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Acknowledgements

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Section I. Introduction

Consider a recent occasion when you needed to find some information or solve a problem. Perhaps it was the last time you looked for a job, looked up information to use in class, or organized information to plan an event. Or maybe even when you realized you needed to read about the connection between problem solving and technology! Now, consider the steps you might have followed.

Let’s look at a simple information problem as an example.

> You are planning a school picnic and need to select a venue. You might begin by asking some questions:
>
> 1 – What sort of space would be most useful?
> 2 – What is my budget for renting it?
> 3 – Where might I find a space that I can afford?
> 4 – What must I do to secure it?
> 5 – How am I going to find this information and then organize it?
> 6 – How should I evaluate the information?
> 7 – What actions do I need to take?

In the example, you start by identifying the goal: in this case, finding an appropriate venue. Then you begin to ask questions to define the problem and strategize about how to solve it.

Our technologically-rich world means that many of these tasks require using some sort of technology (e.g., spreadsheets, Internet search, websites, email, or social media) or, even more likely, some combination of several technology resources. Despite this reality, many adults struggle with one or both dual components of such tasks: 1) sorting out the steps of solving the problem and 2) effectively selecting and then using technology to complete the task. In fact, the Program for International Assessment of Adult Competencies (PIAAC) Survey of Adult Skills showed that an alarmingly high percentage of adults in the U.S. lack both the technology proficiency and cognitive skills necessary to leverage use of technology to solve real-world problems encountered in work, school, and daily life (OECD, 2013b; Rampey et al., 2016a).

Background Information: PIAAC PS-TRE

NCES on PIAAC video: https://youtu.be/UgRwgFD-Ynk

The PIAAC surveys were first given to nearly 166,000 adults aged 16-65 in 24 countries in 2012 and measured literacy, numeracy, and problem solving in technology-rich environments (PS-TRE). The survey most relevant to this brief is the PS-TRE, which measured two interrelated characteristics of work and life in the 21st Century: technology use and higher-level cognitive skills required to carry out non-routine tasks now common in daily life (Reder, 2015). Rather than merely testing basic proficiency with use of common technologies, PIAAC/PS-TRE attempted to measure efficient and creative application of them in everyday tasks encountered at home and work that require 1) accessing information through information communication technologies (ICTs) and/or 2) solving problems that existed because of the presence of ICT itself (OECD, 2013a). (See Appendix A for more information on PIAAC).

Results. Compared to the PIAAC international average, U.S. participants performed poorly. One in six adults demonstrated low literacy skills and one in three adults had weak numeracy skills. Further, the average of U.S. participants' scores in PS-TRE were lower than the overall average of all countries' participants (OECD, 2013b, p. 11).

The PS-TRE results for the U.S. are the most startling. Of the 5,000 adults who completed the PIAAC survey in the U.S. in 2012, many could not even take the PS-TRE, which was only available on the computer-based version of the assessment. Those participants who took the paper-based test did so because they had no computer experience (5%), did not have basic computer skills (4%), or opted out of the computer-based assessment for other unknown reasons (6%). Of the 81% adults who did complete the PS-TRE in 2012, the U.S. had the highest percentage of participants (15.8%) scoring below Level 1, the minimum proficiency level required to succeed with simple problem-solving tasks encountered in daily life (OECD, 2013b, p. 21). Also troubling are these facts about PS-TRE performance for specific groups of U.S. participants:

- 70% percent of adults aged 35-64 had low PS-TRE skills.[1]
- 58% of Millennials (young adults born after 1980 and between ages 16-34) tested at the low-skill level despite spending 35 hours per week using digital media.[2]
- Scores for Millennials in the U.S. were among the lowest reported among all participating countries.[3]
- Of the 13% who took the paper version of the assessment, 30% reported being out of the workforce and 41% reported educational attainment below a high school level,[3] suggesting a correlation between proficiency with skills required to complete the computerized version of the assessment and employability.

Since 2012, there have been two supplemental studies of adults in the U.S. First, the U.S. PIAAC National Supplement conducted in 2013-2014 included 3,660 adults in one of the following categories: unemployed adults (age 16 to 65), young adults (age 16 to 34), and older adults (age 66 to 74). Again, the U.S. did not fare well. Larger percentages of both unemployed and young adults performed at Level 1 or below than the international average, and 44% of older adults scored below a Level 1 (Rampey et al., 2016a). Also of concern is the low participation in PS-TRE in a 2014 study with incarcerated adults in the U.S. In that study, only 61% took the computerized version of the test that included the PS-TRE; 11% said they had no prior computer experience (Rampey et al., 2016b).

[1] *Does Not Compute: The High Cost of Low Technology Skills in the U.S. and What We Can Do About It*, (2015) Change the Equation.
[2] Goodman, Sands, and Coley (2015). *America's skills challenge: Millennials and the future*. ETS.
[3] *Time for the U.S. to Reskill?* (OECD, 2013b).

What Is PS-TRE?

These results are even more troubling considering the definition of PS-TRE and the tasks the assessment items represent:

> *…using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks*.
> (OECD, 2009, p. 9)

Note the phrase *practical tasks* in the definition. PS-TRE represents a process for accomplishing everyday, not specialized, tasks that adult learners encounter in personal, work, and civic life, often due to the presence of or requiring use of new technologies. Because PS-TRE tasks mirror those that learners are likely to encounter, proficiency with the skills represented by PS-TRE are critical. PS-TRE should, therefore, be considered a new domain for learning and instruction, one that encompasses how to accomplish a task or solve a problem in a digital environment by setting a goal or establishing a plan for applying technology skills to find, manipulate, and make use of information.

Goal of This Brief

This brief is a guide for Adult Education and Literacy practitioners who are ready to teach this new domain. One goal of the guide is to nudge practitioners to reconsider current technology integration in ABE classrooms, adding a cognitive dimension to their technology use instruction. In doing so, teachers can include instructional activities that help learners to not only use technologies, but also develop an understanding of the complex processes required to employ them. Whether teaching in Adult Basic Education (ABE), Adult Secondary Education (ASE), or English Language Acquisition programs, practitioners can refer to the brief when creating curricular activities that teach how to solve problems or handle day-to-day activities in the digital environment.

The brief is based on key components of *PIAAC Problem Solving in Technology-Rich Environments: a Conceptual Framework* (OECD, 2009), hereafter referred to as "the conceptual framework." The brief includes a description of:

- the steps of the cognitive process put forth in the PS-TRE conceptual framework
- how complexity varies in given problem-solving tasks
- a teachable PS-TRE process

In addition, it provides examples of instructional activities representing the process and use of technology at varying levels of complexity.

Why Teach PS-TRE?

The PIACC results presented above likely ring true to practitioners who see learners struggle daily, navigating tasks associated with things like communicating with their children's teachers, using public transportation, or finding information that is only available online. Such struggles are also likely evident in the school environment itself, where learners try to effectively use technology resources in ABE, ASE, and English language classrooms. For both immigrant learners and native-born adult learners with a low level of formal education, it is critical that programs support problem-solving skills of learners if they are to succeed in their schooling and fully participate in economic and civic life.

Adult learners also require strong PS-TRE skills in the world of work; indeed, the skills articulated in PS-TRE mirror those rewarded by employers. Shatkin (2012) made visible those desired skills, using O*NET[4] to explore statistical correlation between thirty-five articulated skills and the occupations included in the O*NET database. This process identified the skills that support employability. The top five were, in this order:

1. Judgment and Decision Making
2. Complex Problem Solving
3. Active Learning
4. Reading Comprehension
5. Critical Thinking

The PS-TRE conceptual framework can inform instruction that builds such skills because it provides a research-informed description of the cognitive steps a person might rely on when problem solving in a digital environment. The conceptual framework spells out this problem-solving process as a sequence of actions. It is these actions that can serve as the basis for instruction.

An additional reason for including PS-TRE is that it can illustrate the relevance of computers and the Internet in learners' lives. A Pew Research Center survey of non-internet users in 2013 found lack of interest to be the most consistent reason adults do not go online. Further, data from the survey showed that many of these non-adopters are part of the subpopulations likely to be ABE or ASE learners – 38% were either Black or Hispanic, 25% earned less than $30,000 per year, and 33% had less than a high school degree (Anderson & Perrin, 2015).

Goal of including PS-TRE in instruction. This brief suggests using both explicit instruction of the PS-TRE process and implicit representation of its use in instructional activities. The goal of teaching PS-TRE is to support the development of proficiency using the problem-solving process. A far-reaching goal is to support the facility with which adult learners employ a systematic approach to solving problems in which technology use is implicit, so that they can reach educational and career goals.

How does teaching PSTRE differ from teaching of ICT? While many ABE programs now include some instruction in the various hardware and software most often used in ICT, this is very different than instruction in PS-TRE. PS-TRE requires creative and effective application of basic ICT, so familiarity with them is foundational to it. ABE practitioners are well positioned to take on this more complex domain; in fact, research defining prior work in the field suggests that instruction around technology use has grown much more sophisticated over the past decade.

[4] Career exploration and job database tool supported by the U.S. Department of Labor.

Adult education programs now better understand that development of digital literacy[5] is best supported when taught in tandem with academic content (Littlejohn, Beetham, & McGill, 2012). Many adult educators have begun to strive for seamless integration of these skills into academic content instruction (Smythe, 2012). This acknowledgement of the importance of contextualized use of technology is the first step in thinking about how to teach PS-TRE. A useful publication, *Integrating Digital Literacy into English language instruction: Issue Brief* (Harris, 2015), situates PS-TRE at the most complex end of a spectrum of different digital literacies. It recognizes that in order to help learners become truly digitally literate, teachers must not only teach technical skills but also provide opportunities for students to apply those skills in problem-solving activities. Such contextualized skill building can help prepare learners to solve problems they confront in their everyday lives.

Why should it be taught as an independent unit? When we look at the U.S. results on PIAAC PS-TRE in relation to the extent to which technology infiltrates and even shapes the demands of daily life, it is clear why we need to foster PS-TRE skills in adult learners engaged in formal instruction. PS-TRE was defined in response to the understanding that adults today face many non-routine tasks, tasks that cannot be completed by habitualized actions. Rather, these tasks require a problem-solving process to complete, as well as demanding use of novel technologies. This doubling of newness adds complexity that learners can mitigate by using a problem-solving process as a type of routine.

Rather than hoping that learners develop a sense for how to engage in problem solving through informal exposure to classroom activities, this brief encourages teachers to provide explicit instruction of the problem-solving process. Kirschner, Sweller, and Clark (2006) suggest that providing direct instruction, guidance, and simplified examples in learning activities decreases cognitive load in complicated tasks and results in learning – more so than activities that are purely discovery-based. This suggests that it might not be effective to simply show learners how to use technology and then give them scenarios where they need to use it; rather, teachers must provide some amount of direct instruction in the process by which they plan, select, and employ technology use. Further, Kirschner et al. suggest using "worked examples," which are scaffolded tasks that, in this context, deliberately require learners to build proficiency with each individual stage of the problem-solving process.

Other Initiatives

Integrating PS-TRE in instruction aligns with several other prioritized initiatives in ABE, including:

- P21 Framework for 21st Century Learning
- College and Career Readiness Standards of the Common Core
- digital literacy programming.

[5] Digital literacy can be defined as the skills required to use the technology necessary for finding, evaluating, organizing, creating, and communicating information (U.S. Department of Education, 2015)

Each of these initiatives includes a cognitive focus on problem solving and use of technology to some extent. (See Appendix B for definitions and more detailed explanation of how they are similar.) Additionally, the *Workforce Innovation and Opportunity Act* (WIOA), the legislation authorizing and funding much of the adult education in the U.S., prioritizes development of cognitive skills and proficiency with technology in order to support the employability and economic opportunity of adult learners. See the fact sheet, *Integrating Technology in WIOA*, (U.S. Department of Education, 2015), which spells out how the legislation supports this priority. (See Appendix C for more information about WIOA.)

Section II: Core Principles of the PIAAC PS-TRE

The PIAAC conceptual framework defines PS-TRE as follows:

> *Problem solving in technology-rich environments involves using digital technology, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks.* (OECD, 2009, p. 9)

The opportunity to solve a problem emerges from the need to complete non-routine actions. It requires a process of "setting up appropriate goals and plans, accessing and making use of information through computers and computer networks" (OECD, 2009, p. 9). Because the PS-TRE conceptual framework elucidates a process for problem solving in real-life tasks, it can be useful for shaping contextualized instruction in adult education programs. However, before launching into the work, one must understand what is meant by "problem." This next section explains how the PIAAC conceptual framework (OECD, 2009) defines "problems" and then describes the core dimensions of the PS-TRE domain and how they work in tandem to constitute components of problem solving.

How PIAAC PS-TRE Defines Problems

If you could move through your day and complete tasks relying completely on routines and habitualized actions, such as making a phone call or sending an email (in a familiar environment) to a frequent contact, you would not need to do any problem solving. However, it is more likely that something happens to inhibit a given routine, such as diminished cell signal strength or being logged in to the wrong email account, and then a problem emerges. For example, while completing this brief, I tried to print a few pages for review, something I sometimes do when I am writing, only to find the ink distributed unevenly on the pages and the text unreadable. What had been a fairly routine process of writing and review was disrupted by a problem that occurred because of the technology component of the task. Printing was hampered by what I eventually figured out to be a clogged ink-jet nozzle. I hadn't even known such a thing existed! It was certainly a problem to be solved before I felt I could proceed with my writing.

Information problems. An important characteristic of PS-TRE is ready access to the vast quantity of information that technology and digital environments afford. With the World Wide Web, more people have access to knowledge and information previously available only to specialists (OECD, 2009). However, though the information may be at our fingertips, not everyone can make use of it. Success is dependent, first of all, on one's ability to find information in a digital environment. Then, once found, information in the form of graphs, images, text, videos, etc., must be interpreted and then evaluated for utility. Finally, making use of such information often requires digital communication. Problems arise in tasks at each step of the way, often due to the use of technological resources (e.g., the Internet, database tools, social networking sites, etc.). Indeed, use of technologies can change the very process by which a problem is solved. What might have been a familiar problem requires a new solution simply due to the introduction of technology. An example drawn from the PS-TRE conceptual framework illustrates this.

> *… the management of personal finance using spreadsheets, statistical packages and graphical tools. Here the problem itself may not be new (i.e., keeping spending in balance with income) but the new artifacts modify the distribution of work across social agents (professional vs. laypersons) and they deeply transform the procedures and steps required to solve the problem.* (OECD, 2009, p. 9)

In this example, instead of relying on a bookkeeper or using a financial ledger, a small business owner might now purchase bookkeeping software. In addition to working to make routine the different bookkeeping tasks done in the software, he or she would also need to take on technical tasks associated with using computers and software (e.g., maintenance, software updates, etc.).

According to the research reported in the PS-TRE conceptual framework, problems can vary in complexity depending on a number of factors,

> *the clarity of the initial situation; the number of subgoals and steps needed to solve the problem; the amount of information to be considered; and the pragmatic constraints that surround the person's activity (e.g., time constraints, level of stakes or hazard, probability of unexpected events or outcomes).* (OECD, 2009, p. 8)

Problems might be "open," with unlimited tools and resources that need to be considered when solving them. They might also be "ill-defined," lacking a clear map of how to proceed and requiring a planned series of sub-goals and actions, each utilizing different resources.

To solve such a problem, one must first recognize the difficulty and then move through a series of goal-defined actions to move past the difficulty and complete the task. Locating and making use of information and other resources is typically required, as is the need to draw on technology resources, which can

> Examples provided in the PS-TRE conceptual framework
>
> **Well-defined problem**
> *Using the attached schedule, find a train to go from Paris to Amsterdam on Tuesday, October 15th, leaving no earlier than 11 a.m. and arriving no later than 9 p.m.*
>
> **Ill-defined problem**
> *Find a way to go to Amsterdam on Tuesday, October 15th.*
> (OECD, 2009, p. 8)

make the problem even more complicated if the technology is new. Collaboration and communication with others is also commonly required for solving problems; knowing who to contact, when, and how requires communication skills and technical proficiency with the communication medium.

> *With learning and practice, some activities that were initially experienced as problem solving may become routine activities. Examples include fundamental skills such as reading and performing mental calculations, as well as everyday tasks such as tying one's shoes, replacing a broken light bulb, or installing new software on a personal computer.*
> (OECD, 2009, p. 7)

The PS-TRE conceptual framework suggests that all of this happens in a structured cognitive process, which is determined by the nature of the problem and the end goal. Once mastered, it is possible that a cognitive process might become a routine; consequently, the next time the situation occurs, it is no longer a problem!

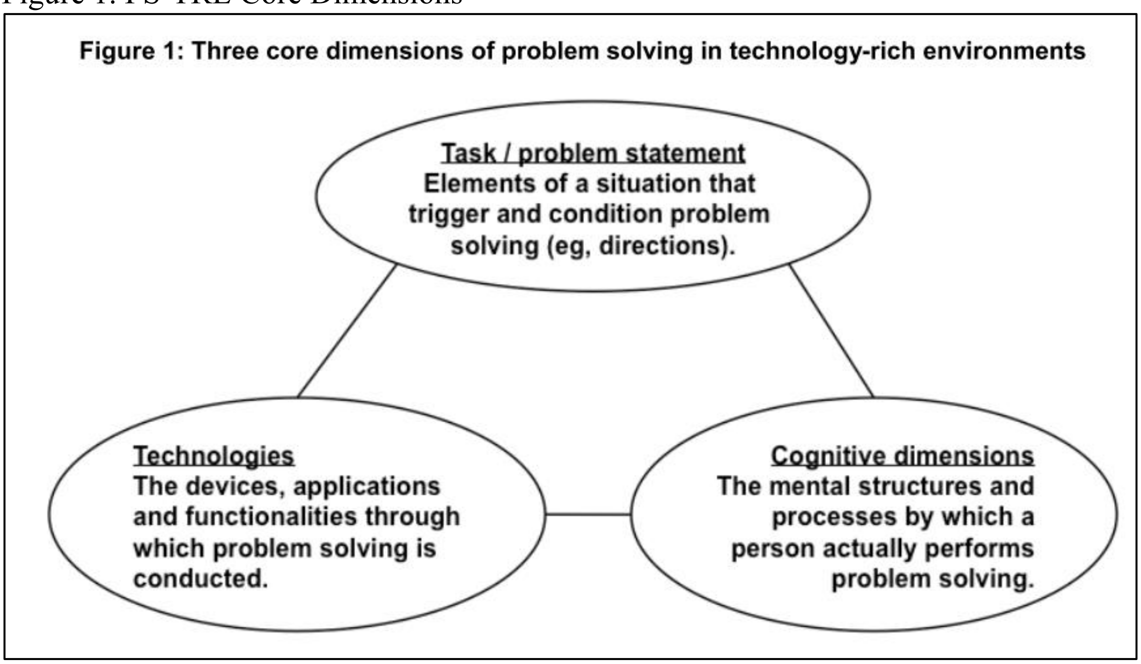
PIAAC Core Dimensions

PIAAC defines three important aspects of PS-TRE in the PS-TRE conceptual framework.

1. The task you need to address (the problem you need to solve)
2. The technology that you draw on to solve that task
3. The skills you need in order to successfully use the technology to accomplish the task or solve the problem

Figure 1 below, drawn from the conceptual framework, illustrates the relationship between these three core dimensions. Each will be described below.

Figure 1. PS-TRE Core Dimensions



PS-TRE conceptual framework (OECD, 2009, p. 11)

Task. "'Tasks' are the circumstances that trigger a person's awareness and understanding of the problem, and that determine the actions to be taken in order to solve the problem" (OECD, 2009, p. 11). The task requires some action to accomplish a goal or reach some end. In creating tasks to instruct and practice PS-TRE, practitioners should ensure they are relevant for the learners and pitched in difficulty so that they are not routine (or there will be no problem to solve!).

Cognitive dimensions. The next component of PS-TRE is the *cognitive dimensions*, the cognitive process employed to solve problems. The conceptual framework illustrates how a non-routine task can trigger the need to solve a problem. Rather than random actions, this requires "the active construction of goals and strategies on the part of the user" (OECD, 2009, p. 9). Although these cognitive processes are hard to observe while one is employing them, they are delineated in the conceptual framework as a series of concrete steps, illustrated here in Table 1. The table also shows examples of elements required to successfully accomplish or employ each aspect or step of the cognitive dimensions.

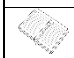
Table 1. Cognitive dimensions in PS-TRE

Dimension	Examples
Goal setting and progress monitoring.	Identifying one's needs or purposes, given the explicit and implicit constraints of a situation Establishing and applying criteria for constraint satisfaction and achievement of a solution Monitoring progress Detecting and interpreting unexpected events, impasses and breakdowns
Planning, self-organizing	Setting up adequate plans, procedures, and strategies (operators) Selecting appropriate devices, tools or categories of information
Acquiring and evaluating information	Orienting and focusing one's attention Selecting information Assessing reliability, relevance, adequacy, comprehensibility Reasoning about sources and contents
Making use of information	Organizing information, integrating across potentially inconsistent texts and across formats, making informed decisions Transforming information through writing, from text to table, from table to graph, etc. Communicating with relevant parties

Note: This table appears in PS-TRE conceptual framework as Table 1 (OECD, 2009, p. 12).

For purposes of instruction, the "Dimension" column might be considered the steps of the process of problem solving that can be taught to learners and, by extension, the elements of the domain that might be assessed. The steps give structure to problem-solving tasks and call for creative use of ICTs. Because of their utility in instruction, they deserve a closer analysis.

Table 2. Teachable steps of the PS-TRE process

	Step 1:	**Goal Setting.** In PS-TRE, a goal is an end result – what you want to happen so that task completion is possible. You can set a goal after you recognize the difference between what is happening and what you want to be happening; this is understanding the nature of the problem. The conceptual framework calls this "problem finding." In the example I gave about printing my draft, fixing the printer became the goal; there are likely several sub-goals to be accomplished for achieving that result.
	Step 2:	**Planning, self-organizing.** This step involves strategizing, setting up, and moving through a series of steps requiring reflection and corresponding actions. Each phase supports a sub-goal, which, when achieved, triggers a new sub-goal and its constituent reflection and actions. PS-TRE also calls this "problem shaping." To further the example above, before I could fix the printer, I needed to find information that would explain what was happening and how to remedy it. So, my planning required setting up a sub-goal of finding support documentation online.
	Step 3:	**Acquiring and evaluating information.** Because PS-TRE is primarily concerned with problems that arise due to use of ICT, this step is important. It involves an awareness of the validity of information sources and, most importantly, a critical read of the content provided. In my printer example, I knew that I needed to do a web search for support documentation and then evaluate the sources and effectiveness of the resources I found. As a result of the search and my review of the information, I realized that I likely needed to clean the printer heads.
	Ongoing:	**Monitoring progress.** Moving to reach a goal is a reflexive process where one continuously gauges how a strategy or action impacts progress. This happens at every step. In my example, the importance of monitoring is very clear; I had assumed that I needed to initiate the action from the control panel of my computer, so I spent quite a bit of time searching for information about how to clean the printer heads within the computer's printer settings. I pored through many resources, but couldn't find anything to help. There was no useful information, so, monitoring, I concluded that I was searching for the wrong type of information. This monitoring of progress indicated to me that I had reached an impasse. I needed to reformulate my sub-goal and try a new strategy.
	Step 4:	**Making use of information.** After finding useful information, one must then be able to act on it. In my example, I finally figured out that the settings for cleaning print heads were on the printer itself, not in the computer's control panel. I then quickly found instructions online. In order to act, I needed to have some familiarity with the printer's buttons and features, which I did. If I had not, I would have used the information to set a new sub-goal, finding a user manual for the printer.

Technologies. In PS-TRE, technologies are "the devices, applications and functionalities through which problem solving is conducted" (OECD, 2009, p.11). The PS-TRE conceptual framework identifies several areas of technology, as shown in Table 3. As an instructor, you will want to use this list of common technologies as a starting point for PS-TRE activities, but also consider integrating technologies not listed, specifically mobile devices and the applications commonly used on them, like texting or navigation apps.

> … digital technologies have deeply transformed the way individuals learn, communicate, work, and more generally the way they function in societies. Shopping, traveling, and interacting with administrations and services, to cite only a few examples, more and more routinely involve the use of digital technologies.
>
> (OECD, 2009, p. 5)

Table 3. Technology dimensions of PS-TRE

Dimension	Examples
Hardware devices	Desktop or laptop computers, mobile phones, personal assistants, geographical information systems, integrated digital devices
Software applications	File management, Web browser, Email, Spreadsheet
Commands, functions	Buttons, Links, Textboxes, Copy/Cut-Paste, Sort, Find
Representations	Texts, Sound, Numbers, Graphics (fixed or animated), Video

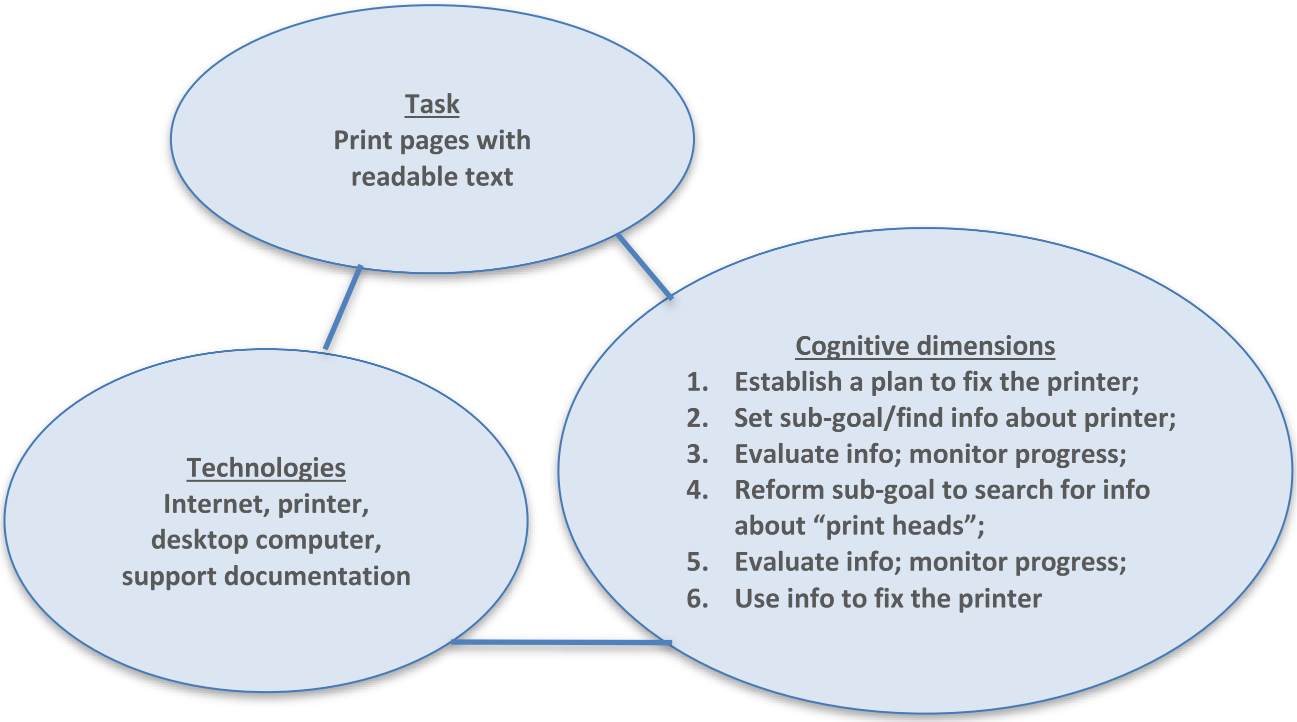
Note. Only laptop devices, a few simulated software applications and a restricted range of representations will be included in the first cycle of PIAAC.

Note: This table appears in PS-TRE conceptual framework as Table 2 (OECD, 2009, p.13).

Because PS-TRE is concerned with how ICT skills are actively integrated within the problem-solving process, learners need opportunities to be pushed to apply their skills with these given technologies in novel ways.

Putting the steps together. You can see from the example described in the steps how the three core dimensions of PS-TRE are tightly integrated. A problem arises because *a task* has some non-routine element; the *cognitive dimension* involves recognizing the problem, strategizing, and implementing the steps to solve it; and, finally, actions motivated by the cognitive dimension and the task at hand impact or determine the resources and *technologies required* to solve the problems. To illustrate the interconnection of the dimensions of problem solving, it is useful to map them onto the core dimensions diagram presented in Figure 1 above. Figure 2 below shows how solving the problem about my printer maps on to the core dimensions diagram, with the numbered steps in the cognitive dimensions circle aligned with the step numbers featured above.

Figure 2. Mapping a problem



You can see in Figure 2 how interconnected the core dimensions are, and also how application of the process defined in the cognitive dimension is not necessarily linear, requiring more than one series of setting and then testing sub-goals in order to reach a conclusion to the problem.

Here is a sample item from the actual PIAAC PS-TRE assessment, which also illustrates the interconnectedness of the core dimensions. This example was designated a Level 1 example. (There will be more guidance on levels and item complexity later in the brief. See also Appendix C for a description of proficiency required at the different PS-TRE levels.) As you read through the example, reflect on the different steps required to accomplish the task described.

Figure 3. Level 1 PS-TRE item example

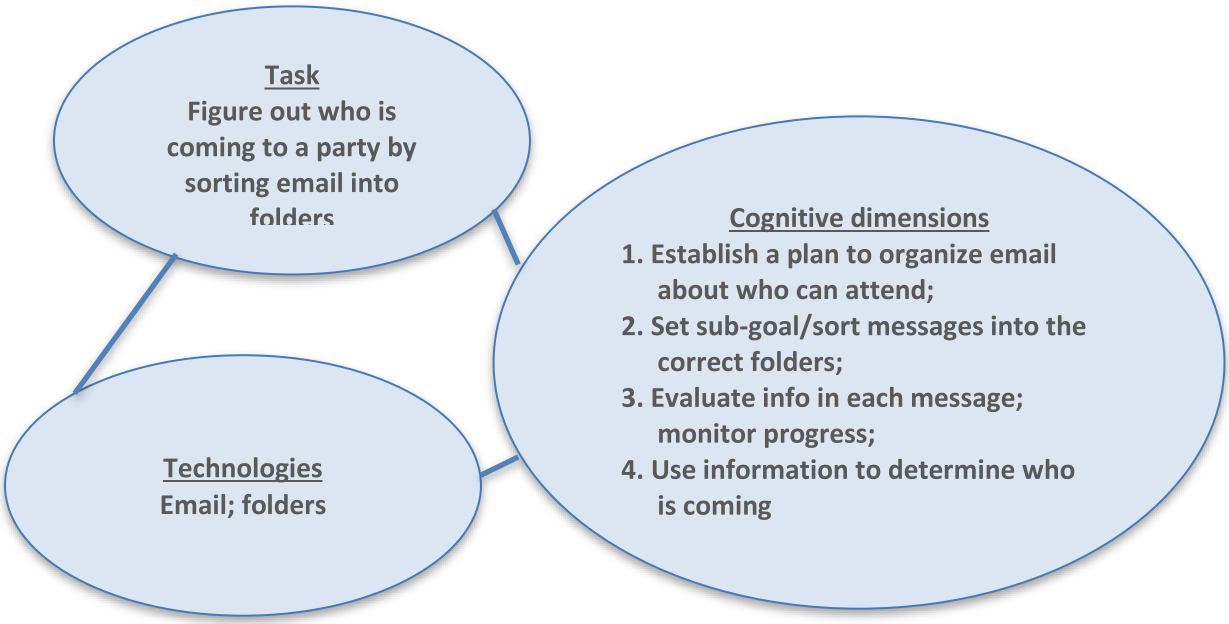
Level 1: Party invitations (Item ID: U01A)
Cognitive strategies: Plan and use information
Technology: E-mail
Context: Personal
Difficulty score: 286

This task involves sorting e-mails into pre-existing folders. An e-mail interface is presented with five e-mails in an Inbox. These e-mails are responses to a party invitation. The test-taker is asked to place the response e-mails into a pre-existing folder to keep track of who can and cannot attend a party. The item requires the test-taker to "Categorise a small number of messages in an e-mail application in existing folders according to a single criterion." The task is performed in a single and familiar environment and the goal is explicitly stated in operational terms. Solving the problem requires a relatively small number of steps and the use of a restricted range of operators and does not demand a significant amount of monitoring across a large number of actions.

(OECD, 2013a, p. 89)

Figure 4 shows how this PS-TRE item might map onto the PS-TRE core dimensions presented in Figure 1.

Figure 4. Mapping a Level 1 PS-TRE item



Like all Level 1 items, this problem includes a relatively simple task. The example states the goal explicitly, and all operations (i.e., required activities and strategies) occur in one familiar digital environment, email. Level 1 items like this are accomplished in one or two steps and require only minimal monitoring. Note that this item requires only one step and use of one type of technology. However, within that one step there are two operations, opening an email and then sorting it into a folder.

From the example above, it should be fairly evident that limiting instruction to "how to" use ICTs will fall short of preparing learners to draw upon them in the non-routine tasks. To lead learners into this instruction, it might be helpful for teachers to elicit examples from the learners themselves and then use them as the context for making use of ICTs. The section below will spell out how to create a unit to teach the process required to successfully engage with problem solving in digital environments.

Section III: How to Teach PS-TRE

This section provides guidance for creating a PS-TRE instructional unit and activities employing the problem-solving process described above. While limitations on space preclude presenting a comprehensive curriculum, the brief shares suggestions for how to provide explicit instruction of the PS-TRE approach, followed by ample practice of it in instructional activities employing problem-based scenarios. Finally, the brief touches on how to integrate implicit representation of PS-TRE more broadly in other academic content domains. The goal of both explicit presentation of the process and application of it is the same – to provide ample opportunities for learners to employ the process so that problem solving in a technology-rich world becomes more routine, or less problematic. Because this is fairly new ground, teachers will need to do some planning to best map out an instructional unit on PS-TRE. Such planning should include setting overall instructional goals, deciding on a teaching approach, and thinking about how to measure learners' ability to employ PS-TRE.

> From the PS-TRE conceptual framework: "The core characteristic of problem solving is that it is impossible for a person to achieve the goal through routine actions. In problem solving, one has to reflect on the situation in order to identify the proper arrangement of decisions and actions that may lead to a solution. Thus, the status of problems is conditional upon a person's familiarity with the problem or category of problems. With learning and practice, some activities that were initially experienced as problem solving may become routine activities."
>
> (OECD, 2009, p. 7)

Where and How to Integrate PS-TRE Instruction

Problem-solving opportunities abound in formal learning, so you could include a PS-TRE unit in almost any ABE, ASE, or English language course. It might be useful to start with thinking about PS-TRE as an extension of the digital literacy work you are doing with your learners. True digital literacy means not only technical proficiency with a computer skill, but also knowing when it is appropriate to use a particular technology skill or tool. This level of understanding comes from multiple opportunities to transfer skills from initial instructional activities to different contexts (Harris, 2015; Jacobson, 2012; Lazonder & Rouet, 2008; Smythe, 2012) (e.g., teaching mousing skills with a drag and drop exercise found online and then applying mousing skills to formatting text in a document). Teachers might view PS-TRE as a means by which to provide a structure for such contextualization, especially for learners with higher-level digital literacy skills.

As you read through the example of instructional cues and activities that follow, you will likely notice several things. First, the recommended approach to teaching PS-TRE is to start with very simple examples and then allow learners to develop proficiency by gradually adding complexity in both the description of task (i.e., making it less explicit) and the process required to solve a problem (e.g., requiring more steps). The approach recommended here also suggests not pushing challenging PS-TRE concepts at the same time as introducing new technologies. As you will read later, PS-TRE is an excellent means by which to extend instruction on use of a technology tool, but because it relies on creative application of any technology, learners should have a minimum understanding of the online environment and some of the basic computer functions. It is a pre-requisite for this domain.

Finally, if you are familiar with the instructional approach problem-based learning (PBL), you might observe that the process of problem solving recommended here resembles the structure of PBL lessons. In both cases, a problem is the central organizational element of instruction and learners build metacognitive skills as they learn academic content (Barrows, 1996). PBL holds that learning depends on active engagement with both social and contextual factors, where through learning by doing learners develop metacognitive awareness (Barrows, 1996; Gabe & Vale, 2011). One interesting difference is that PBL works to develop interdisciplinary knowledge while it is strengthening learners' problem-solving skills; whereas, our approach here is explicitly on teaching the process. However, once the students gain control over the process, they might continue to develop their skill by applying it in service of other learning.

Identifying Overall Goals for PS-TRE Instruction

Explicit instruction of PS-TRE will illustrate that problems are not best solved through trial and error. Therefore, the primary goal of a PS-TRE instructional unit should be to teach the problem-solving process described in Table 2 and to provide learners sufficient practice to be able to make use of it (eventually) in daily life. Additionally, by providing contextualized instruction of digital literacy skills and guidance on using these skills in real problem-solving tasks, teachers can reinforce the relevance of Internet and computer skills and build confidence with them through use in a supportive environment.

Getting Started

For the process to be teachable, it must be contextualized into tasks that are relevant and require a use of technology that learners have sufficient skill to apply. This means that teachers must devote time for needs analysis both initially and throughout the unit. Early class meetings should include activities to 1) establish a shared understanding of the importance of PS-TRE, 2) determine learning needs, and 3) present the actual steps of the problem-solving process. Each element of the early phase of instruction will be developed below.

1) Teaching learners why PS-TRE is important. Some class time early on should be designated for explaining to students the significance of PS-TRE and the connection to use of technology. This should be an interactive session, asking students to participate by sharing their experience, their challenges, and examples of their frustrations finding/accessing information online.

One possible activity for accomplishing this involves leading the class in a discussion about technology tools and their uses, and documenting responses in a graphic organizer (e.g., mind map, chart, or table). Such an activity might unfold like this:

1) The teacher starts by having learners list computer skills that they find valuable – either those they draw on regularly or those they wish they could learn.
2) A teacher or student volunteer(s) can create a table, starting by writing the elicited computer tools and skills down in one column.
3) The teacher then facilitates the discussion further by asking for what each tool or skill is used and why it would be useful, completing the chart as the discussion unfolds.
4) If learners do not have a familiarity with any given tool or skill, the teacher or students can demonstrate it or find an image of it to share.

Table 4 (on the following page) shows an example of a table that be used to document such a class discussion. For higher-level students, teachers might have learners work in pairs or small groups.

Table 4. Class discussion report

Computer Tools & Skills	**What they do?**	**Why/How they are useful?**
Computer	*Access and store information*	*In school, apply for jobs, get online*
Word	*Make documents*	*Write a class paper or résumé*
Excel	*Organize information and calculate numbers*	*Make a budget, keep track of expenses*
World Wide Web	*Connect to the world*	*Find information or email*
Internet search	*Find information*	*Find a school, learn English*
Online maps	*Tell you how to get someplace*	*Help you get to a new job, show you a bus route*

Another option is a simple matching exercise, requiring students to match a technology resource to a problem. One possible approach to this activity follows.

Teachers ask learners to brainstorm a list of technology resources. The prompt could ask them to think about all of the technology resources they have seen in the past day or what they see in the classroom.

1) A teacher elicits stories from learners about a time when someone had to help them solve a problem that required a technology they could not use. As learners tell stories, a teacher can capture the gist of the problem being explained (e.g., paying a bill, contacting a teacher, finding a bus map, etc.).
2) The words generated in the list of technology resources and list of problems can be put on notecards and distributed around the room; half of the learners have a technology resources card and half have a problem card. Have each learner with a problem card find a learner holding a technology resource card that might solve his or her problem. The fact that many of the same technologies might be applied to more than one problem will create opportunities for conversation, negotiation, and reflection on the best use of the different technology tools.

For example, cards might look something like what is shown in Table 5.

Table 5. Example of technology problem and resource activity cards

Problems	Technology Tools/Resources
Paying a bill electronically	*Online form*
Contacting a teacher	*Email*
Finding a bus schedule & route map	*Cell phone*
Finding the name of a local business	*Internet search*

These exercises are useful not only for spelling out the connection between problematic tasks and technologies, but also as an informal analysis of learners' awareness of technologies at play in their daily lives and the context for problem-solving scenarios that might seem relevant to them. A teacher might take this a step further by asking the learners to define more problems or tasks with which they have struggled or to describe success stories.

2) Determining needs. Let's assume that you are looking to PS-TRE as a means by which to support contextualizing computer skills or digital literacy lessons. It is very likely that in any given classroom the range of students' computer skills can be represented along a continuum. Though it is useful to integrate some aspects of PS-TRE at all levels, it should be noted that at the very minimum, success with PS-TRE depends on a foundational knowledge of how to use common ICTs.

The PS-TRE conceptual framework describes areas of required proficiency as follows:

- Skills required to control a device (e.g., the mouse, keyboard, and digital displays).
- Conceptual knowledge of how information is organized and stored in files, folders, and basic file management operations such as save, open, close, delete, move, and rename.
- Recognition and understanding of symbols and icons that convey key information (e.g., iconic representation of files and folders, hyperlinks, scrollbars, and different types of menus and buttons) (OECD, 2009, p. 16).

In a PS-TRE unit, teachers need to determine the students' facility with the relevant technologies in order to better understand which need to be explicitly taught before teaching the problem-solving process. Learner success will be determined by achieving a balance between technology challenges and the level of difficulty of the problems being solved. In a typical mixed-level classroom, there will be learners working on building computer skills at the lowest levels. With these learners, teachers might decide to use simple problem-solving scenarios as the context for practicing new computer skills. More advanced learners, who have already achieved competence with foundational computer skills, are arguably ready to engage in PS-TRE at a higher level by applying technology skills to more complex problems. In either case, learners should work toward simultaneously strengthening digital literacy skills and gaining opportunities to practice the problem-solving process.

For more guidance defining what skills serve as a useful foundation for PS-TRE, teachers might look to the Northstar Digital Literacy standards. The standards offer concrete descriptors that teachers use to describe their students' computer skills in the following areas: basic computer skills (e.g., using mouse, click, copy/paste, move, highlight, delete, etc.), World Wide Web, Windows, Mac OS X, email, Word, Excel, PowerPoint, social media, and information literacy. Teachers can track student skills using a checklist of the standards in each category or by giving students the Northstar Digital Literacy Assessment modules (found at www.digitalliteracyassessment.org), and then, depending on the level of the class, set goals for instruction. It is likely that some early direct instruction on the actual technology tools may be required to be sure that learners can not only control them but also are aware of the overall capabilities and functionality of each tool, so that they can better apply them in real use.

Rather than thinking of an approach where a teacher first covers all technology skills a given problem might require and then goes over the problem-solving process, it is likely better to layer instruction of different technology skills with instruction of strategies for dealing with increasingly complex problems. This should be done in a way that focuses new instruction on either one or the other – not both a new technology and a new level of complexity of the cognitive dimension of PS-TRE at the same time. For example, in the PIAAC PS-TRE example shown in Figure 4 (about email and party invitations), a teacher is likely to encounter learners who can use email but may have never had occasion to organize email messages into folders. The simple problem posed in the example provides a context where learners can practice this skill without the distraction caused by a complicated problem.

3) Spelling out the process. After you have determined the technology skill level and learning needs of your students and helped them understand the connection between relevant technology resources and the tasks or problems that they suggested, you can begin to lay out the steps of the PS-TRE process, the cognitive dimension of PS-TRE (described in Table 1 above), gradually introducing them as learners gain familiarity with each step.

One might begin by organizing the scenarios, tasks, and problems that were elicited by learners in the previously described exercises and then referring back to them in instructional activities for each step. The tables below show how teachers might explain each of the steps to students and provide example activities pitched to fairly low-level students (i.e., the activities represent fairly straightforward problems, to which a solution might be reached in a few simple steps). These activities should be considered a springboard for further instruction or activities supporting differentiated instruction in mixed-level classrooms.

Table 6. Step 1

<table>
<tr><th> Step 1: Set a Goal</th><th>Activity Idea</th></tr>
<tr><td>This is “problem finding,” or figuring out the end result, what you need to accomplish so that task completion is possible.

You can set a goal after you recognize the difference between what is happening and what you want to be happening. Recognize that this might not be immediately clear. Decide how you will know when you have accomplished your goal.</td><td>Use the scenarios or problems that the learners identified in the previous exercise. Have them do “problem finding.”

<table><tr><th>What is happening</th><th>What I want to happen</th></tr><tr><td>Need to contact teacher, but no phone number</td><td>Need to contact teacher some other way: possibly email or through online curriculum website</td></tr><tr><td>Need to pay a bill, but can’t use a check</td><td>Need to find some way to pay electronically</td></tr></table></td></tr>
</table>

Table 7. Step 2

<table>
<tr><th>Step 2: Plan and Organize</th><th>Activity Idea</th></tr>
<tr><td>Create a plan for solving the problem. This is “problem shaping,” setting up and moving through a series of phases of reflection and corresponding actions. Each phase supports a sub-goal, which when achieved triggers a new sub-goal and its constituent reflection and actions.

What strategies, technology resources, or sort of information is critical for accomplishing your goal? How will you employ it or access it?</td><td>Use the scenarios or problems that the learners identified in the previous exercise. One at a time, ask learners to make a planning chart showing technology to be employed and for what task. This will be the first draft of their plan.

<table>
<tr><th colspan="2">Task: Contact your teacher</th></tr>
<tr><th>Technology</th><th>What I will do</th></tr>
<tr><td>Computer and Internet</td><td>See if teacher’s email is on the school website</td></tr>
<tr><td>Email</td><td>Send a message to the teacher</td></tr>
</table>
</td></tr>
</table>

Table 8. Step 3

<table>
<tr><th>Step 3: Monitor Progress</th><th>Activity Idea</th></tr>
<tr><td>Moving to reach a goal is a reflexive process where one continuously gauges how a strategy or action impacts progress.

Pay attention to your progress. Did you make a mistake in your planning and now need to reassess the tasks and technology resources?</td><td>As an extension to the activity above, teachers ask students to discuss how they will know if the steps they laid out are useful and if they are making progress. The table in Step 2 could be expanded with an additional column for registering such information.

<table>
<tr><th colspan="3">Task: Contact your teacher</th></tr>
<tr><th>Technology</th><th>What I will do</th><th>Progress?</th></tr>
<tr><td>Computer and Internet</td><td>See if teacher’s email is on the school website</td><td>There is an online staff directory</td></tr>
<tr><td>Email</td><td>Send a message to the teacher</td><td>If you get a response you know email address was correct</td></tr>
</table>

Teachers follow up with an activity about what to do if a plan fails. In the example, students might need to come up with a new sub-goal if there is no online staff directory, like checking to see if it’s possible to message the teacher through an online curriculum website (e.g., Moodle) they might be using.</td></tr>
</table>

Table 9. Step 4

Step 4: Acquire & Evaluate Information	Activity Idea
Not all information is equally useful or reliable. Selecting helpful information involves an awareness of the source and a critical read of the content provided. After finding information, consider these questions: Is this what I need to know? Can I trust the source? Do I understand it and know how to use it?	A useful focus for developing proficiency with this step is building awareness about how to interpret information and evaluate its source. There are a number of resources available online for building evaluation skills, especially critiquing information found online. A place to begin is the OER Commons.[6] A useful search term for finding instructional resources is *information literacy*. One particularly useful resource found there is GCFLearnFree Digital Skills - Search Better, which is geared for learners with low literacy skills.

Table 10. Step 5

<table>
<tr><th>Step 5: Use the Information</th><th>Activity</th></tr>
<tr><td>Consider what the task requires to make the information useful: Does it need to be organized? Combined with information from another source? Put into a different format? Consider how it will be best presented or shared.</td><td>Ask students to consider the task and what final action is required to make use of the information or solution gleaned through the previous steps. You might create a T-Chart showing the task description on one side and a space for noting the action(s) required for making use of information on the other side. Remind students that they are done after they have completed some final action.
<table>
<tr><th>Task</th><th>Final Action</th></tr>
<tr><td>✓ Contact a teacher</td><td>✓ Compose and send an email</td></tr>
<tr><td>✓ Pay a bill online</td><td>✓ Locate or calculate amount owed and complete payment on a webpage</td></tr>
<tr><td>✓ Take the bus to work</td><td>✓ Use information about mapped routes and schedules to board the correct bus</td></tr>
</table>
</td></tr>
</table>

[6] OER Commons is a database and clearing house of Open Educational Resources (OERs); OERs are learning objects (videos, images, quizzes) or fully developed curricula developed by educators and shared freely.

One way to approach this would be a series of at least five lessons, minimally one focusing on each step of the process. After a time, as learners demonstrate mastery with a given step, teachers can propose tasks that require stringing the steps together; however, teachers need not include every step of the problem-solving process each time. Some classroom activities may be framed by tasks that require only one cognitive process (like planning for what kind of technology is appropriate to complete a task), others may draw on two cognitive processes (like evaluating the results of an information search and then communicating relevant information). Careful framing of the task will establish the cognitive dimensions or steps required. Additionally, careful attention to the technology resources required for completing the task will ensure that classroom activities only require those available in the instructional environment.

4) Describing PS-TRE complexity levels. Because adult learners come to school with diverse experiences and a range of formal schooling, they bring different prior knowledge and skills to the classroom. It is important to provide opportunities for learners to engage in problem-solving tasks representing the complexity that they can handle – hence teachers must view difficulty as a continuum and learn how to control the complexity of problems they pose. In the framework, difficulty is determined by how a problem statement is framed (whether problem is explicitly stated) and its *intrinsic complexity*. The cognitive dimensions are all central to a task's complexity, including:

> *the number of required cognitive processes (e.g., goal setting and monitoring; planning; acquiring and evaluating information; making use of information); the number and kind of steps required to complete a task; the inclusion of unexpected outcomes or impasses to which a test taker must respond; and the extent to which tasks are open-ended or explicitly broken down into a series of defined steps.* (OECD, 2009, p. 17)

The following table shows how teachers might control each of these categories of complexity in order to create the "worked examples" recommended by Kirchner et al. (2006). Teachers can use the table to better understand each complexity factor and then begin to imagine how they might be variously combined to create items of varied complexity in order to finetune worked examples that provide adequate scaffolding for their classroom activities.

Table 11. Representing varied complexity in PS-TRE activities

Complexity Factor	Guiding Questions for Adjusting Complexity	Continuum of Complexity	Tips for Worked Examples
Definition of problem or goal	*How clearly is the problem described; is the goal directly stated?*	Explicit ➔ Inferred	Be intentional about word choice and whether or not the problem statement includes ample clues for learners.

Table 11. Continued

Complexity Factor	Guiding Questions for Adjusting Complexity	Continuum of Complexity	Tips for Worked Examples
Number of online environments or applications	*How many ICTs are required to solve the problem?*	One ➔ Two or more	Determine required number of ICTs based on the number of steps required and the learners' technology skills.
Familiarity of environments	*Are the ICTs commonly used applications, devices, or functions or are they unfamiliar (e.g., email versus a unique web-based form)?*	Familiar ➔ Novel	Balance choices about familiarity of environments and applications with learners' broader technology experience and other complexity factors.
Number of steps	*Can the information required to reach the goal be accomplished in one step?*	Limited ➔ Multiple	Given learner proficiency with required ICTs and other complexity factors, determine what number of steps might inhibit persistence.
Number of operators	*Does the activity require more than one activity or strategy within any of the steps (e.g., running a sort function and printing a report in Excel)?*	One ➔ Multiple	Given learner proficiency with required ICTs and other complexity factors, determine what number of operators might tax task persistence.
Degree of monitoring	*Does the task require attending to incremental progress toward goal? What might indicate positive progress toward the goal?*	Little or none ➔ Some	Limit degree of monitoring if the ICT or operators required are fairly new.
Distractors, unexpected outcomes and impasses	*How controlled is the task? Are there likely to be unintended results that distract or hinder progress toward the goal?*	None ➔ Some	In the early stages, limit distractors. Set up worked examples unlikely to result in surprises and impasses.

Examples of varied complexity. Let's examine two different complexity factors to more deeply explore how complexity might vary in a worked example. First consider the impact of *distractors*. In PS-TRE, commonly addressed problems have to do with issues using websites, software, and hardware. At some point, a teacher needs to make choices about the environment or resource that serves as the stimulus for answering the question. One aspect of a worked example that a teacher can control is the context of the problem-solving activity. For example, suppose a teacher is staging a problem-solving activity touching on finding an apartment online. Consider the difference in the choice of the two web environments shown in Figures 5 and 6, either of which would be useful for such task.

Figure 5. Website example one

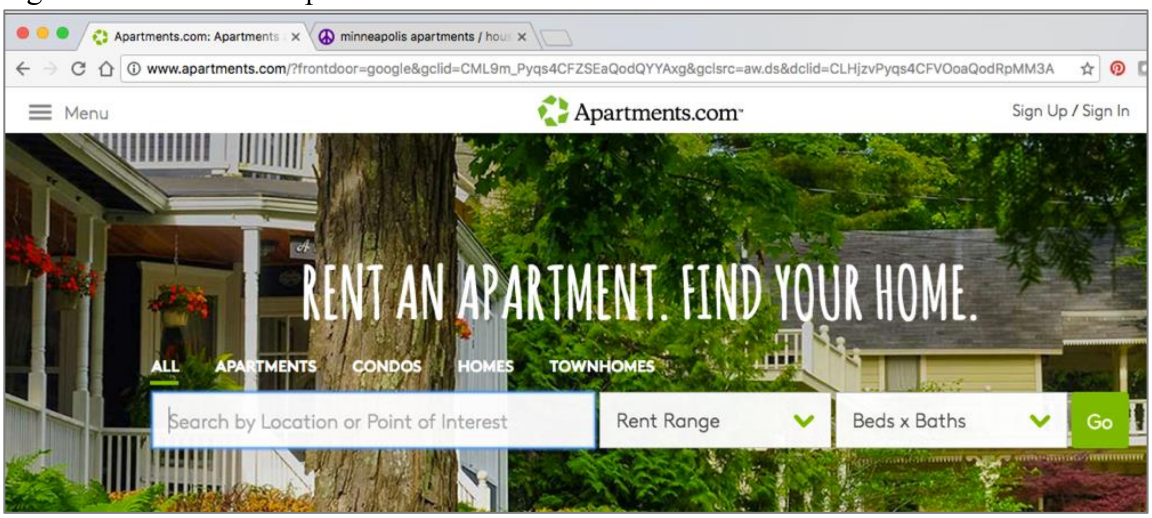
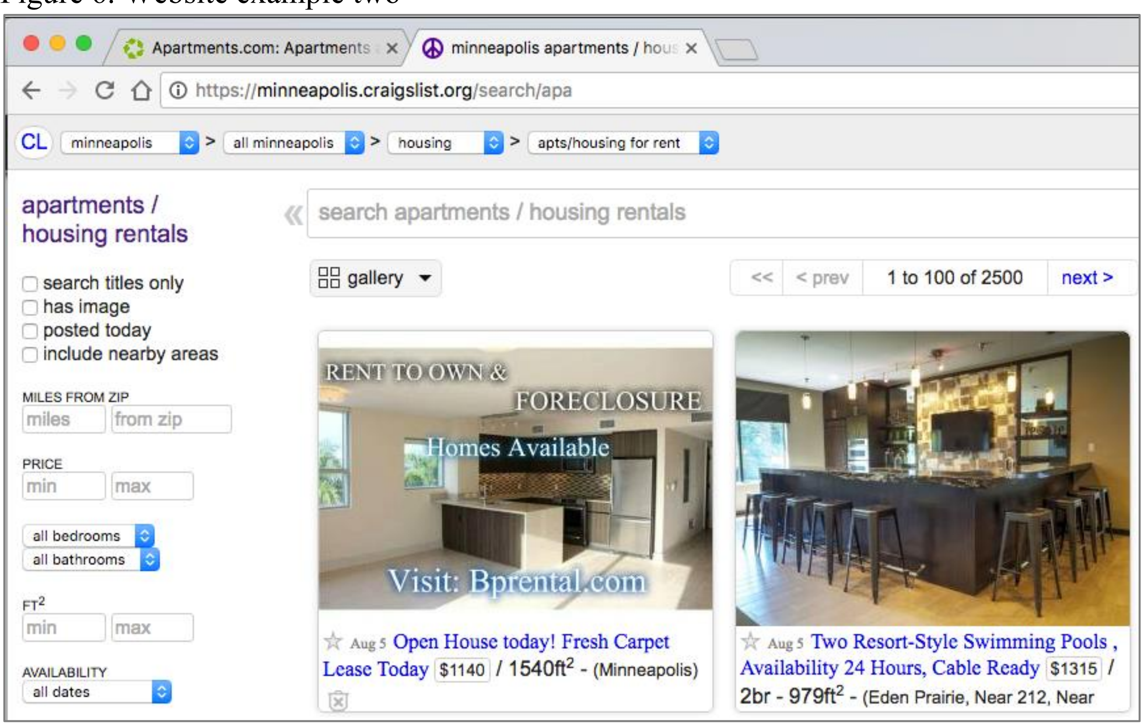


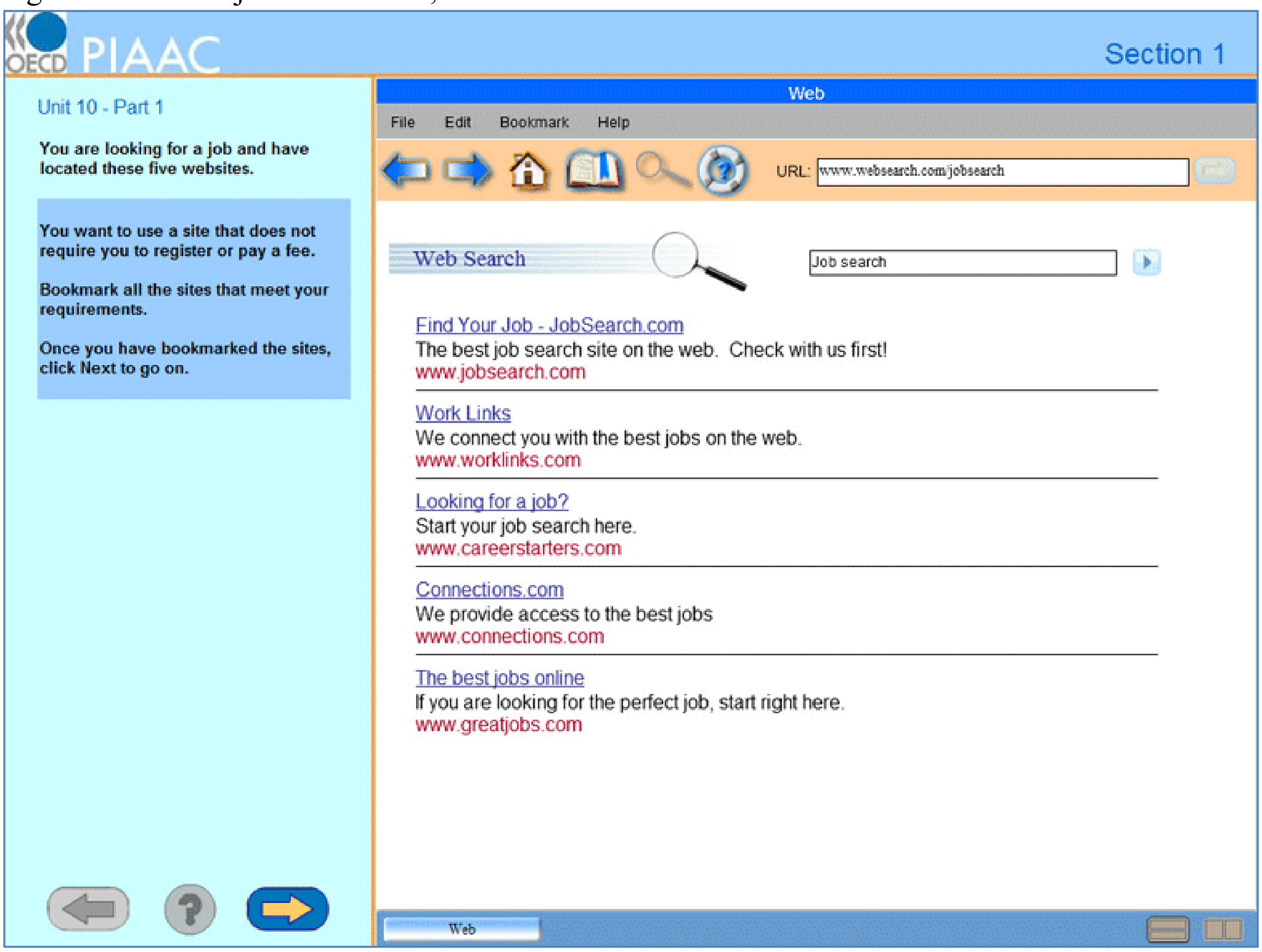
Figure 6. Website example two



A teacher can vary the stimulus for a problem-solving task by controlling for simplicity in the visual environment required for completion of the task. In this specific case, it's clear that the amount of information on the page in Figure 6 makes it more cluttered and perhaps more difficult to use than the website shown in Figure 5, with less information. Such choices are perhaps the easiest way to control the level of complexity.

Another complexity factor that is relatively easy to control is the *number of steps or operations* required to solve a problem. The following sample item from the PIAAC PS-TRE assessment is a good example of a complex task because it requires use of multiple web pages and knowledge of bookmarking. The task requires exploring a search result page displaying links helpful for a job search. To answer correctly, respondents need to find and then bookmark the free sites. You will note, from the series of images laid out in Figures 7, 8, and 9, that to answer correctly you need to interpret information on a page and click through different webpages to figure out if a site is free or not. Figure 7 shows the list of possible links.

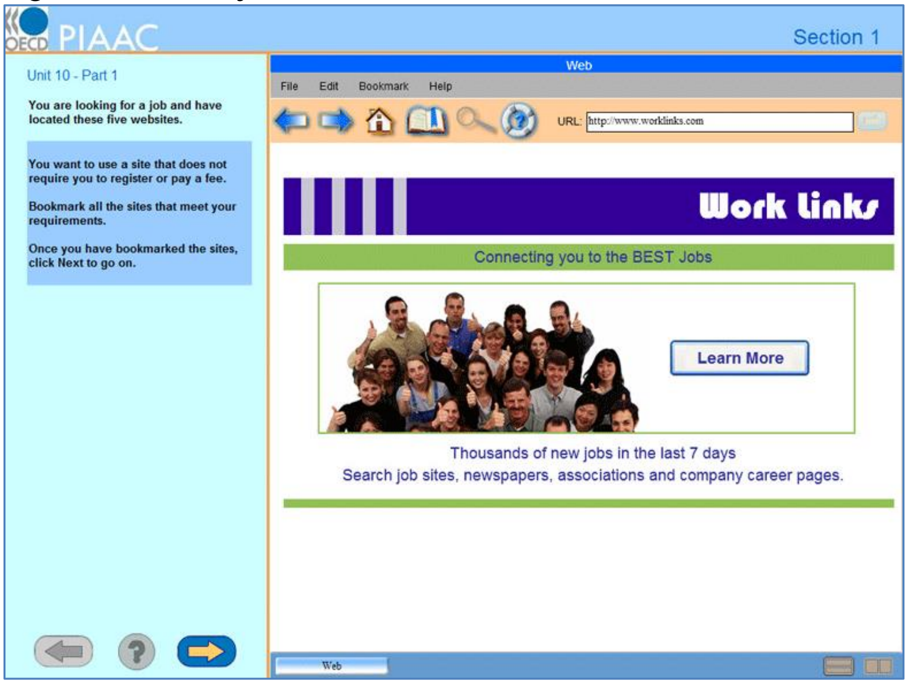
Figure 7. PS-TRE job search item, first screen



Note: "Figure 1. Opening screen of job search task" from https://nces.ed.gov/surveys/piaac/images/sample_pstre1.gif

In the next stage of answering this question, Figure 8 shows what one might see after clicking on "Work Links" in the screen above.

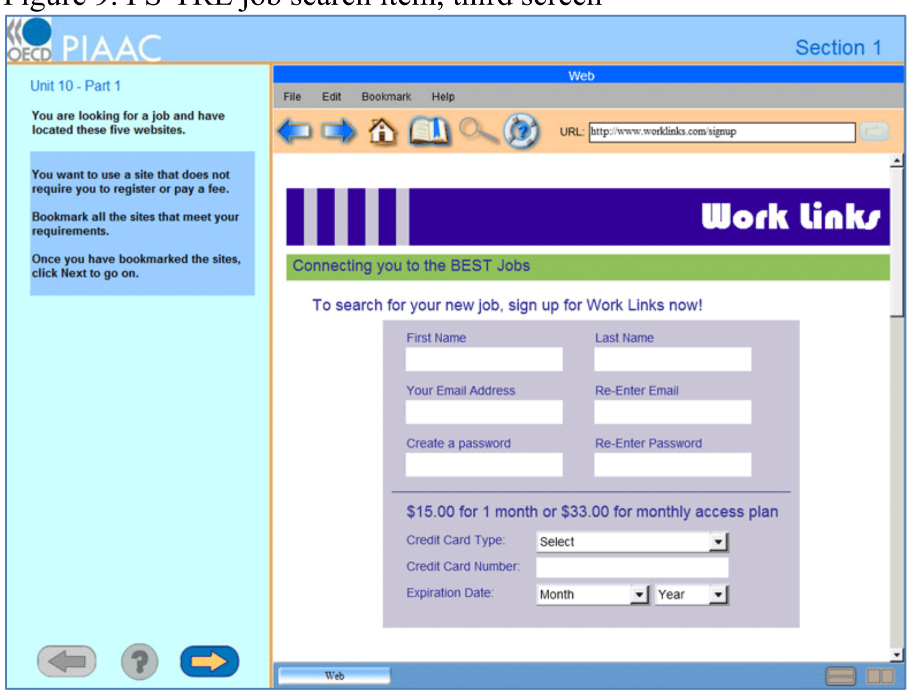
Figure 8. PS-TRE job search item, second screen



Note: "Figure 2: Website where relevant information regarding fees and registration is not on opening screen" from https://nces.ed.gov/surveys/piaac/images/sample_pstre1b.gif

It is still not clear in Figure 8 whether "Work Links" is free or not. It is not until one clicks on "Learn More" that it becomes apparent that this site would not be bookmarked, as indicated by the request for credit card information in the form shown in Figure 9.

Figure 9. PS-TRE job search item, third screen



Note: "Figure 3: Second page of same website – relevant information is located in the directions for the form which indicate that users must sign up (register) and pay a fee." from https://nces.ed.gov/surveys/piaac/images/sample_pstre1c.gif

In this example, not only must the respondent click through multiple webpages to find the relevant information, they must also complete the primary operation required by the task, bookmarking the correct sites. Such problem-solving activities require more than one step and operation.

Putting it All Together: Guidance on Creating Learning Activities

Now that you have been introduced to the core elements of PS-TRE, have seen some instructional activities that might be used to introduce a problem-solving process, and understand what factors contribute to complexity of a task, it's time to think about how to put it all together. It might be helpful to start planning for instruction by using the following guiding questions.

1) What tasks are relevant to my learners' work, family and everyday living, or education and further learning?
2) What are some representative problems inherent in those tasks?
3) What technologies are required for solving the problems and accomplishing the tasks?
4) What context or environment will provide the stimulus for the task and planning for problem solving (e.g., website, software, hardware, etc.) and how complex is it?
5) By what combination of complexity factors can I vary the difficulty of the required tasks to meet the diverse needs of all my learners?

By asking these questions, teachers can create worked examples that fit the needs of any given group of learners. Teachers might then organize integration of PS-TRE tasks utilizing the following rubric:

Table 12. Activity planning rubric

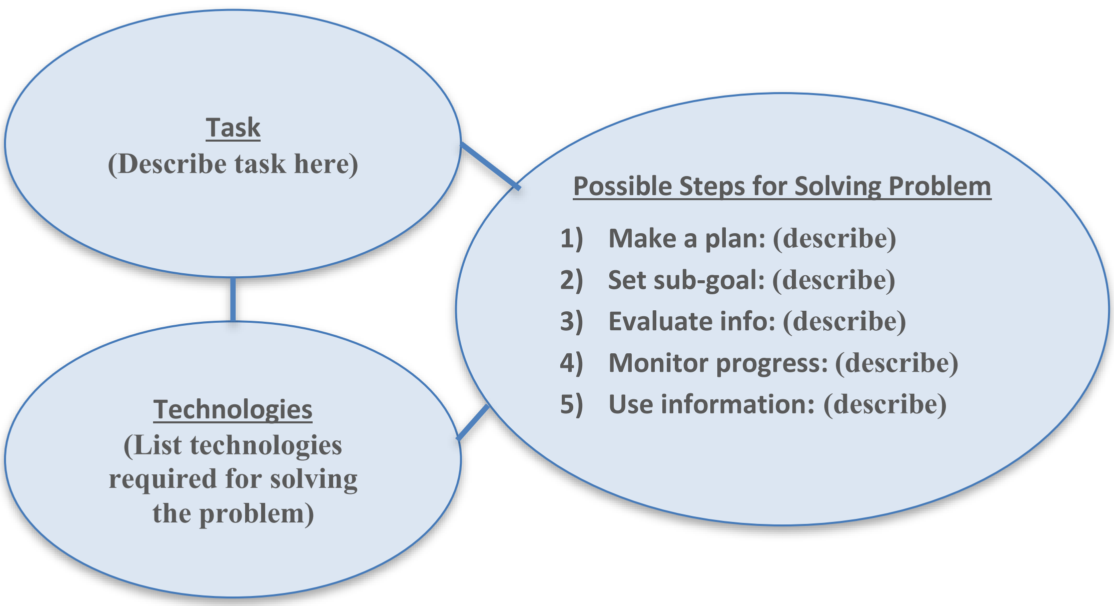
Stimulus	Describe the resource or environment.	Example: Requiring students to use email
Task	Define it.	Students need to figure out who is coming to a school event by sorting email responses into folders
PS-TRE Steps Required	List the possible steps.	Students will use all steps
Technologies Required	List possible technologies.	Internet, email, possibly Word or Excel (for higher level students)
Complexity Factors		
Clarity of problem statement:	Explicit? Inferred?	Varied instructions for different students. For those new to email, make it explicit
Use of online environments or applications	One? Two? Three? New? Familiar?	One or two, depending on prior experience
Number of steps	One? Multiple?	Open email, read email, sort into folders. Possibly require creating a Word doc or Excel spreadsheet.

Table 12. Continued

Complexity Factors		
Number of operators *(e.g., running a sort function in Excel)*	One? Multiple?	Opening and reading the email, then sorting email. For advanced students, more operations with Word or Excel.
Degree of monitoring *Attending to progress toward goal*	Limited? Some? Much?	Some monitoring to be sure email is sorted correctly and files are made.
Distractors, unexpected outcomes and impasses	None? Some? Many?	Can create a few distractor emails that contain insufficient information to file

Remember that a goal of PS-TRE instruction is to show students that planning is required in order to efficiently conduct tasks in complex digital environments and to show that trial and error is not an effective way to conduct tasks or solve a problem. One way to reinforce the importance of planning is to use the PS-TRE Core Dimensions figure from the PS-TRE conceptual framework. To make it more learner-friendly a teacher might call it a *Problem-Solving Planning Map.* A teacher could use the Map in Figure 10 as a template for classroom activities.

Figure 10. Problem Solving Planning Map



The following example shows application of the planning map by integrating it into instruction and practice about using email. In this example, assume a teacher has just done some instruction on how to use the basic features of an email application, including organizing email messages. After ample explanation and practice activities,[7] it is time to contextualize the lesson and provide opportunity to apply the skills in an exercise requiring at least some of the PS-TRE process. Here is a possible activity that makes use of the full process. Students are told that they have just sent resumes to three employers and are waiting to hear back. A teacher might set up the activity by posing as an employer (or using more than one email address and posing as more than one

[7] There are some excellent examples of instructional activities on email from Public Library Association lesson on email and fully developed lesson plans on email use created by the Denver Public Library.

employer) and sending several email messages to the students in the class. The teacher's email messages could represent the range of messages one might receive in response to an email about a job application: a rejection, a job offer, or a request for more information. The email messages are the stimulus for the task and their complexity could vary. For learners used to using email and possessing strong English literacy proficiency, there could be distractors (e.g., more messages than needed, distracting and extra information within each email, etc.).

Depending on the level of the learners in class, a teacher could frame description of the task in different ways. For learners who are new to problem solving and email, a teacher might explicitly tell learners that they need to sort email according to the type of response (will hire or will not hire). For higher-level learners, the task could be framed less explicitly, perhaps "Keep track of communication with employers" or "Make a list of all employers who might hire you." For the purposes of this example (and acknowledging the limited space here) let's assume the teacher presented the following task to learners: keep track of employer responses to job applications.

The first step of the activity is to have the class complete the Problem Planning Map, possibly together. Figure 11 shows a completed example done by a learner somewhat familiar with PS-TRE but in need of practice with the whole process. Note that people often solve problems differently, but that these differences need not be interpreted as correct or incorrect. Depending on the learner's comfort and experience with email, he or she may include a step of sorting email into folders or just skip to creating a list in a Word document. Allowing for such flexibility creates open-ended instructional activities that support differentiated instruction.

Figure 11. Example of a completed Problem Solving Planning Map

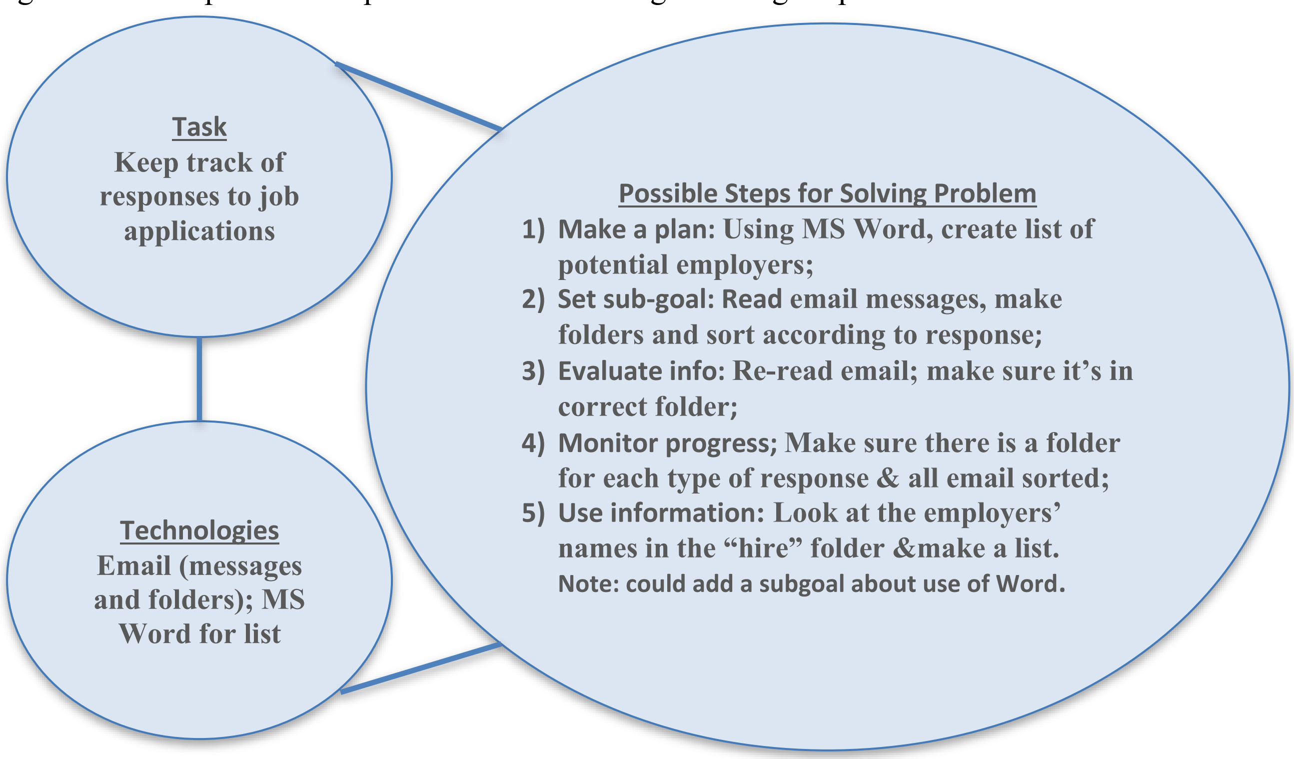


Table 13 shows an alternative way to guide learners through the problem-solving steps required to accomplish this task. Teachers might fill out the Student Notes column together with students as they are working through a task either independently or in small groups, using computers in a school lab. Note that this sort of graphic organizer provides more space for recording steps of tasks with multiple sub-goals. To illustrate this, this table shows more discrete detail on sub-goals from the map above.

Table 13. Problem Solving Chart

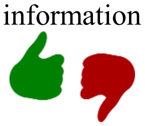
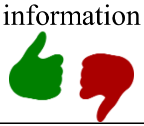
Task: Keep track of responses to job applications.		
Technologies: Email and folder sorting, Microsoft Word or Excel for making a list.		
Step	What's Involved	Student Notes
Set a goal 	"Problem finding." What do I want to happen so that I can complete the task? What is the end result?	*Determine which of the employers I contacted might hire me.*
Plan and organize 	"Problem-shaping." Create a plan for solving the problem. What subgoals, strategies, technology resources, or sort of information is critical for accomplishing the goal?	*First, I need to read the email I have received and then I need to organize the information according to how each employer responded.*
Set subgoal 	What is the first action?	*Reading email from employers, creating email folders and filing email in correct folder: "Will Hire" or "Won't hire."*
Monitor progress 	Pay attention to your progress. Did you make a mistake in your planning and need to reassess the tasks and technology resources?	*I correctly made two folders! Now I can sort the email.*
Acquire & evaluate information 	While locating and after finding information consider: Is this what I need to know? Can I trust the sources? Do I understand what it says?	*Re-read emails as I file them to evaluate or compare and contrast the information included in the email.*
Monitor progress 	Pay attention to your progress. Did you find the right information? Do you need more?	*While reading, I see an email from an employer that asked for more information. I see that I need an additional folder called "Maybe hire."*

Table 13. Continued

Step	What's Involved	Student Notes
Use the information you found 	Consider the task required to make the information useful: Does it need to be organized, combined with information from another source, put into a different format? Consider how it will be best presented or shared.	*Now that I have the mail sorted, I want to make a list.*
Set subgoal 	What is the next action?	*I will use Microsoft Word to make a list of employers who "will", "might," or "won't" hire me.*
Monitor progress 	Pay attention to your progress. Did you make a mistake in your planning and need to reassess the tasks and technology resources?	*I realize that I have no idea how many employers I'll have to contact before I get a job and I want to keep all of their information in one place. I know how to use Excel so I'll make a spreadsheet instead of a Word doc so that I can keep their contact information and other information about them in one place and be able to sort and organize it easily.*
Acquire & evaluate information 	While locating and after finding information consider: Is this what I need to know? Can I trust the sources? Do I understand what it says?	*Carefully read the email to gather all the important contact info included in the email and add it to spreadsheet.*
Monitor progress 	Consider whether or not you solved the problem. If not, go back to the beginning and set a new goal or add a subgoal.	*In a few cases, I am missing the employer's phone number. Must remember to search for it later if I need to call them.*
Use the information you found 	Consider the task required to make the information useful: Does it need to be organized, combined with information from another source, put into a different format? Consider how it will be best presented or shared.	*I sort the spreadsheet to make a list of all of the employers who said they will or might hire me. I get a short list that also includes their contact information!*

As students are getting used to the process, it may make more sense to create a number of separate activities that each require just one or two of the steps. The example shown above in Table 13 is meant to illustrate the sequence completed by a learner ready to work through the entire process. It is fairly complex, simply because it requires every one of the components of the cognitive dimension. To make it even more complex, a teacher might introduce extra steps, like requiring follow-up email to clarify information in an employer's note. Complexity could also vary by dropping the Excel part of the activity, making it less complex, or requiring use of the sort operation on Excel to make it more difficult. Teachers might consider posting an enlarged copy of a blank Problem Solving Map or Problem Solving Chart somewhere in the classroom to provide a visual guide for planning and making use of any or all of the process steps.

Integrating the process into further instruction. After a teacher has introduced the process, and learners have had ample practice using it, he or she can integrate implicit representation of it into instruction of other academic content. Teachers can accomplish this by employing the process for solving issues students encounter in daily life, work, or in academic contexts. Examples of such tasks include: finding low-cost healthcare in the community, understanding benefits and expectations at a place of employment, or finding information for academic essays/reports. Teachers can use a version of the activity represented in Table 4 to help students along.

Choosing the right scenarios for this instruction is critical, because it will shape the task and technologies employed. Think back to the activities included earlier in the paper where the learners described relevant uses of technology (see Tables 4 and 5). It's likely they mentioned use of the Internet to find information. Here are some example websites that can serve as the foundation for PS-TRE activities in class.

Easy: Ask learners to use either map or local transit websites to get from one location to another by a specific time. Google Maps (www.maps.google.com) works well for this because it gives learners options to map routes depending on mode of transportation. You might use an online transit website from your city. Here are two examples of such websites:

- Twin Cities Metro Transit - https://www.metrotransit.org/
- Massachusetts Bay Transportation Authority - http://www.mbta.com/

More moderate tasks: Ask learners to search for information on sites that require more extensive online forms and make it possible to set up comparison of information found. You might use the following sites for this if you think they are areas of interest for your students:

- Determining the availability of different pets - http://www.petfinder.com
- Comparing apartments in particular neighborhoods - http://www.apartmentfinder.com

Advanced tasks: Set up activities that require even more complex forms, evaluation, and comparison. Relevant scenarios for such websites might include the following:

- Search for college programs - https://www.petersons.com/college-search.aspx#/sweeps-modal or http://www.collegeview.com/collegesearch/index.jsp
- Job search - https://www.ziprecruiter.com/ or www.craigslist.org

No matter what level you are trying to teach, as a final step, include some way for learners to communicate the information they found. It could be a simple email, or sharing a spreadsheet or document they used to organize and communicate their findings.

Remember that the entire process need not be integrated as a whole each time. Teachers can set goals for instruction depending on the learning needs of students by reintroducing pieces of the process as is required by the instructional context. For example, if a teacher sees that students are struggling with recognizing bias in different sources of information, he or she can integrate activities requiring evaluation of information when practicing web search. If learners find structuring a job search unfamiliar, teachers can focus on the planning and organizing steps of the process as they introduce job search resources found online or support learners as they gather information for resume writing.

Education and Skills Online. One possible resource for measuring student progress is the PS-TRE assessment in Education and Skills Online Assessment (ESO). ESO claims to measure "cognitive and non-cognitive skills that individuals need for full participation in modern societies" (*Education and Skills Online Assessment: the online version of PIAAC*, 2014). These are skills that adults draw upon in diverse contexts and are consequently difficult to capture in a snapshot assessment. That said, ESO can provide a baseline indication of where learners are and show teachers where to begin to develop a solid foundation on which to grow. Given the level of complexity of the items, ESO is most likely to be useful for determining PS-TRE competency of learners assumed to possess at least Level 1 proficiency, which is fairly high given the description of results provided early in this brief.

Of greater utility is an approach of continuous formative assessment, where teachers can attend not only to learners' demonstration of successful task completion but also the degree to which learners can plan and make use of the steps of the problem-solving process. Teachers might use either the Problem Solving Planning Map (see Figure 11) or Problem Solving Chart (see Table 13) as an assessment tool to show the degree to which learners are able to plan and then articulate or document the process for completing a task. Another idea is to have a learner do two versions of the Problem Solving Planning Map, one before they engage in a task and another as they are completing a task. Noting shifts made during task completion might signal where planning falls short, or problem-solving steps or technologies with which a learner struggles.

Problem-based learning. As mentioned previously, there are many similarities between PS-TRE and problem-based learning (PBL); this is certainly true with assessment. In both cases, learning occurs through addressing real life tasks. Though teachers might test knowledge of the process for accomplishing these tasks, like requiring learners to identify key concepts, assessment in PBL and PS-TRE is best contextualized in relevant or authentic tasks. Gallagher (1997) suggests that in PBL, this sort of assessment cannot be readily handled through multiple-choice questions. Rather, learners need to actually complete relevant tasks that show both an understanding of the process and accomplishment of tasks they are likely to encounter in daily life. The same can be said of assessment in PS-TRE.

To implement this approach to assessment in PBL, Gallagher (1997) suggests using peer feedback; this also could be useful in PS-TRE. Teachers could use the Problem Planning Map or Problem Solving Chart to structure peer support and feedback by asking students to explain to each other their plans for problem solving and how they address each aspect of the process as they work through problems. Student self-assessment has similar potential. Teachers can create student self-assessment rubrics for learners to monitor their skill using a problem-solving process. One useful resource for creating such a rubric is Jobs for the Future's guide to developing student-centered self-assessment (Brooke & Andrade, 2013). The short report presents a simple three-step process teachers can use to make a self-assessment rubric.

Section IV. Implications of Teaching PS-TRE

Teaching PS-TRE can enrich classroom learning and support the relevance of ABE programming. In addition to the obvious benefit of teaching learners a critical transferable skill, an important pragmatic benefit is that use of the PS-TRE framework can provide a common language and means by which to organize training across multiple agencies collaborating under WIOA. Because these agencies serve the same learners, such common language can help them align programmatic goals. At the instructional level, use of the approach affords teachers opportunities for open-ended tasks in multilevel classrooms by providing an additional dimension for differentiation of instruction. It also provides a means to meaningfully integrate technology into instruction.

Integrating instruction of the process described above likely requires shifts in program resources and instructional goals. For example, teachers in programs without access to broadband[8] will need to think creatively about using the devices and access that learners do have, such as smart phones. A 2015 Pew Research Center study found that home computer and Internet access has plateaued at around 41% for adults with an annual income under $20,000, while smartphone access has risen (Horrigan & Duggan, 2015). Similarly, a 2015 Tyton Partners study of adult learning programs found that “approximately 55% to 75% of the 4.1 million adult education students in programs today, own smartphones” (Newman, Rosbash, & Sarkisian, 2015, p. 17).

Integrating PS-TRE into instruction also requires that teachers have access to professional development opportunities. Crafting problem-solving tasks that align with specific complexity characteristics is challenging. Most classrooms include students with a wide range of skills and life experiences; consequently, a realistic instructional strategy would include an open-ended approach where learners can complete similar tasks but attend to differentiated cues to vary complexity. Also, teaching the PS-TRE process and then integrating it into other learning likely represents a significant shift in instructional practice. Many ABE programs utilize Professional Learning Communities (PLC), where teachers work collaboratively over extended periods of time to improve practice by sharing ideas, observing each other teach, and discussing instructional strategies.[9] PS-TRE integration would be a fine topic for PLC work.

The challenges in integrating a PS-TRE approach need to be acknowledged and addressed if programs are to succeed with PS-TRE instruction. Because integration of PS-TRE is likely a shift at the programmatic level, program administrators need to provide time and opportunities for experimentation while instructors develop strategies. Further, program administrators might view moving to integrate PS-TRE as an impetus for bolstering the technology resources they provide learners onsite.

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[8] A 2014 survey of ABE practitioners (1057 respondents) suggest that though 84% of the ABE sites represented by survey respondents have computers on site, only 54% reported that students “always” have access to computers in class (Newman et al., 2015, p. 11).

[9] Further information about PLCs can be found at the Solution Tree’s PLC website, http://www.allthingsplc.info/about

Conclusion

This brief is an invitation to practitioners to engage in the work of teaching problem solving in technologically-rich environments. I encourage you to start by teaching the problem-solving process and embedding it into units of study enhanced by the process. Along the way, expand your knowledge by exploring the list of PIAAC reports and other relevant research literature below to gain a deeper understanding of PIAAC.

> At the heart of sustainable change is developing and helping people to build up an "inner resilience" that guards them from experiencing every change that comes their way as disruptive. Instead, this resilience ensures that they learn to cope with these changes more as part of their continuous "agile development and learning" (Cashman, 2009), recognizing patterns in one situation and making sense of them and applying them in another.
> (Kop, Fournier, & Mak, 2011)

The increasing complexity and number of technology tools in our communities has altered the nature of work, schooling, and daily life. This, and the attendant increased complexity in tasks and problem solving, positions learners (as well as teachers!) as life-long learners. To truly prepare learners to succeed outside the classroom, we need to teach more than academic content. Our instruction must also help learners develop the resilience they need to address future changes. By building a learner's ability to employ the problem-solving process, we can support their continued learning in a dynamic world.

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*Workforce Innovation and Opportunity Act (*2014). U.S. Retrieved from https://www.congress.gov/113/bills/hr803/BILLS-113hr803enr.pdf

Appendix A

What Is PIAAC?

In 2013, The Organization for Economic Cooperation and Development (OECD) released the results of its most recent study of adult skills – the Program for International Assessment of Adult Competencies (PIAAC). Twenty-three countries – including the U.S. and most other developed countries in the world – participated in the first round of this assessment in 20011-12[*], which was designed to give countries critical information on how well-prepared their adult residents were to participate fully in the civic, cultural, and economic life of their countries in the 21st century.

In addition to assessing three key information-processing skills – literacy, numeracy, and problem solving in technology-rich environments – PIAAC included an extensive Background Questionnaire, which collected information on education and work history; additional skills used in the workplace, including communication, interpersonal, problem-solving and learning skills (thru a skills use module); as well as demographic data, in order to help each country understand the range and distribution of skills among its adult population so that it could use the assessment data to make important policy decisions about the best ways to improve adult skills (OECD, 2011). Taken together, these features of PIAAC make it the most comprehensive assessment of adult skills undertaken to date.[**]

What makes PIAAC useful for teaching and learning, as well as assessment, are the conceptual frameworks for the three content domains assessed. Because PIAAC was designed to measure the skills that provide a foundation for success in advanced economies, a great deal of attention was given by international and U.S. experts in the adult learning field to developing a conceptual framework for each skill that reflected the increased demands adult face for using that skill – at home, at work, and in the community. We believe that these conceptual frameworks provide an expanded, research-based definition of the literacy, numeracy, and problem solving in technology-rich environments domains that can serve as a guide for professional development and rigorous instruction aimed at preparing adults to meet the increased demands for these foundational skills in twenty-first century everyday life.

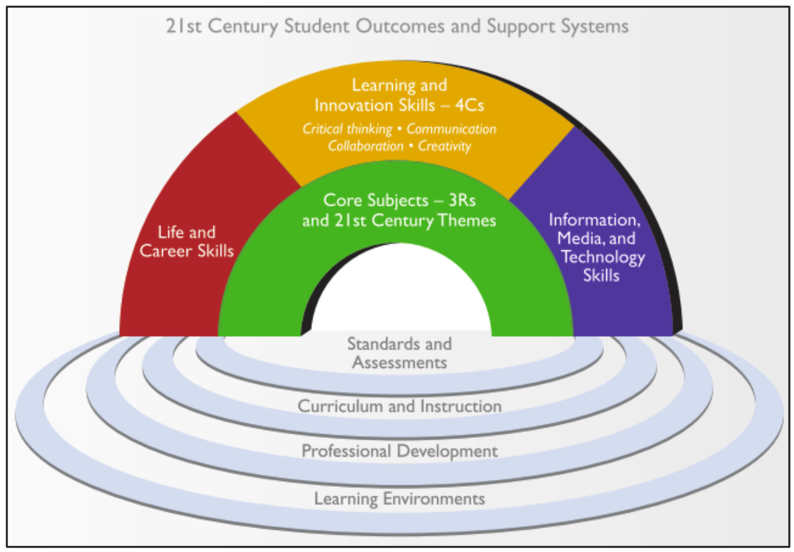
[*]Nine additional countries participated in the assessment in 2014
[**]For more information on PIAAC visit **www.piaacgateway.com**

Appendix B

Prioritized Initiatives and PS-TRE

The PS-TRE focus on using technology aligns with prioritized curricular initiatives in ABE. The overlap with PIAAC evident in these initiatives should provide confirmation to practitioners of their significance and beneficial impact on the lives of their learners.

P21 Framework for 21st Century Learning. Teachers and leaders in education, policy, and business created this learning framework to serve as a vision for the scope of schooling in the 21st Century. It reflects a system-wide vision defining the skills and knowledge learners need to succeed in work, daily life, and civic engagement. Significant here is a component called "Learning and Innovation Skills," which focuses on skills supporting creativity, critical thinking, and communication.



Framework for 21st century learning, 2011

The "Critical Thinking and Problem Solving" component includes skills articulated as follows:

- Reason Effectively – appropriately use both inductive and deductive reasoning
- Use Systems Thinking – recognize and leverage parts of a whole system to reach a desired outcome
- Make Judgments and Decisions – evaluate, synthesize, and interpret information in order to make a decision; critically reflect on process
- Solve Problems – engage in problem solving touching on both familiar and unfamiliar tasks; critically reflect on different approaches and their impact on solution

Building learner proficiency with these skills, along with "Information, Media, and Technology Skills," and then employing them in learning academic content, teaches both content and how to be a flexible learner. By expanding the role of education to include development of these skills, the P21 Framework aims to achieve the goal of showing learners how to engage with the world as life-long learners – "to pay rigorous attention to developing adequate life and career skills" (*Framework for 21st century learning*, 2011).

CCRS. States have adopted the Common Core State Standards in K-12 and their counterpart, *The College and Career-Readiness Standards in Adult Education* (Pimentel, 2013), along with their various state versions, in proactive efforts to prepare both children and adults for the literacy and numeracy demands of the 21st century. For the first time, these efforts are aligning K-12, postsecondary education, and adult education in a vision for what it means to be "college and career ready," with an eye toward preparing students "for today's entry-level careers, freshman-level college courses, and workforce training programs" ("What Parents Should Know," 2016).

CCRS aligns with PS-TRE in two ways. First the standards embed technology into several anchor standards, including:

> Anchor 5: Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations (Pimentel, 2013, p. 32).
>
> Anchor 6: Using technology and the Internet to produce and publish writing and to interact and collaborate with others (Pimentel, 2013, p. 28).

Additionally, the CCRS - Lifelong Learning framework supports instruction of non-academic skills that are critical to academic success at the postsecondary level. It defines lifelong learning skills as foundational social emotional skills that support learning and engagement: "student thinking, self-management, and social interaction, enabling the pursuit of education and career goals" (McGarrah, 2015, p. 1). These skills are considered essential for motivation, persistence, and action required to continually build and utilize knowledge in a technological world.

LINCS Community Technology and Learning Listserv
https://community.lincs.ed.gov/group/technology-and-learning

Digital literacy initiatives in ABE. In addition to the initiatives described above, there are significant resources devoted to building the digital literacy skills of adult learners in the U.S. OCTAE maintains a list serve supporting the sharing of effective practice on issues of technology in support of learning. Experts in the field moderate the list, and features thematic discussion on topics ranging from curricula and pedagogy to evaluation of learning technologies and the policies that shape their implementation. LINCS also provides a self-paced course for practitioners called "Integrating Technology in the Adult English Classroom" defining why technology is important, how to approach integrating it, and how to access and employ tools to support technology integration in classrooms (https://courses.lincs.ed.gov/1/course/index.php).

Appendix C

WIOA and PIAAC

There is synergy within the priorities behind the PIAAC work and U.S. education policy initiatives at the federal level. This is clearly illustrated by the legislation authorizing adult basic education, the Workforce Innovation and Opportunity Act, which prioritizes development of proficiency with technology and cognitive skills in order to create economic opportunity for adult learners in the U.S. The definitions section of Title II clearly illustrates this priority in its definition of workforce preparation activities as

> "activities, programs, or services designed to help an individual acquire a combination of basic academic skills, critical thinking skills, digital literacy skills, and self-management skills, including competencies in utilizing resources, using information, working with others, understanding systems, and obtaining skills necessary for successful transition into and completion of postsecondary education or training, or employment" (WIOA, 2014, p. 187).

Similarly, WIOA recognizes the impact of technology on the lives of ABE learners by including a call for technology use both in the classroom and in distance learning (HR 803, Workforce Innovation and Opportunities Act, 2014). This focus on use of technology is included in several places in WIOA, including Section 223 (2)(B), which lists permissible agency activities:

> the development and implementation of technology applications, translation technology, or distance education, including professional development to support the use of instructional technology. (p. 523-524)

Section 231 (e)(7) lists the following provision for selecting eligible ABE service providers:

> whether the eligible provider's activities effectively use technology, services, and delivery systems, including distance education in a manner sufficient to increase the amount and quality of learning and how such technology, services, and systems lead to improved performance. (p. 533)

From a practical perspective, this alignment between WIOA and PS-TRE suggests that integrating a PIAAC-based problem-solving approach can support programming that provides learning opportunities with the potential to create learning outcomes desired by federal and state funding guidelines. From a perspective of professional practitioner ethics, integrating digital problem-solving proficiency development can help a teacher support learner development of critical proficiencies needed to fully engage in economic and civic life.

Appendix D

PIAAC PS-TRE Proficiency Levels

The PS-TRE assessment in PIAAC results has been categorized in the following proficiency levels, as reported in Exhibit B-5 of Goodman, Finnegan, Mohadjer, et al. (2012) *Literacy, Numeracy, and Problem Solving in Technology-Rich Environments among U.S. Adults: Results from the Program for the International Assessment of Adult Competencies 2012, First Look*. p. B-11.

Exhibit B-5. Description of PIAAC proficiency levels on the problem solving in technology-rich environments scale: 2012

Proficiency levels and cut scores for problem solving in technology-rich environments	Problem solving in technology-rich environments task descriptions
Level 3 (341 – 500)	At this level, tasks typically require the use of both generic and more specific technology applications. Some navigation across pages and applications is required to solve the problem. The use of tools (e.g., a sort function) is required to make progress toward the solution. The task may involve multiple steps and operators. In terms of cognitive processing, the problem goal may have to be defined by the person, and the criteria to be met may or may not be explicit. There are typically high monitoring demands. Unexpected outcomes and impasses are likely to occur. The task may require evaluating the relevance and the reliability of information in order to discard distractors. Integration and inferential reasoning may be needed to a large extent.
Level 2 (291 – 340)	At this level, tasks typically require the use of both generic and more specific technology applications. For instance, the person may have to make use of a novel online form. Some navigation across pages and applications is required to solve the problem. The use of tools (e.g., a sort function) can facilitate the resolution of the problem. The task may involve multiple steps and operators. In terms of cognitive processing, the problem goal may have to be defined by the person, though the criteria to be met are explicit. There are higher monitoring demands. Some unexpected outcomes or impasses may appear. The task may require evaluating the relevance of a set of items to discard distractors. Some integration and inferential reasoning may be needed.
Level 1 (241 – 290)	At this level, tasks typically require the use of widely available and familiar technology applications, such as email software or web browser. There is little or no navigation required to access the information or commands required to solve the problem. The problem may be solved regardless of one's awareness and use of specific tools and functions (e.g., a sort function). The task involves few steps and a minimal number of operators. At a cognitive level, the person can readily infer the goal from the task statement; problem resolution requires one to apply explicit criteria; there are few monitoring demands (e.g., the person does not have to check whether they have used the adequate procedure or made progress toward the solution). Identifying contents and operators can be done through simple match; only simple forms of reasoning (e.g., assigning items to categories) are required; there is no need to contrast or integrate information.
Below Level 1 (0 – 240)	Tasks are based on well-defined problems involving the use of only one function within a generic interface to meet one explicit criterion without any categorical, inferential reasoning or transforming of information. Few steps are required and no subgoal has to be generated.

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