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Problem-based Learning in Computer-assisted Translation Pedagogy

Abstract

This article discusses problem-based learning (PBL) and its potential application to computer-assisted translation (CAT) pedagogy. Problem-based learning is situated in the CAT classroom as a final course component in which students challenge their previously-acquired knowledge and skill sets to solve unique, ill-defined problems that mirror those encountered in the language industry. This constructivist approach to education is designed to empower students to be self-directed, collaborative learners and to foster critical thinking and reflection. Moreover, problem-based learning is a means to encourage professional behavior and to develop skills beyond the mere use of translation technologies. This article explores the potential advantages and disadvantages of this educational approach as documented in related professional fields. In addition, the article addresses the ways in which problems are designed and implemented in the translation classroom, with a discussion of how they can and should be aligned with course learning objectives. The article concludes with a discussion of ways students' work ought to be assessed to enhance gains often seen in PBL environments.

Keywords

problem-based learning; computer-assisted translation; pedagogy; CAT tools; course design; translation curriculum

1. Introduction

Translator training and education programs regularly incorporate translation technologies in the curriculum in an effort to prepare students for working conditions and tasks encountered in the language industry. Tools regularly appearing in coursework, which can take the form of separate courses or integrated throughout the curriculum, include computer-assisted translation (CAT) tools, machine translation, localization tools, terminology management systems, and monolingual and bilingual corpora.[1] Reflection on how these tools could be taught began as early as the 1990s – concurrently, perhaps, to their commercial availability to translators. Scherf (1992: 153), for instance, indicates that universities "face the challenge of having to provide students with both knowledge and skills required by the new computerized multi-lingual document processing work environment." Bowker (2002: 131) echoes this emphasis on preparation for the language industry, noting that technology and its continuous development to optimize the translation process is generating new jobs and tasks in translation. Recognition of the role that translation technologies play in shaping the translation task continues to increase in the literature (e.g., Bowker/Marshman 2010; Bowker 2015), with a recent special issue of *The Interpreter and Translator Trainer* edited by Rodríguez de Céspedes, Sakamoto, and Berthaud (2017) extending this discussion to employability as well.

1 For several descriptions on how these tools can figure into translation curricula, see Zanettin et al. (1998), Samson (2005), Kenny/Doherty (2014), Jiménez-Crespo (2015), and Mellinger (2017).

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This preparation, however, has not always been provided by university programs; translators and localizers have needed to develop some of the skills required to work in these computer-intensive environments on their own. As Arevalillo Doval (2000: 119) describes, many of the first localizers were veteran translators with high levels of subject matter expertise. These professionals, despite lacking formal education or training in localization, learned their trade via practical job experience. And while the profile of professional translators has perhaps shifted with the increased number of translator training programs (e.g., Al-Batineh/Bilali 2017; Plaza Lara 2016), reports such as the *Translation and Interpreting Compensation Survey, Fifth Edition* conducted by the American Translators Association indicate that not all translators have formal education in translation (ATA 2016). As a case in point, just over 70% of respondents to the ATA survey report not having a degree in translation. While this figure is specific to one survey and should not be generalized to the entire language services industry, its magnitude suggests that formal education in translation is not presently a market requirement and that translators at times learn translation technologies by other means.

A growing body of scholarship examines the role of translation technologies and their potential impact on translation. Doherty (2016), for instance, provides an overview of many of the changes that occur with respect to the translation product and process. He suggests that while there are advantages to using translation technologies, such as an increase in productivity, quality, and throughput, there exist simultaneous challenges to their incorporation in the language industry. These challenges may be the result of changes in the translation paradigm and have an impact on cognitive processing. Empirical investigations on the translation process and product have shown changes in the amount of cognitive effort exerted by translators when working with translation memories (e.g., O'Brien 2006, 2008) as well as the tendency to over-edit proposed translations (e.g., Mellinger/Shreve 2016). Cognitive changes with respect to segmentation of the source text are also described by Dragsted (2005, 2008), further demonstrating differences between computer-assisted translation and translation without the use of CAT tools.

Despite the clear need and general agreement to incorporate computer-assisted translation in the curriculum, there is a relative dearth of scholarship on how to teach the requisite skills and competences. The wide range of skills, coupled with the evolving technological landscape, stymies any attempt to establish a static curriculum and instead necessitates a focus on the translation process. An emphasis on the translation process as opposed to specific functions of translation technologies may be one way to address the diverse ways in which tools are used in professional contexts. For example, Taravella/Villeneuve (2013) and Marshman (2014) note the varying degree to which these tools are adopted in professional environments and the dynamic implementation of tools in translation workflows. Moreover, Marshman's (2014) study reveals that translators are able to recognize the benefits garnered from tool use, despite lingering concerns related to their use and the relationship with the client or remuneration practices.

From a pedagogical perspective, Sabaté Carrové (2000: 385) points to this challenge of preparing students for an evolving industry, stating that "the real issue becomes then to coach them into how and when to use computerized tools rather than whether or not it is convenient to use them." In most cases, translation programs have relied on the experience and knowledge of individual instructors to dictate how to teach the material. Nevertheless, graduates of translation programs are expected to be prepared for immediate work assignments upon graduation, so a strong foundation in using these tools is imperative. This article proposes problem-based learning as one means to accomplish this goal. First, this article reviews the basic tenets of problem-based learning and its potential application to computer-assisted translation pedagogy. Subsequently, the advantages and potential shortcomings are reviewed, as are several considerations related to overall course design and sequencing in the curriculum. In closing, several potential problems are offered as models for incorporation in the CAT classroom.

2. Problem-based learning

Barrows/Myers Kelson (1993: 2) describe problem-based learning (PBL) as "an ordered instructional approach that models the process by which experts systematically approach real-life problems." This instructional practice – widely employed in medical education, engineering, and other professional contexts – regularly takes the form of posing problems that are ill-structured, incomplete, and interdisciplinary (Savery 2006: 12). Rather than an instructor-centered, transmissionist approach to pedagogy, PBL adopts a constructivist epistemology, wherein students are empowered to collaboratively construct knowledge guided by a facilitator (e.g., Savery/Duffy 1995; Williams/Williams 1997; Hendry et al. 1999).

The idea of what constitutes a problem in problem-based learning, however, differs somewhat from current conceptualizations of translation problems in the extant translation studies literature. In translation, much of what is characterized as a problem occurs at the textual or cognitive levels. For instance, Krings's (1986) review of translation problems distinguishes between source-text-oriented attempts to identify potential linguistic problems or target-text-oriented analyses of errors produced by translators. González Davies/Scott-Tennent (2005: 164) similarly define a translation problem as a segment that requires a translator to consciously decide on how to proceed during the translation task, which they link to Kussmaul's (1995) process-oriented work. Still other scholars, such as PACTE (2011), outline problems not only as they relate to the source text or translated text, but also to the transfer between both languages.[2]

Problems as conceived in problem-based learning can take a variety of forms, and Jonassen (2000, 2004) situates problem-solving as a cognitive activity. He describes its two essential attributes: a problem is an "unknown entity in some situation (the difference between a goal state and a current state" and that "finding or solving for the unknown must have some social, cultural, or intellectual value" (2000: 65). These characteristics – i.e., an unknown entity and the value of finding the unknown – align with conceptions of translation problems as they have been described with respect to textual elements encountered by translators.

However, problem-based learning often adopts a broader view to conceive of problems that move beyond a single text or document in an effort to address 'real-life' problems. For instance, Hung et al. (2008) describes several problems such as diagnosis in medical education, case analyses in business programs, and argumentation in law schools (Hung et al. 2008). The problems posed in these settings naturally vary given the disciplinary and professional differences, but exhibit the ill-defined, incomplete nature that is a hallmark of problem-based learning. With the challenges faced by translators in the workplace relative to translation technologies (e.g., LeBlanc 2017; O'Brien et al. 2017), problem-based learning could be used to encompass both the micro-level problem-solving tasks related to the translation task itself as well as macro-level problems involving the selection, application, and use of translation technologies. Moreover, problem-based learning may be able to address, as Angelone (2018: 18) describes, "problems in translation […] as a multilayered conglomerate at the crossroads of the product and the process."

For problem-based learning, one foundational characteristic is student engagement. While active participation can be difficult to foster initially, Barrows/Myers Kelson (1993) suggest the aim of the educator is to facilitate learning and the co-construction of knowledge.[3] To an extent, this engagement is the result of appropriate framing of expectations; as Pepper (2010) suggests, students often require support to learn to be self-directed learners. The need for such support is unsurprising, given the significant departure from traditional lectures and instructor-centered teaching models. Harland (2003) describes potential hesitation on the part of some students who are unfamiliar with assuming the role of peer-teaching or mentoring. Their previous knowledge and

2 For an overview of translation process research and its relationship to pedagogy and problem-solving, see Massey (2017). See also the overview presented by Núñez/Bolaños-Medina (2017) and Angelone's (2018) review of problems in translation process research.

3 For a review of the role of the problem-based learning facilitator, see Hmelo-Silver/Barrows (2006).

experience can serve to inform the group on the whole, and students must also assume the responsibility to gather information and share their findings with the rest of the group to generate potential solutions (Savery 2006; Savery/Duffy 1995). Moreover, the varied nature of student skill level and background knowledge potentially complicates the ability of teachers to pose problems that are just beyond the reach of the students' capabilities to maintain sufficient engagement. Harland (2003) links Vygotsky's zone of proximal development and problem-based learning and illustrates how this practice should be attainable with sufficient time, resources, and guidance. Moreover, varied student profiles enhance PBL environments since each student can contribute previous knowledge and experiences at some point to solving posed problems.

Another important aspect of problem-based learning is self-reflection. Savin-Baden/Howell Major (2004) note the importance of reflective behavior throughout PBL, since reflection emphasizes not only the final product produced by a team, but also the process by which the solution was generated. This sentiment is echoed by Ryan (2013), who also recognizes the importance of appropriate scaffolding for critical reflection that will be meaningful for the student. Moreover, Ryan outlines several different levels of reflection (in increasingly higher orders of abstraction: reporting/responding, relating, reasoning, and reconstructing) that must be appropriately scaffolded to maximize the benefit to student development.

The impact of problem-based learning is well-documented in a number of fields. Results presented by Williams/Williams (1997) on the integration of PBL in the technology classroom suggest that PBL fostered a realistic work environment while successfully achieving learning goals and outcomes. Sungur/Tekkaya (2006: 315) indicate that "PBL enhances students' use of elaboration strategies, critical thinking, metacognitive self-regulation, effort regulation, and peer learning." Moreover, the authors suggest PBL moves beyond teaching content and instead facilitates students learning how to learn.[4]

These gains are also seen outside of the traditional classroom setting. Brodie (2009), for instance, illustrates the effectiveness of PBL in a virtual environment. The integration of this instructional practice into a fully online course overcame commonly-touted criticisms of distance learning, namely the lack of social interaction and under-developed computer skills. Shimic/Jevremovic (2012) echo the applicability of PBL in e-learning environments, demonstrating that self-directed learning can benefit from PBL integration to learn specific skills related to technology. Students demonstrated the ability to seek out appropriate information. Moreover, instructor-provided resources and declarative knowledge provided sufficient scaffolding in many instances to solve problems encountered during specific projects or tasks. Overall, these students showed greater progress in acquiring programming skills in a shorter time frame, further justifying the use of PBL in this technology-mediated environment.

Such an approach is particularly suited to computer-assisted translation pedagogy, given the uniqueness of translation projects and the potential information asymmetry between client and translator (Dunne 2012b). In translation studies, Inoue (2005) has explored the applicability of problem-based learning in courses related to the practice of translation. Inoue argues that PBL increases learner autonomy and self-reflective actions to help students develop the necessary skills needed to work in professional situations. Similarly, García González/Veiga Díaz (2015) also present a study suggestive of the problem-based learning paradigm in specialized translation by examining project-based learning as a means to simulate authentic work projects. These authors note an increase in students' reflectiveness and a greater awareness of the context in which translation occurs as well as improved motivation, involvement, and collaboration. Lastly, Washbourne (2014) explores self-directness in translation education and the importance of fostering learner autonomy and learner control. Given that language professionals frequently work as in-

4 While too numerous to include all of the studies related to PBL-facilitated gains in learning, see Hung et al. (2008). See also Walker et al. (2015) for more information on the development of PBL and its implementation.

dependent subcontractors and rely on a variety of translation technologies, fostering self-directed learning in CAT pedagogy appears to be a relevant goal.

3. Integration of PBL into the CAT classroom

The initial development of CAT tools arose out of attempts by software companies to achieve high quality machine translation and a subsequent shift to solve specific problems faced by translators.[5] These tools aim to improve efficiency and consistency, to increase throughput during the translation process, and to decrease work effort. To provide two concrete examples, translation memories avoid duplicative work and retrieve previously-translated material quickly, while alignment tools allow translators to create translation memories out of legacy translations. In each case, explicit knowledge of the tool is not an end unto itself, but rather the user must understand the context in which each is used for the tools to be effective. Therefore, instructors must move beyond declarative knowledge about how the tools work and incorporate the rationale for their use and the conditions under which their use is favorable.

Computer-assisted translation pedagogy seems well positioned to adopt problem-based learning as a means of accomplishing the previously-mentioned goals while increasing student reflection on the translation process, improving problem-solving skills, and situating CAT tools in the multilingual document lifecycle. Educators who wish to incorporate PBL will need to frame the expectations of students enrolled in courses adopting this instructional approach. Bolaños Medina/Isern González (2012), for instance, describe the impossibility of being able to teach every feature or every tool available on the market and, based on self-reported survey data, that a focus on a limited number of tools and functions might improve students' overall performance. This claim needs to be tested to determine the extent to which improvement can be observed when instructors limit the scope of instruction to a specific subset of tool functionality; however, this suggestion merits consideration given the increasing complexity and functionality of tools. Instead, a more efficient approach would be to pose problems likely to occur in the language industry within a PBL framework that would allow students to generate solutions using the specific tools at their disposal. In doing so, students can gain procedural knowledge of how to implement these tools and develop the ability to analyze and select the most appropriate tools for the problem.

The likelihood of encountering a specific problem is closely related to the notion of authenticity. As Honebein (1996: 11-12) describes, "educators [often] remove the noise of real life from the learning activity," suggesting that learning is at times divorced from actual practice. This separation is often counterproductive – the goal of translation education programs is to prepare students to solve problems in the language industry that have not been previously sanitized or decontextualized. Language industry projects are by their very definition unique (see Dunne 2012b), thereby requiring a novel solution that is not always readily apparent. If learning activities do not approximate problems potentially encountered in industry settings, students are disadvantaged when entering the workplace.

Problems encountered in professional translation projects can stem from a number of areas; while too numerous to list comprehensively, problems can occur during the source language (SL) authoring stage, software or website development and implementation, target language (TL) production, and re-creation of target language files. At any of these stages, translation technologies may be introduced to help mitigate risk or solve specific issues. The ability to appropriately select and implement these tools is of paramount importance if translation program graduates are to meet market demands or industry standards (Sikora 2014; EN15038). Likewise, student reflection and problem-solving related to tool selection helps move students beyond the acquisition of solely declarative knowledge about the tool. Students additionally gain procedural knowledge of

5 Initial efforts to develop fully-automated high-quality machine translation are described by Hutchins (1998) and Quah (2006). For an overview of computer-assisted translation and its development, see Dunne (2012a).

how to critically evaluate solutions to a specific problem and how to appropriately use the tools to achieve a desired outcome.

Problems posed in the CAT classroom need to be designed in such a manner that the difficulty is appropriate to the students' skill level. Keegan (1995: 207) notes that these problems should "approximate the relative challenge of the real world" and need to contain a certain level of noise that students must learn to remove themselves. That is not to say, however, that the problems should be of the highest level of difficulty, but rather, should include authentic components that would "stimulate learners so that their thinking is related to actual practice" (Honebein 1996: 20). In the context of translation studies, Angelone (2018) also describes the importance of posing problems to students that are at an appropriate level; however, he recognizes that in many instances, the assessment of difficulty is made on the basis of trainer intuition. Moreover, the heterogeneous nature of the translation studies classroom complicates attempts at ensuring problem difficulty to be the same for students with differing abilities.

Nevertheless, PBL emphasizes collaborative learning, thereby obviating a number of concerns related to the level at which problems are posed since students will jointly solve problems. Moreover, the unique backgrounds of students may foster peer-to-peer learning; variation among students with respect to skills and knowledge provides an opportunity for students to share their experience in some contexts and to rely on those of their group members in others. Consequently, well-designed problems in the computer-assisted translation classroom ought to be beyond the students' current ability (see Harland 2003 and the discussion of Vygotsky), but that are attainable with sufficient resources, guidance, and modeling.

Creating a learning environment in which students are challenged just beyond their current abilities is congruent with research in expertise studies. As Shreve (2006: 32) describes, "any translator looking for performance improvement as a result of deliberate practice will necessarily have to choose texts whose difficulty profile and characteristics challenge existing and perhaps very specific skills." Deliberate practice as a means of developing expertise is not confined to translation proper; rather, this concept is applicable to any skill development, which in this case would pertain to the use and application of computer-assisted translation tools. The overarching goal of PBL in the CAT classroom is to create an environment in which students engage with the problems and tasks within the domain, receive feedback on their progress, and have an opportunity to implement changes to their working process. PBL does not presume to develop expertise in a single course but does allow students to actively engage the material and develop skills by challenging their existing knowledge and requiring newer skills to be acquired.

4. Course design and sequencing

While the merits of PBL in the CAT classroom are apparent, instructors who incorporate PBL in their courses must consider the course design and schedule as well as the course's position in the curriculum. Computer-assisted translation courses are typically offered as a standalone module, course, or series of courses that operate independently of translation courses. This practice has begun to shift as researchers and instructors recognize value in integrating CAT tools into specialized translation courses. As an example, Rodríguez-Castro/Sullivan (2015) discuss the integration of CAT tools into the legal translation classroom. In addition, Mellinger (2017) argues for the integration of machine translation into language-specific translation courses to reinforce the use of translation technologies in the service of translation tasks. A full discussion of course sequencing and design is outside the scope of this article; however, problem-based learning may prove most appropriate as a final component of a course or module given the requisite skillsets that students must have to function effectively in a self-directed environment.

Several researchers, such as Scherf (1992) and Olvera Lobo et al. (2007), suggest that students entering CAT tool courses do not have significantly developed computer skills or that their experience with information and communication technologies (ICT) is limited, which can hinder a stu-

dent's ability to understand the concepts driving CAT tools. While the prevalence of technology and its increased integration in many facets of daily life require researchers to regularly revisit the extent to which their students are familiar with technology, instructors would be prudent to recognize the importance of this type of background knowledge in the CAT tool classroom.[6] Problems encountered in language industry settings regularly move beyond typical computing tasks, and the overall technological complexity of translation projects has equally increased. However, the ways in which translators use electronic resources is not fully understood (Hvelplund 2017) and the intersection of ICT, translation technologies, and translation pedagogy remain underexplored (González Davies/Enríquez-Raído 2016). And while students may enter the CAT tool classroom with some experience using a range of technologies, exposure to CAT technologies is likely to be limited to the CAT classroom. Consequently, students benefit from being exposed to various translation technologies to gain familiarity with their use early in the module or course. From there, instructors can transition to a problem-based learning environment.

5. Posing problems

Drawing on the characteristics of problem-based learning and the potential means to integrate PBL into the computer-assisted translation classroom, this section proposes two problems as proof of concept. Ill-defined and interdisciplinary by design, these problems do not have a definitive answer and allow multiple groups to approach a solution in unique and diverse ways. To an extent, the problems highlight the information asymmetry often encountered between clients and translators (e.g., Dunne 2012b), recognize the challenges of context inherent when working with translation memories (e.g., Killman 2015), and emphasize the amorphous nature of quality (e.g., Dunne 2009).

These examples also aim to accomplish what Barrett (2010, 2013) suggests – namely the creation of problems that not only account for students' previous knowledge, but also strive to maximize the development of professional behaviors and identities in addition to declarative and procedural knowledge. This approach may heighten the ability of students to transfer process skills to other problem-solving domains and better position translation students upon graduation.

For each example, the overarching premise of the problem is first presented. Perhaps most notable about each example is the relatively amorphous and open-ended nature of the question, allowing students and the instructor sufficient flexibility to engage with a range of translation technologies and tools, as well as incorporate macro-level considerations of the practice of translation in professional contexts. Several variations are also included to help instructors adapt the problems to a specific course or university level. The rationale for the problem's structure is then presented, as well as some of the skills required of students to successfully solve each. Future research might empirically test the effectiveness of this particular design in a classroom to compare with learning outcomes; however, the goal here is to present how problem-based learning can be integrated and aligned with learning outcomes.

5.1. Example 1: Why did this website localization project of a travel website fail?

As described previously, problem-based learning relies on ill-defined, authentic problems that ostensibly could occur outside of the classroom. The first example takes as a point of departure the following question: Why did this website localization project of a travel website fail? This problem meets the general criteria for a problem suitable for problem-based learning, as it leaves several variables undefined and does not prescribe a singular path to answer the posed problem. In addition, this type of question could arise in any number of professional contexts, either as an in-house translator or localizer who formed part of the team that created the project or as a language

6 Alcina et al. (2007) also note a diverse range of technology skills in translation students, with some requiring additional student-teacher interaction or greater repetition to grasp specific skills or competences.

service provider who has been engaged to determine why initial efforts to localize their website have failed. In either case, an end user or client has decided that their website localization project was unsuccessful and wants to know why.

It is important to recognize that this question is naturally biased; if a company approaches a language service provider stating that the project was a failure, the students are thrust into a situation in which they must first define a number of key concepts to better understand the problem prior to analyzing the website for potential faults. This approach avoids sterilizing the learning environment and allows noise such as an implicit bias in the prompt to require students to analyze the prompt itself to better understand the context in which the problem is being posed. In addition, the determination of what constitutes failure of a project may not be related to the final localized website and is instead based on client's dissatisfaction with how it ultimately functioned in the new locales. The course instructor can use these initial discussions as a starting point to examine what constitutes quality in localization projects, the distinction between product-oriented and process-oriented approaches to translation, and the role that technology plays in localization. Moreover, these initial queries should be student-driven, with the course instructor guiding students to examine different aspects of website localization to develop a macro-level understanding of the problem.

The posed problem is accompanied by a travel website that contains two or three levels of navigation to limit the overall scope and focus their analysis on a restricted number of pages.[7] To facilitate a translation technologies course or module that has a variety of language pairs, the content of the website can be in a commonly-shared language. Language-specific issues can be raised in a diverse set of language combinations, which may help spur discussion among group members. For an added level of complexity, some materials presented in the failed localization attempt could be the result of machine translation or faulty translation provided by colleagues or modified by the instructor. Content included in the website could include images, documents, advertising, rate sheets, or any other information on which the course instructor wishes to focus. Time constraints may also dictate the overall size and scope of the problem under consideration.

This type of problem is suitable for PBL since it challenges students to simultaneously address macro-level and micro-level analyses. For instance, students must first determine what constitutes a project failure and the criteria by which language service providers and clients make these determinations, contextualizing the product in the larger communicative environment. Moreover, students must learn to discriminate between the salient features of the product that have a direct bearing on project success and potential noise introduced by the context in which the problem has been presented. Students are also faced with the challenge of defining quality in translation and localization and recognizing how textual features may not account for systemic issues spanning multiple documents (i.e., navigation structure, cultural appropriateness, lack of internationalization). The problem can be extended so that students then must create an appropriate version of the website and justify the rationale behind any changes as is often necessary in professional projects – in order to convince the company to reconsider a new version. An additional problem can be posed about how changes and suggestions will be documented such that they can be reused and referenced for future projects.

To solve this problem, students must challenge and apply previous knowledge and skill sets related to localization, translation, and language courses. Depending on the overall scope and whether a new version of the website is required, students will be able to use a variety of tools, including translation memory, corpora, localization software, image editing software, HTML and XML editors, terminology management systems, authoring tools, or presentation materials. The fact that the posed problem does not have a pre-determined, singular solution makes a full explanation impossible regarding how each of these tools may be brought to bear on the present prob-

7 While the proposed website in this problem is a travel website, the content domain could just as easily be that of another area.

lem. Two examples are provided here to illustrate how these tools might be integrated into a solution. Perhaps most obvious would be the need to use HTML and XML editors or authoring tools to update specific aspects of the website that the students determined to be suboptimal. Errors in the translation, inappropriately localized dynamic context, or presentational aspects can all be addressed using these tools and would require students to learn the necessary functionalities of each to ensure that the website was appropriately updated.

Alternatively, students might rely on translation memories and terminology management systems to generate a new version of the website. In line with best practices, many translation memory environments present HTML and XML files in intermediary files to allow translators to work outside of the source files. These tools might be used by students to simultaneously update legacy translation material while adjusting the website content. In this case, the translation memory tool may not be used as a means of improving consistency of repetitive text, but rather as a means to ensure the necessary content is updated and that the stored content does not continue to hold suboptimal translation matches. Likewise, terminology management systems might be used in conjunction with the translation memories for the same purpose – to document client-preferred or client-approved terminology to avoid similar errors in the future.

As noted above, the first subcomponent requires students to analyze the problems present in the website and determine what specific aspects of the website localization project failed. This task extends beyond the simple identification of errors to include considerations of a potential lack of tool implementation during the website's creation. In addition, this aspect of the problem allows students to critique the success-failure binary initially posed in the problem. The second subcomponent requires students to reflect on mistakes and fosters discussion on how to resolve these issues. The third and fourth subcomponents require the actual implementation and use of the tools. Here, students are simultaneously analyzing areas for improvement, but also the manner in which this is possible and the appropriateness of each tool. As mentioned previously, the ability to use translation technologies is not an end unto itself, but rather computer-assisted translation requires the ability to determine which tools are best suited to solve specific problems. Finally, students are required to synthesize the information in an organized and compelling manner. The procedural and declarative knowledge gained throughout the problem-solving process must be contextualized and rationalized to an outside source to potentially resolve the information asymmetry between client and translation provider.

5.2. Example 2: How can Company X increase the number of words translated and maintain the same level of quality?

In this example problem, students are examining computer-assisted translation in the context of professional work environments. The instructor can structure this problem as a case study with each group of students working with a different company, language combination, or domain. These decisions can be driven by the class composition and interests, and might include international organizations, government entities, multinational companies, or non-governmental organizations. Regardless of the specific parameters established, the instructor would indicate a company or entity that has already undertaken sizeable translation projects.

As in the first example, the problem is ill-defined and incomplete. If decomposed into smaller sub-components, students might first conduct a needs analysis to determine the types of texts that are translated and their corresponding quality. The second component includes an evaluation of the translation technologies that might be implemented and the strategy with which the company would proceed. Then, students could evaluate specific tools that are available and select the most appropriate tool(s) for the task. Lastly, students could test the adopted strategy and technology to measure whether throughput has increased or if the overall quality of the translation product has changed based on their initial proposed solution. A final step would be to present their findings to the company (in a mock setting) as a solution to their increased volume problem.

The solutions to the problem are numerous. Students will once again need to draw on their knowledge of computer-assisted translation and translation technologies to analyze the problem as an initial attempt to formulate a hypothesis or potential solution. Additional research will be needed to understand how some of these tools can be implemented at the enterprise level in addition to that of the role of the individual linguist. The first subcomponent requires students to analyze the texts involved and to operationalize the notion of translation quality. Furthermore, if the specific company or governmental entity has a pre-established style guide, students would need to reconcile previous knowledge with this externalized description of the required translation project. This information would need to be captured in a digital format to allow students to integrate this additional input into the proposed solution (see Washbourne 2012).

The next subcomponent focuses on the analysis and review of translation technologies and their various functionalities. The problem context guides the specific challenges to be addressed. After this review, students are able to test the selected tools and analyze whether their initial selection is appropriate or if other choices would be more prudent. The complexity of this task could be modified based on the availability of software or the use of trial versions or could focus specifically on reporting and analysis tools regularly included in these software programs. For instance, students might limit their investigation to tools that report word counts, repetition, time on task, or productivity measures. Analysis of this type integrates the translation process with the translation product and obliges reflection on their interplay.

The final subcomponents related to measuring any potential increase in throughput and presenting these findings to a client illustrate the incomplete and ill-defined nature of a problem appropriate to problem-based learning. As is often the case in industry settings, language service providers do not always have information related to previous practices of their clients. Nevertheless, these providers need to find ways to differentiate their process from others. While the ways to do this can vary, students might test their solution prior to any simulated client presentation. For instance, students could translate a small portion of the same text twice, once without the aid of translation technologies and once with their proposed solution. The iterative nature of analyzing and implementing potential solutions allows students to focus on the translation technologies being used and experience firsthand how their incorporation into a specific translation project alters the process. The inclusion of a mock presentation to the client then precipitates a logical ordering of the gathered information, synthesizing what has been learned as they work toward a solution.

5.3. Discussion

Both proposed examples engage students at higher orders of thinking and provoke students to explore beyond their background knowledge. By extension, neither of the problems can be solved with a single answer; instead, various solutions are possible as students gain sufficient understanding of procedural and declarative knowledge related to computer-assisted translation. Savery (2006) notes this critical thinking component and raises the important final consideration of assessment when implementing problem-based learning in the classroom. With equal emphasis on both product and process, students must be assessed "on both dimensions at regular intervals to ensure that they are benefiting as intended from the PBL approach" (Savery 2006: 14). Assessment will largely be driven based on the posed problems; however, learning logs, guided questions, reflective essays and narratives may all form part of timely formative feedback strategies. In each of the example problems, a final assessment is built-in, namely a final presentation. However, summative assessment is insufficient to capture the reflective nature of PBL in its entirety. The integration of both summative and formative assessment is paramount to maximize the benefits of the problem-based learning approach.

Feedback, however, need not come from the instructor alone; self-assessment, peer assessment, and collaborative assessment can also be useful to include. Macdonald (2005: 86, emphasis original) states that "it is through peer, self and collaborative assessment that students are able to make judgments about how *well* they are learning and not just how *much* they have learned." As such,

instructors need to incorporate students in the assessment process at various stages of the project to ensure that students are benefiting from the problem-learning environment. Macdonald/Savin-Baden (2004) suggest multiple assessments, peer assessment, reflective journals, online journals, progress reports, or individual presentations as potential means to accomplish this goal. Though an instructor cannot incorporate every type of assessment in a single course, he or she must match the posed problem to the appropriate assessment tools. The best forms of assessment will address the various learning objectives and skills, knowledge, and tasks engaged in by students.

6. Conclusion

The previous example problems demonstrate ways in which problem-based learning can be incorporated in the computer-assisted translation classroom. Formative and summative feedback, in addition to authentic problems and a collaborative learning environment, allow instructors to achieve benefits derived from a PBL approach to education. Moreover, this instructional practice helps students foster professional behavior and identity while engaging material that situates specific translation technologies in the larger context of professional translation. This type of learning extends beyond the classroom to develop intentionality in self-directed learning (see Washbourne 2014) and integrate procedural and declarative knowledge to solve novel and unique problems. Further research on these educational practices is needed to examine the impact that PBL may play on developing skills and knowledge related to computer-assisted translation; however, this article serves as a proposal for the applicability of problem-based learning in the CAT classroom. In sum, problem-based learning appears to be a natural pairing with translation technology pedagogy to help universities better prepare students to integrate into an ever-changing language industry.

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