texts, and phone calls, among many other cases (Leonard 2006). The problem introduced at the beginning of the semester describes a missing-person case under investigation by the police, and throughout the course leads are presented that include limited but varied linguistic evidence: text messages, social media presence on Twitter, recordings of interviews with persons of interest, and a voice message from an alleged kidnapper. All characters and most of the linguistic evidence used for this simulated case study come from a freely available Spanish Proficiency Exercises website at the University of Texas at Austin (Kelm n.d.). The anonymous threat message was fabricated, and Twitter accounts were selected on the basis of geographical area and gender in order to match the characters' backgrounds.

The particular case study presented to students was designed in such a way that, due to missing pieces of information, no student would arrive at one true solution, although they were not aware of this. However, some would get closer than others as a result of quality of work, systematic analysis, and reasoning. This design was intended to place more emphasis on the process and the development of critical thinking necessary at each stage of the investigation, allowing student progress even for those who did not perform as well on the initial analyses. Since this approach is experimental in this instructional environment, it currently lacks control-group comparison, but it addresses the fundamental issues of PBL as a skill-building and deep-learning approach to teaching.

Implementation. The case study was introduced with an early discussion of the scientific method, scientific reasoning, and critical thinking required for data analysis, interpretation, evaluation, and reporting. A rubric and a model of a forensic report were discussed in class, and students were encouraged to collaborate on the data analysis in order to make sense of each subproblem. See the appendix for sample instructions and a forensic report template (these are also provided in separate PDF format at http://muse.jhu.edu/resolve/93).

Pieces of linguistic evidence for the case were presented to students in five stages, as five subproblems, each toward the end of a content unit: pragmatics, morphology, syntax, phonology, and sociolinguistics. Students were expected to review and use the factual and conceptual knowledge they had gained and practiced early in the unit to narrow down the suspect pool through critical analysis and scientific forensic reports at each stage. Each forensic report builds upon and tests the students' previous hypotheses, always requiring them to support and critique their reasoning, and resulting in an informed verdict at the end of the semester. Table 1 outlines the timeline of the case with respect to the content units of the course.

CONTENT UNIT	CASE STORY LINE	LINGUISTIC OBJECTIVE	REAL-WORLD OBJECTIVE
1. PRAGMATICS	The missing person's cellphone is recovered with a chat history that produces 8 persons of interest.	Speech acts, conversational maxims, implicatures, register	Identify relationships and intentions of 8 persons of interest.
2. MORPHOLOGY	An anonymous threat message appears on the recovered cellphone, deemed to be from the kidnapper.	Morphemes, parts of speech, composition, inflection, derivation	Determine gendered style of the anonymous text (Krawetz 2006, Lakoff 1973, Newman et al. 2008).
3. SYNTAX	Twitter accounts of the 8 persons of interest have been identified.	Lexical and grammatical categories, syntactic phrases, syntactic and semantic roles, verb categories	Determine level of neuroticism and psychological inclination toward criminal activity (Boduszek et al. 2013, Oberlander & Gill 2004).
4. PHONETICS AND PHONOLOGY	Video recordings of interviews of the 8 persons of interest become available as well as police evidence that the missing person has been taken to the country of origin of the alleged kidnapper.	Articulatory description of consonants, phonemes, allophones, phonetic transcription	Determine the dialect and country of origin of the main suspect so far.

(Table 1. *Continues*)

CONTENT UNIT	CASE STORY LINE	LINGUISTIC OBJECTIVE	REAL-WORLD OBJECTIVE
5. SOCIOLINGUISTICS	The number of the anonymous threat message leads to a tapped telephone conversation (voice message) of the alleged kidnapper.	Graphemes, phones, dialectal phonological variation, social evaluation of phonological traits (stigma, prestige), social factors of sex, age, and education level	Reverse-transcribe the transcribed spectrogram signal and analyze represented sound patterns for dialectal and social features such as sex, education, and age. Determine whether it matches the main suspect or another of the persons of interest.

TABLE 1. PBL case-study timeline with respect to the course organization and objectives.

The design of the case as an ill-structured problem resulted in different students developing different opinions throughout the semester, which especially invigorated their search for truth and the problem-solving competition toward the end. In this particular case, none of the eight persons of interest was actually the kidnapper, and the linguistic evidence presented as that of the kidnapper had been produced by the missing person herself (or rather the selected character). This was a conscious decision made early on by the instructor in order to motivate critical thinking and encourage discussions about research and the scientific approach to data analysis and presentation.

According to Sipes (2017), this particular implementation of PBL may be placed midway between well-structured and ill-structured problems and dilemmas, as it allows multiple paths toward multiple possible solutions, which are presented in an organized way and are ultimately limited (cf. Jonassen 2011). The curricular implementation can be classified as a hybrid problem-based case method, in which the problem is introduced prior to content and is used throughout the course to reinforce content, with students finally evaluating their reasoning at the conclusion of each problem-solving stage (Barrows 1986). The solution (unexpected by students but logical) is revealed to students at the very end of the course, prompting critical discussion of the scientific method and self-evaluation of the skills necessary for successful problem solving.

In order to avoid the pitfalls faced by previous studies (cf. Hung et al. 2003) and to address Schmidt's (1993) outline of a suitable cognitive environment for PBL (i.e. activation of prior knowledge, active processing and restructuring of knowledge, scaffolding in context, and motivating epistemic curiosity), several measures were implemented to ensure students' successful development of the skills involved in problem solving. These can be classified into the four support areas summarized in Table 2.

PBL SUPPORT AREAS	HELPFUL IMPLEMENTATION STRATEGIES
Scaffolding, structuring, and modeling	• Initial whole-class workshop on the scientific method • Early semester presentation and discussion of case-study context, procedure, and expectations • Modeling of linguistic analysis and report process • Using the same report template and rubric for all five reports: objective, data, analysis, interpretation, and preliminary conclusion, limitations, and future directions
Sufficient preparation time	• Review of unit concepts at the time of presentation of new linguistic evidence and strategizing • Allowing at least one week for students to delve into the problem, ask questions, and write up a well-reasoned report
Collaboration and discussion	• Permission to collaborate on the analysis portion of the report, but with an individual write-up (adaptable) • Some follow-up class discussion on the progress, without revealing the 'correct' answer

(TABLE 2. *Continues*)

PBL SUPPORT AREAS	HELPFUL IMPLEMENTATION STRATEGIES
Assessment and feedback that ensures development	• Grading the process on completeness, accurate use of unit terminology and concepts, and soundness of reasoning and support of each claim • Timely feedback (before introducing the evidence for the next report)

TABLE 2. Helpful implementation strategies to support successful student learning in PBL.

These strategies reinforce the focus on skill building with the consideration of the scientific method and a systematic approach to research and reporting. This approach also entails a move away from the comfortable but simplistic view of problem solving as finding one 'right' answer in favor of fostering critical thinking, which is what PBL is truly meant to promote and assess.

ASSESSMENT. To address the criticism of prior studies that failed to test deep learning and problem solving (Belland et al. 2009), the forensic reports were designed as a tool to develop and to assess these skills at the same time. The rubric, given in Table 3, provides some help for the students to structure their thinking and writing processes as part of developing professional ethics in scientific work, one of the higher-order course objectives. Most importantly, 75% of the grade is dedicated specifically to the analysis and discussion sections, in which the problem has to be deconstructed; evidence broken down, evaluated, and synthesized; and preliminary conclusions made—all based around the key concepts of the unit.

CATEGORY	SPECIFIC CRITERIA	QUALITY
Format and general completeness	• At least 300 words of own narrative (complete and connected sentences, with appropriate grammar and lexicon) • At least 4 paragraphs: (1) Introduction and objective, (2) Analysis and results, (3) Discussion, and (4) Preliminary conclusion and future directions • Completes all parts (answers every question) • Cites sources and includes a bibliography	**5%**
(1) Introduction and objective	• Describes the problem to be solved and how it is proposed to solve it • At least 3 complete and connected sentences	**5%**
(2) Analysis and results	• Follows the instructions for the analysis: deconstruct the problem, select evidence, analyze, synthesize, and interpret the evidence	**30%**
(3) Discussion	• Explains the results of the analysis in narrative form • Argues the importance of the results in relation to the objective • Supports the arguments with concrete examples from the data • Uses terms and concepts from the unit appropriately	**45%**
(4) Preliminary conclusion and future directions	• Summarizes what was most important in the analysis • Connects the analysis with the objective of the report • Mentions limitations and possible future directions • At least 3 complete and connected sentences	**10%**
(5) Bibliography	• Cites sources of the data and referenced materials	**5%**
Comments & Grade		

TABLE 3. Forensic report guidelines and rubric (translated from Spanish).

Each forensic report is followed by an in-class conceptual quiz (multiple-choice, matching, and short-answer format) as another measure of content learning. These quizzes are used to assess the short-term effects of PBL on content-knowledge retention. For an approximation to long-term retention, a cumulative midterm and a final exam use a compilation of previous quiz questions with modified examples. Finally,

students complete self-evaluations of their mastery of the course objectives at the halfway point and the ending point of the semester, and also submit a final reflection on the effects of PBL on their learning and on their personal, professional, and academic development more generally.

4. Analysis and results.

4.1. Grade performance and long-term retention. Given the exploratory nature of this pedagogical experiment, the quantitative data are limited to the grades observed within the experimental sections without group comparisons. Overall, forensic problem solving proved to be the most challenging part of the entire course for the students, as illustrated in their reflections (§4.2), which are also consistent with Hung et al.'s (2003) and Alessio's (2004) reports on student discomfort with ill-formed problems. In fact, earlier studies tracking enrollment and attrition rates noticed that, in general, less than 50% of students selected the PBL track when a traditional lecture-based track was available (Albanese & Mitchell 1993). What may further complicate the issue of enrollment is that linguistics courses in comparison to other general education courses are known to have lower enrollments (Spring et al. 2000). Given the short two-semester lifespan of the current pedagogical experiment and the lack of a formal control group, no statistics on course completion and withdrawal rates are available at this time, although based on the author's teaching experience at the same institution, there was no noticeable difference in completion and withdrawal rates in the PBL sections compared to the others.

According to Belland et al. (2009), if the purpose of PBL is to promote deep content learning, the appropriate assessment should evaluate not students' basic knowledge of content but their ability to apply that content to previously unseen real-life situations. Appropriately, each forensic report was meant to address new pieces of evidence that would encourage students to review the unit material and apply it in new ways to get a little closer to solving the mystery. Reports were completed at home and submitted right before the more traditional in-class quiz testing conceptual knowledge, serving as a treatment and an assessment at the same time.

Table 4 demonstrates that students performed as well on the quizzes as on the forensic reports (B average), checked by a repeated measures pairwise *t*-test ($t = 0.706$, $p = 0.485$). This is not surprising, given that the two assessment techniques engaged conceptual knowledge at different levels: the quizzes tested understanding and mechanical application of practiced skills on practiced examples, while the reports required students to use that knowledge to complete complex tasks. Therefore, increased time-on-task and attention for elaboration in the PBL component yielded results that are not significantly different from those of an in-class quiz, which is more controlled but did not provide students the opportunity for elaboration. According to Dochy et al. (2003), it is this attention for elaboration that is likely to lead to better retention of knowledge. While time-on-task and elaboration are not exclusively PBL traits, they are definitive aspects of it.

		GRADE AVG
PBL FORENSIC REPORTS	Application of conceptual and procedural knowledge	83.6%
UNIT QUIZZES	**Short-term** retention of conceptual knowledge	85.9%
CUMULATIVE EXAMS	**Long-term** retention of conceptual knowledge	85.1%
OVERALL COURSE SUCCESS	(including participation, oral presentations, homework readings, and drill exercises)	86.7%

TABLE 4. Assessment of student success in grade averages with respect to short-term and long-term retention of conceptual knowledge (out of 100%); $n = 35$ students.

In a way, the forensic reports were a treatment whose immediate effects on short-term retention of conceptual knowledge could be measured via the quizzes. However, most existing study techniques are capable of producing such short-term effects, and one of PBL's celebrated advantages is long-term retention. For example, Strobel and van Barneveld's (2009) meta-analysis of PBL effects highlights a clear long-term advantage on post-tests of twelve weeks (Coulson 1983) to two years after instruction (Eisenstaedt et al. 1990). One approximation to measuring long-term effects over the course of the semester in this study is comparing quiz scores with midterm and final cumulative exams. The midterm exam was given at the end of the first three units with their corresponding forensic reports (the end of week 8). The final exam was completed at the conclusion of all five units and forensic reports (week 16), more than twelve weeks after the first material had been learned. Given the cumulative nature of these exams and a general tendency for memory to decline with time, it is encouraging to observe the high retention levels of this knowledge that are suggested by the unchanged average scores between quizzes and cumulative exam grades ($t = 0.728$, $p = 0.471$). The nonsignificance of differences in these scores suggests that there is no significant change between short-term and long-term performance within the semester.[3] This quantitative evidence supports the proposal of incorporating higher-level cognitive outcomes into introductory-level courses such as linguistics, in spite of their main focus on conceptual knowledge development. While understanding of concepts is found at the lower end of cognitive difficulty, evidence points to a comparative level of development of this skill through higher-order tasks such as application and analysis, which additionally has a desired lasting effect. It is important to acknowledge that the absence of a control group in this study makes these conclusions tentative but worth replicating in the future. Additionally, follow-up studies focused on later post-tests, such as in Coulson 1983 and Eisenstaedt et al. 1990, are certainly necessary.

4.2. Student reflections on PBL. Similar to many prior studies on PBL (e.g. Solomon & Crowe 2001), the best support for PBL as an effective reinforcement of conceptual knowledge comes from the students' end-of-semester reflections on their experience with forensic reports as the main PBL course component. When asked about the role of forensic reports in their achievement of course objectives, student reflections consistently coincided with the previous literature on two main counts: the reports were said to be very challenging, yet an effective way to connect all course units to each other and to the real world outside of class.

All of the reflections combined were analyzed qualitatively in a bottom-up approach: all comments were tagged for content and grouped by similarity, producing seven categories identified by the students as positive effects of PBL on their learning and growth and one category identified as a negative effect. Table 5 lists these from most to least frequently mentioned (raw counts are given in the first column), with accompanying illustrative comments from the students from Fall 2016 and Spring 2017.

As Table 5 shows, it is not the case that forensic reports had no negative effects. The category identified as a negative effect from the student comments is labeled 'difficulty' (raw count of ten mentions by different students). As seen in comments (p)–(r) of Table 5, students from both semesters repeatedly used the words 'hard', 'challenging',

[3] The only statistical difference between the pairs of pairwise *t*-tests is between the distribution of the cumulative exam grades and the overall course grades ($t = 2.70$, $p = 0.015$), which takes into account and is likely to be due to various non-PBL course components such as attendance, participation, and homework completion.

	REPRESENTATIVE STUDENT COMMENTS (keywords used for categorization purposes are highlighted)
MENTIONS: 14 BENEFITS: Hands-on application of course material	(a) They were beneficial because they forced you to actually **APPLY** what you were learning. Oftentimes, we learn things and have no idea how they could be **applied** to the real world, but working with this approach definitely provides a better understanding & makes it more interesting/engaging. (Fall 2016) (b) In terms of the forensic reports, it was something that we could do to **apply** what we are learning to a real world situation in a **hands-on** way. While a lot of it was complex and confusing, it truly challenged us in a good way to work through what we knew and use the resources provided for what we didn't know … (Spring 2017)
MENTIONS: 10 BENEFITS: Deeper understanding of content	(c) I think this approach helped me really **delve** in to the topic and gain a **better understanding** because it provided a greater sense of urgency. I learned **more about the material** because these projects required me to **further my depth of knowledge** and apply it to a real-world problem rather than just a test. (Fall 2016) (d) I found that they were really challenging, but they made me apply the content in a way that made it **much more memorable**. By doing these reports, I was given the opportunity to critically use what we learned in class and it gave me a **deeper understanding of the content**. (Spring 2017)
MENTIONS: 9 BENEFITS: Real-world connection	(e) … I did think that the forensic reports did a good job having us actually apply what we are learning to **real-world problems**. It gave us an idea of how what we are learning can be used in the **work force**. (Fall 2016) (f) I thought that the [forensic reports] were a great way to apply the lessons we had learned in class to **real life situations**. (Spring 2017)
MENTIONS: 6 BENEFITS: Professional writing	(g) … I had to **explain and back up my reasoning** to every answer. [translated] (Fall 2016) (h) … I feel like they also helped learn how to **site** [sic] **sources correctly in APA format**, because I have never had to site APA before I started college… (Spring 2017) (i) … I had to learn how to **professionally convey my answers**, and the reports helped me do that. I think with each report I got a little better and understood what worked well and what did not … (Spring 2017)
MENTIONS: 4 BENEFITS: Critical thinking	(j) I found these activities beneficial because it not only helped me learn the topics of the class, but it taught me valuable lessons on **problem solving, critical thinking, and tackling a task that may seem overwhelming**. These activities benefited me more than a classic 'fill in the blank' worksheet because it gave me **insight on how to face problems in the real world** … (Fall 2016) (k) … The reports were a challenge, yet still helped develop **critical thinking skills** as well as **professional growth**. (Spring 2017)
MENTIONS: 3 BENEFITS: Motivation	(l) They helped me because they gave me a **reason to do my work as best as I could** because they showed me that I could **actually use this material in the future**. (Fall 2016) (m) For me, I like to see how things would be used in a daily context, so by being able to play the role of an investigator I think **I became more invested in the learning** because I was **really trying to discover** who was responsible for Clarena's disappearance … (Spring 2017)
MENTIONS: 2 BENEFITS: Attention to detail and instructions	(n) The forensic reports helped the most because you really had to put in **a lot of effort** to finish it. (Fall 2016) (o) … The [forensic reports] also helped me **work through a lot of data and break it into smaller steps** in order to solve the objective … (Spring 2017)

(TABLE 5. *Continues*)

	REPRESENTATIVE STUDENT COMMENTS (keywords used for categorization purposes are highlighted)
MENTIONS: 10 NEGATIVE EFFECTS: Difficulty	(p) I think the most beneficial (and **tedious**) were the forensic reports. They made me put into action why people study linguistics and it helped to remember and solidify all that I knew about the topic even **as much as I didn't want to do them**. (Fall 2016)
	(q) Personally I was **not the biggest fan** of the [forensic reports], but I did think that they did a good job having us actually apply what we are learning to real-world problems. It gave us an idea of how what we are learning can be used in the work force. (Fall 2016)
	(r) I think the forensic reports were a great gauge of how well I understood the content. Each report was **challenging-** I had to struggle and work through every one. When I understood the content better, the report went a little more smooth. I think the reports were useful to further understand the content in an applicable situation to prepare for the quizzes. I had to learn how to professionally convey my answers, and the reports helped me do that. I think with each report I got a little better and understood what worked well and what did not. The reports were a **challenge**, yet still helped develop critical thinking skills as well as professional growth. (Spring 2017)

TABLE 5. Student-identified categories of PBL benefits and challenges for learning and growth.

'tedious', and similar paraphrases, including 'copius [sic] amounts of time', 'I was not the biggest fan', and 'as much as I didn't want to do them'. Most of these comments, however, were accompanied by an acknowledgment of the benefits in spite of the difficulty of the assignments, underlined in (p), (q), and (r). What makes reflection entry (r) particularly important is that it comes from a student whose average grade on forensic reports and unit quizzes was around 75%. It is encouraging that the imperfect scores did not impede this student from trying their best on each of the five problems, still learning to become better at the process itself even if not always getting every concept right.

4.3. STUDENT SELF-EVALUATIONS. In addition to these open-ended reflections on forensic reports as the main PBL course component, students also turned in self-evaluations of their mastery of the course objectives and various skills they had learned or improved on in this course. Learning outcomes d, e, and f (reproduced from 3 above) correspond to the higher cognitive processes of applying, analyzing, and evaluating from the revised Bloom's taxonomy (Anderson & Krathwohl 2001), as well as procedural and metacognitive dimensions of knowledge. On average, students from the two semesters reported having gained mastery on the lower- and higher-order course objectives at a 4 on a scale of 1–5 (1 = not met, 5 = met very well), meaning that they felt they had met these objectives well. The accomplishments were especially felt for the lowest-order learning objectives (a, b) and two of the three higher-order learning objectives (e, f) that are given in boldface. The self-evaluation ratings are summarized in 4, from highest to lowest personal accomplishment (Fall 2016 and Spring 2017).

(4) Student self-evaluation ratings of learning outcomes, ordered from highest to lowest
   e. Develop basic skills in research and critical analysis [4.2/5]
   b. Understand basic concepts of pragmatics, morphology, syntax, phonetics, and phonology [4.2/5]
   f. Develop professional ethics related to scientific work [4.1/5]
   a. Distinguish among different levels of linguistic analysis (word, sound, etc.) [4.1/5]
   g. Prepare for other courses in Spanish, linguistics, or Hispanic linguistics and your professional career [4.1/5]

c. Understand regional and social variation in the Spanish-speaking world [4.0/5]
d. **Apply knowledge of the material to solving linguistic problems [3.9/5]**

It is worth mentioning that the student author of reflection (r) in Table 5, while acknowledging their underperformance on the higher-order objectives, also felt the biggest improvements in developing basic abilities for research and critical thinking (objective d) and professional ethics related to scientific work (objective e) from midterm to final self-evaluation. This speaks to PBL's ability to benefit students of different aptitude levels and to truly promote transferable skills that go beyond content and discipline.

Finally, the students were asked to describe their personal achievements in the areas of professional development, learning strategies, and communication. The most frequently mentioned achievements from both semesters include linguistic knowledge for everyday life and work, self-regulated learning, collaboration and communication skills, work ethic, and time management, as illustrated in Table 6.

PERSONAL ACHIEVEMENT CATEGORIES	Fall 2016 (n = 20)	Spring 2017 (n = 15)	TOTAL (n = 35)
PROFESSIONAL DEVELOPMENT			
• Spanish/linguistic knowledge for everyday life and job	13	2	15
• Professional communication	9	1	10
• Work ethic, time management, and autonomous learning	6	4	10
• Collaboration skills	4	2	6
• Relationship with instructors	3	2	5
SUCCESS STRATEGIES			
• Self-regulated learning (autonomous, active learning, asking questions, and use of resources)	11	4	15
• Time management, preparation, and organization	10	2	12
• Learning to know and understand, not for a test	4	2	6
• Note taking and constant review	4	1	5
COMMUNICATION			
• Collaborative communication with peers	12	3	15
• Public speaking, self-confidence, and self-expression	7	4	11
• Communication with instructors	7	4	11
• Context-appropriate communication (dialectal and situational/pragmatic differences)	5	2	7
• Oral/listening Spanish skills (language proficiency)	5	1	6
• Written Spanish skills	3	1	4

TABLE 6. Summary of self-reported professional, academic, and personal achievements (Fall 2016 and Spring 2017).

These transferable skills correspond to five of the core career competencies established by NACE, and even though not mentioned by students, application of information technology and global/intercultural fluency were also practiced throughout the investigation by way of problem design.

5. CONCLUSION. In conclusion, the problem-based approach to introduction to Hispanic linguistics described here has proven effective for stimulating such higher-order thinking skills and learning objectives as (i) applying knowledge of the material to solving linguistic problems, (ii) developing basic skills in research and critical analysis, and (iii) developing professional ethics related to scientific work. A simulated forensic investigation provided the context for the content to be learned and the skills to be improved in the course for students of different majors. This context required putting basic conceptual knowledge to work on a set of ill-structured subproblems, which acted si-

multaneously as practice and assessment of higher-order thinking skills. With an appropriate amount of scaffolding, preparation time, collaborative support, and feedback, students were able to improve their short-term and long-term conceptual knowledge, practice their problem-solving skills and critical thinking, and develop a range of interdisciplinary transferable skills crucial in the twenty-first-century world of work (NACE 2018). As with most previous studies, qualitative reflections provide the most direct evidence of PBL's effectiveness, and more quantitative analyses are still needed to advance this research.

There are two main future directions for this study, to be addressed together or separately: further investigation of PBL and more evidence-based research into teaching linguistics. Given the wide range of PBL implementations and assessments in the literature across disciplines, more quantitative analyses and reliable results will be possible once the methodology is streamlined (cf. Belland et al. 2009). Furthermore, PBL still needs to be tested and improved with social sciences and the humanities, which so far remain on the periphery of disciplinary research. Additional attempts at a PBL approach to teaching linguistics would help to address that gap, as linguistics is often found at the intersection of social sciences and humanities. Beyond that, however, linguistics as a field is still relatively new to the scholarship of teaching and learning (SOTL)—whether with PBL or other active-learning approaches. Drawing from the current study and the current trends in SOTL, some concrete steps to add to the evidence-based research on teaching linguistics include strengthening research design to incorporate control-group comparisons, longitudinal data, and other more objectively measurable and quantifiable data. For example, accounting for student individual differences, such as aptitude, and any instructor individual differences would enable the effects of pedagogy to be measured more directly. Replications and extensions of this and other existing studies (e.g. Fitzgerald 2010, MacKenzie 2018, Sanders 2016) would provide opportunities for further comparison of different pedagogical approaches to teaching linguistics. The ultimate benefit of these efforts would be maximizing the impact of linguistics at various levels of formal education and out in the public.

While the specific case study utilized in this course is most directly related to the teaching of linguistics, it is also adaptable and generalizable to other humanities, social sciences, and STEM disciplines as discovery-driven and problem-solving approaches to content mastery. Readers are encouraged to refer to Sipes 2017, which presents a range of possible ways to incorporate PBL to the appropriate degree and in a manner most suitable to the discipline, from a case-based lecture to a course-long inquiry-based dilemma. Research into types, implementations, and effectiveness of PBL is still at a growing and experimental stage, but PBL is a promising direction for teaching and learning that should be explored further.

Appendix: Forensic report 1 instructions and template (translated from spanish)[4]

S326 Forensic Report 1: Introduction to the Case Study

Below you will find a police report with preliminary information about a specific case. Analyze the evidence that we have so far, following the instructions of the detective and using the material of the Pragmatics unit. Write a 300-word report that meets the expectations of the rubric.

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CASE STUDY: DISAPPEARANCE

[Police Report]

- Name: Clarena X
- Residence: XXX, University of Texas, Austin
- Country of origin: Colombia
- Date of birth: XX/XX/XXXX
- Height: X'XX
- Weight: XX kg

Crime details: Clarena X was reported missing on September 13, 2016 by Analucía A, a friend and a classmate at the University of Texas, Austin.

Results of the residence search:

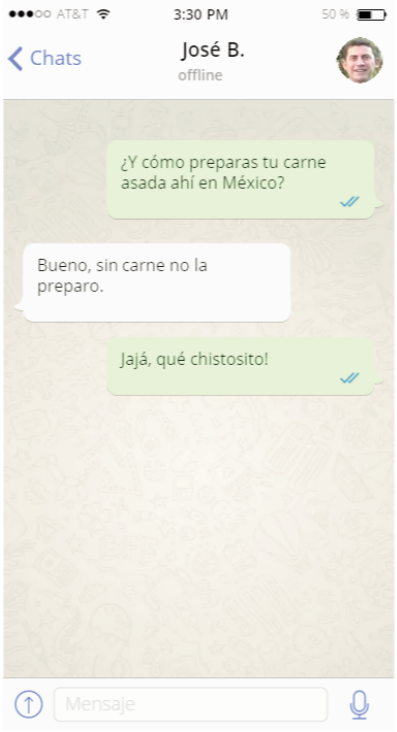
- Clarena X's personal cellphone
- 8 recent text messages

Objective: Identify the suspects via a pragmalinguistic analysis of identity and intentions of recent contacts

Analysis: Language functions, speech acts, registers, conversation maxims, implicatures

Data:

A.



B.

C. Karla C. <omitted for space purposes>
D. Alberto D. <omitted for space purposes>
E. Isabel E. <omitted for space purposes>
F. Fernando F. <omitted for space purposes>
G. Emilia G. <omitted for space purposes>
H. Antonio H. <omitted for space purposes>

REPORT TEMPLATE (for Forensic Report 1)

Name Lastname
S326
Forensic report _#_

1. Introduction and objective

Describe the problem to be solved (what do you know, what do you not know) and how it is proposed to solve it. Use the information from page 1 and reformulate it, using complete sentences (at least 3 sentences).

2. Analysis and results

Complete the schematic analysis of the data (this part can take shape of a list or a table; it is not necessary to use complete sentences). For the Forensic Report 1, use the following table to organize your analysis:

Summary of data

Name of the contact (person of interest)	**Language functions** (phatic, factitive, directive, performative, expressive, ludic, metalinguistic)	**Speech acts** (compliment, disagreement, apology, greeting, request, promise, invitation)	**Register and relationship** (more/less formal: close friends-acquaintances-strangers)	**Observation and violation of conversational maxims** (quality, quantity, relevance, manner)	**Implicature** (implicit meaning that can be inferred from an indirect formulation)
A.					
B.					
C.					
D.					
E.					
F.					
G.					
H.					

Connections and interpretation:

a. Who expresses themselves with indirect (not literal) speech acts?
_____

b. Who has a less intimate relationship (uses a more formal register) than others?
_____

c. Who violates conversational maxims?
_____

d. Based on your answers to the above questions, what 3 characters have less clear intentions toward Clarena? (personal, but informed opinion) _____
_____

3. Discussion

Explain your analysis in Section 2 in narrative form. Argue for the importance of the results in relation to the objective. Support your arguments with concrete examples from the data (specific words or phrases). Use unit terms and concepts appropriately.

4. Preliminary conclusion and future directions

Summarize the most important aspects and results of your analysis. Connect your analysis with the objective of the report (what do you know now that you didn't know before the analysis?). Mention at least one limitation and a possible future direction to continue investigating the case.

5. Bibliography

Cite the sources of the data and any referenced materials in the APA format.

REFERENCES

ABET. 2013. Criteria for accrediting engineering programs. Baltimore, MD: Engineering Accreditation Commission. Online: http://www.abet.org/wp-content/uploads/2015/04/E001-14-15-EAC-Criteria.pdf.

Albanese, Mark A., and Susan Mitchell. 1993. Problem-based learning: A review of literature on its outcomes and implementation issues. *Academic Medicine* 68(1).52–81.

Alessio, Helaine. 2004. Student perceptions about and performance in problem-based learning. *Journal of Scholarship of Teaching and Learning* 4(1).23–34. Online: https://scholarworks.iu.edu/journals/index.php/josotl/article/view/1607.

Anderson, Lorin W., and David R. Krathwohl (eds.) 2001. *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.

Arámbula-Greenfield, Teresa. 1996. Implementing problem-based learning in a college science class: Testing problem-solving methodology as a viable alternative to traditional science-teaching techniques. *Journal of College Science Teaching* 26(1).26–30.

Baeten, Marlies; Eva Kyndt; Katrien Struyven; and Filip Dochy. 2010. Using student-centred learning environments to stimulate deep approaches to learning: Factors encouraging or discouraging their effectiveness. *Educational Research Review* 5(3). 243–60. DOI: 10.1016/j.edurev.2010.06.001.

Barrows, Howard S. 1986. A taxonomy of problem-based learning methods. *Medical Education* 20(6).481–86. DOI: 10.1111/j.1365-2923.1986.tb01386.x.

Barrows, Howard S., and Robyn M. Tamblyn. 1980. *Problem-based learning: An approach to medical education*. New York: Springer.

Bateman, Nicoleta. 2019. Linguistics in middle school: Incorporating linguistics into project-based learning. *Language* 95(2).e300–e326. DOI: 10.1353/lan.2019.0044.

Belland, Brian R.; Brian F. French; and Peggy A. Ertmer. 2009. Validity and problem-based learning research: A review of instruments used to assess intended learning outcomes. *Interdisciplinary Journal of Problem-Based Learning* 3(1).59–89. DOI: 10.7771/1541-5015.1059.

Bloom, Benjamin Samuel (ed.) 1956. *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain*. New York: David McKay.

Blumberg, Phyllis. 2009. *Developing learner-centered teaching: A practical guide for faculty*. Hoboken, NJ: John Wiley & Sons.

Boduszek, Daniel; Mark Shevlin; Gary Adamson; and Philip Hyland. 2013. Eysenck's personality model and criminal thinking style within a violent and nonviolent offender sample: Application of propensity score analysis. *Deviant Behavior* 34(6). 483–93. DOI: 10.1080/01639625.2012.748628.

Boud, David, and Grahame Feletti (eds.) 1997. *The challenge of problem-based learning*. 2nd edn. London: Kogan Page.

Bruffee, Kenneth A. 1993. *Collaborative learning: Higher education, interdependence, and the authority of knowledge*. Baltimore, MD: Johns Hopkins University Press.

Chakravarthi, Srikumar; John Paul Judson; and Priya Vijayan. 2009. An evaluative study on comparison of problem based learning and lecture based pedagogy on self directed learning in undergraduate medical education. *Indian Journal of Science and Technology* 2(12).59–67. Online: http://www.indjst.org/index.php/indjst/article/view/29561.

Cheaney, James D., and Thomas Ingebritsen. 2005. Problem-based learning in an online course: A case study. *The International Review of Research in Open and Distributed Learning* 6(3). Online: http://www.irrodl.org/index.php/irrodl/article/view/267/433.

Coulson, Richard L. 1983. Problem-based student-centered learning of the cardiovascular system using the problem-based learning module (P.B.L.M.). *Physiologist* 26.220–24.

Dochy, Filip; Mien Segers; Piet Van den Bossche; and David Gijbels. 2003. Effects of problem-based learning: A meta-analysis. *Learning and Instruction* 13.533–68. DOI: 10.1016/S0959-4752(02)00025-7.

Eisenstaedt, Richard S.; William E. Barry; and Karen Glanz. 1990. Problem-based learning: Cognitive retention and cohort traits of randomly selected participants and decliners. *Academic Medicine* 65(9).S11–S12. DOI: 10.1097/00001888-199009000-00020.

Felder, Richard M., and Rebecca Brent. 2003. Designing and teaching courses to satisfy the ABET engineering criteria. *Journal of Engineering Education* 91(1).7–25. DOI: 10.1002/j.2168-9830.2003.tb00734.x.

Fitzgerald, Colleen M. 2010. Developing a service-learning curriculum for linguistics. *Language and Linguistics Compass* 4(4).204–18. DOI: 10.1111/j.1749-818X.2010.00196.x.

Fosnot, Catherine Twomey, and Randall Stewart Perry. 1996. Constructivism: A psychological theory of learning. *Constructivism: Theory, perspectives, and practice*, ed. by Catherine Twomey Fosnot, 8–33. New York: Teachers College Press.

Gallagher, Shelagh A., and William J. Stepien. 1996. Content acquisition in problem-based learning: Depth versus breadth in American studies. *Talents and Gifts* 19(3).257–75. DOI: 10.1177/6235329601900302.

Garrison, D. Randy. 1997. Self-directed learning: Toward a comprehensive model. *Adult Education Quarterly* 48(1).18–33. DOI: 10.1177/074171369704800103.

Gijbels, David; Filip Dochy; Piet Van den Bossche; and Mien Segers. 2005. Effects of problem-based learning: A meta-analysis from the angle of assessment. *Review of Educational Research* 75(1).27–61. DOI: 10.3102/00346543075001027.

Harris, Cristen, and June Kloubec. 2014. Assessment of student experience in a problem-based learning course using the course experience questionnaire. *Journal of Nutrition Education and Behavior* 46(4).315–19. DOI: 10.1016/j.jneb.2013.12.002.

Hung, Woei; Jessica Harpole Bailey; and David H. Jonassen. 2003. Exploring the tensions of problem-based learning: Insights from research. *New Directions for Teaching and Learning* 95.13–23. DOI: 10.1002/tl.108.

Jonassen, David. 2000. Toward a design theory of problem solving. *Educational Technology Research and Development* 48(4).63–85. DOI: 10.1007/BF02300500.

Jonassen, David. 2011. Supporting problem solving in PBL. *Interdisciplinary Journal of Problem-Based Learning* 5(2).95–119. DOI: 10.7771/1541-5015.1256.

Kelm, Orlando R. n.d. *Spanish proficiency exercises*. Austin: University of Texas at Austin. Online: http://www.laits.utexas.edu/spe/.

Kirschner, Paul A.; John Sweller; and Richard E. Clark. 2006. Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist* 41(2).75–86. DOI: 10.1207/s15326985ep4102_1.

Koromyslova, Ekaterina, and Byron G. Garry. 2016. Problem-based learning in a supply chain management course. Paper presented at the 2016 ASEE Annual Conference & Exposition, New Orleans. DOI: 10.18260/p.25960.

Krajcik, Joseph S., and Phyllis C. Blumenfeld. 2006. Project-based learning. *The Cambridge handbook of the learning sciences*, ed. by R. Keith Sawyer, 317–34. New York: Cambridge University Press.

Krathwohl, David R. 2002. A revision of Bloom's taxonomy: An overview. *Theory into Practice* 41(4).212–18. DOI: 10.1207/s15430421tip4104_2.

Krawetz, Neal. 2006. Gender guesser. Hacker Factor Solutions. Online: http://www.hackerfactor.com/GenderGuesser.php#Analyze.

Lakoff, Robin. 1973. Language and woman's place. *Language in Society* 2(1).45–79. DOI: 10.1017/S0047404500000051.

Leonard, Robert A. 2006. Forensic linguistics: Applying the scientific principles of language analysis to issues of the law. *International Journal of the Humanities* 3(7).65–69.

Lima, Rui M.; Dinis Carvalho; Maria Assunção Flores; and Natascha van Hattum-Janssen. 2007. A case study on project led education in engineering: Students' and teachers' perceptions. *European Journal of Engineering Education* 32(3).337–47. DOI: 10.1080/03043790701278599.

MacKenzie, Laurel. 2018. What's in a name? Teaching linguistics using onomastic data. *Language* 94(4).e293–e310. DOI: 10.1353/lan.2018.0068.

McKee, Cecile; Elly Zimmer; Amy Fountain; Hui-Yu Huang; and Mia Vento. 2015. Public outreach in linguistics: Engaging broader audiences. *Language and Linguistics Compass* 9(9).349–57. DOI: 10.1111/lnc3.12153.

Nardi, Deena, and Martin Kremer. 2003. Learning outcomes and self-assessments of baccalaureate students in an introduction to nursing course. *Journal of the Scholarship of Teaching and Learning* 3(3).43–55. Online: https://scholarworks.iu.edu/journals/index.php/josotl/article/view/1602.

National Association of Colleges and Employers (NACE). 2018. Online: http://www.naceweb.org/.

Newman, Matthew L.; Carla J. Groom; Lori D. Handelman; and James W. Pennebaker. 2008. Gender differences in language use: An analysis of 14,000 text samples. *Discourse Processes* 45(3).211–36. DOI: 10.1080/01638530802073712.

Oberlander, Jon, and Alastair J. Gill. 2004. Individual differences and implicit language: Personality, parts-of-speech and pervasiveness. *Proceedings of the annual meeting of the Cognitive Science Society* 26.1035–40. Online: https://escholarship.org/uc/item/94c490mq.

Perrenet, Jacob C.; Peter A. J. Bouhuijs; and Jan G. M. M. Smits. 2000. The suitability of problem-based learning for engineering education: Theory and practice. *Teaching in Higher Education* 5(3).345–58. DOI: 10.1080/713699144.

Piaget, Jean. 1955. *Construction of reality in the child*. London: Routledge & Kegan Paul.
Piaget, Jean. 1977. *The development of thought: Equilibrium of cognitive structures*. New York: Viking.
Prince, Michael. 2004. Does active learning work? A review of the research. *Journal of Engineering Education* 93(3).223–31. DOI: 10.1002/j.2168-9830.2004.tb00809.x.
Sanders, Nathan. 2016. Constructed languages in the classroom. *Language* 92(3).e192–e204. DOI: 10.1353/lan.2016.0055.
Savery, John R., and Thomas M. Duffy. 1995. Problem based learning: An instructional model and its constructivist framework. *Educational Technology* 35(5).31–38. Online: https://www.jstor.org/stable/44428296.
Schcolnik, Miriam; Sara Kol; and Joan Abarbanel. 2006. Constructivism in theory and in practice. *English Teaching Forum* 44(4).12–20.
Schmidt, Henk G. 1993. Foundations of problem-based learning: Some explanatory notes. *Medical Education* 27(5).422–32. DOI: 10.1111/j.1365-2923.1993.tb00296.x.
Schmidt, Henk G.; Henk T. van der Molen; Wilco W. R. te Winkel; and Wynand H. F. W. Wijnen. 2009. Constructivist, problem-based learning does work: A meta-analysis of curricular comparisons involving a single medical school. *Educational Psychologist* 44(4).227–49. DOI: 10.1080/00461520903213592.
Sipes, Shannon. 2017. Development of a problem-based learning matrix for data collection. *Interdisciplinary Journal of Problem-Based Learning* 11(1). DOI: 10.7771/1541-5015.1615.
Solomon, Patricia, and Jean Crowe. 2001. Perceptions of student peer tutors in a problem-based learning programme. *Medical Teacher* 23(2).181–86. DOI: 10.1080/01421590020031101.
Spring, Cari L.; Michael Flynn; Brian D. Joseph; Rae Moses; Susan Steele; and Charlotte Webb. 2000. The successful introductory course: Bridging the gap for the nonmajor. *Language* 76(1).110–22. DOI: 10.2307/417395.
Stentoft, Diana. 2017. From saying to doing interdisciplinary learning: Is problem-based learning the answer? *Active Learning in Higher Education* 18(1).51–61. DOI: 10.1177/1469787417693510.
Strobel, Johannes, and Angela van Barneveld. 2009. When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *Interdisciplinary Journal of Problem-Based Learning* 3(1).44–58. DOI: 10.7771/1541-5015.1046.
Vygotsky, Lev Semenovich. 1978. *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
Walker, Andrew, and Heather Leary. 2009. A problem based learning meta analysis: Differences across problem types, implementation types, disciplines, and assessment levels. *Interdisciplinary Journal of Problem-Based Learning* 3(1).12–43. DOI: 10.7771/1541-5015.1061.
Willis, A. Sandra. 2002. Problem-based learning in a general psychology course. *The Journal of General Education* 51(4).282–92. DOI: 10.7771/1541-5015.1061.
Woods, Donald R. 1996. Problem-based learning for large classes in chemical engineering. *New Directions for Teaching and Learning* 68.91–99. DOI: 10.1002/tl.37219966813.
Yilmaz, Kaya. 2008. Constructivism: Its theoretical underpinnings, variations, and implications for classroom instruction. *Educational Horizons* 86(3).161–72. Online: https://www.jstor.org/stable/42923724.

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