Learning by Doing

Hands-On Training for Transportation Technicians

JOHN SCHIAVONE, TRANSPORTATION LEARNING CENTER

DR. ROBERT GLOVER, UNIVERSITY OF TEXAS AT AUSTIN

TRANSPORTATION LEARNING CENTER

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Introduction

More than twenty-four centuries ago, Aristotle observed: *What we learn to do, we learn by doing* (adapted from Aristotle, 350 BC). Yet traditional learning today consists of sitting students in a classroom and having an instructor lecture them.
But is this approach appropriate for teaching technicians the advanced skills needed to maintain and repair today's highly sophisticated transit equipment? For many, the answer is a resounding "no" regardless of the subject being taught. John Dewey, progressive American philosopher, psychologist, and educational reformer, questioned the traditional approach of "learning by passive absorption" in his 1916 book entitled *Democracy and Education*:

> Why is it that … learning by passive absorption … [is] still so entrenched in practice? That education is not an affair of "telling" and being told, but an active constructive process, is a principle almost as generally violated in practice as conceded in theory. Is not this deplorable situation due to the fact that the doctrine is itself merely told? But its enactment in practice requires that the school environment be equipped with agencies for doing ... to an extent rarely attained." (p. 46)

During the 90 plus years since Dewey made these remarks, many have advocated "learning by doing" methods over traditional teaching approaches. In reality, the process is not fully utilized despite research that strongly suggests those being trained in technical trades acquire knowledge and skills best by doing or through practice. One book title puts it succinctly: *Telling Ain't Training* (Stolovitch and Keeps, 2001).

In fact, many of today's baby-boomer technicians now retiring in droves began their careers without first receiving any formal training, learning by being thrown into the fire so to speak and receiving informal "training as you go" provided by fellow workers, many of whom lacked essential skills themselves. Vehicles and technologies were much simpler then, and some basic knowledge and skills were acquired as teenagers by working on rudimentary automobiles of the 1950s, 60s and early 70s.

The technology landscape is far different today. Transit buses and trains are controlled by electronics that surpass those found in spacecraft when baby boomers first began working as mechanics. Yesterday's mechanics are now technicians using laptop computers to program and diagnose equipment, and apply highly specialized tools and procedures to maintain and repair mechanical, hydraulic, pneumatic and chemical equipment that simply did not exist even 10 years ago.

Today, formal training is absolutely essential to produce technicians capable of providing safe, efficient and cost-effective transport services. The consequences of jeopardizing passenger and public safety are just too great to turn inexperienced workers loose on advanced transit vehicles without proper training, hoping they will learn "as they go." The question becomes how best to construct an effective training program. This paper examines the subject of technical training and advocates "learning by doing" as an essential element to acquiring needed technical knowledge and skills. It stands to reason that someone attracted to becoming a technician is interested in working with his or her hands. Training, therefore, should make use of that natural inclination and engage students in hands-on activities throughout the entire learning process.

Learning: An Overview

Over the past century, research has generated new conceptions of learning. The National Research Council has commissioned a series of publications summarizing what is known about learning and enhancing human performance based on evidence (See Druckman and Boark 1991, and Bransford, Brown and Cocking. 1999). In addition, the subject of expertise and its acquisition has been much researched (Ericsson et al, 2006). The American Society for Training and Development (ASTD) and others have published numerous books providing practical guidance on training to build expertise (see, for example, Stolovitch and Keeps, 2001; Clark, 2008).

How people learn is a complex subject and numerous theories have been developed through the years. Each approach has advantages and disadvantages, and implies different roles for learners and facilitators of learning (Rothwell 2009). Most agree that to be effective, the design of instruction must fit the needs of the learners and the aim of the training. Individuals vary in their approaches, strategies, and preferences during learning activities.

Training needs to take account of learners' characteristics, learning preferences, and foundation knowledge, as well as the training content and instructional goals. Teachers need to adapt instructional methods most appropriate for the experience level of their learners and for the job performance outcomes required. In short, there is no one best way to conduct training for everyone. Nevertheless, research findings point to approaches and principles that can be helpful in designing and implementing training especially for maintenance technicians, whose job requirements tend to be largely tactile which favors a hands-on approach to training.

A traditional model of classroom education which many of us have experienced, involves a lecture-based delivery method where a professor/instructor who has been deemed a subject matter expert speaks at length on the theory and application of the course content. Interaction is kept to a minimum to minimize opportunities for potential disruption of the instructor/professor's narrative and to allow the greatest chance for students to take in the knowledge through listening and/or taking notes. In his seminal work, *Pedagogy of the Oppressed*, published in 1970, Brazilian educator Paulo Friere, aptly labeled this approach to education as the "banking concept of education" (Friere, 1993). With this approach, knowledge is seen as a gift given by those who consider themselves knowledgeable to those who are considered to know nothing.

Friere goes on to describe how this approach teaches students to be passive observers in the workplace and society. Problems can result when employees are trained in this method when viewed by both a labor and management perspective (Friere, 1993, chp. 2). From a labor perspective, people taught to be passive will be less willing to take action to improve their work conditions. From a management perspective, passive employees tend to be less willing to demonstrate creative problem solving or to take on the challenges of new technology.

Research indicates that a learner-centered approach – which focuses on providing the maximum opportunity for students to interact with each other, the content and the instructor – is the most successful at producing an effective transfer of learning from the classroom to the jobsite. Recent studies have demonstrated that methods that focus on problem-solving such as guided discovery methods where the students are given a problem to work out with the instructor serving as a guide to lead in the right direction without providing them the answers, is an effective way to build motivation, confidence and skills in the students. Other recommendations include providing students with the opportunities to work with and learn from one another, and using a variety of instructional strategies including small group tutorials, peer tutoring, and computer-based material. To be effective, employee training should also reflect the actual work tasks and conditions that the students will be asked to perform in post-training (Merriam and Leahy, 2005).

Too often, technical training is taught in a detached way, in which students learn formal scientific laws that define the domain but not their context of use (Gott and Lesgold, 2000). For example, in electrical systems, the series of laws that describe the fundamental relations among voltage, current, and resistance in a circuit (i.e., Ohm's Law and Kirchoff's Laws) are in many cases taught as detached pieces of declarative knowledge to be learned and then regurgitated on a test. Rarely does instruction take the next step and provide the student with learning experiences where, for example, resistance can be manipulated in a circuit to demonstrate how the law works in practice.

Contextual Learning

Learning involves interaction between short-term and long-term memory where limited "chunks" of information presented during instruction as short term memory becomes integrated with existing knowledge already encoded into long-term memory. Information presented during training needs to contribute to something the learner can use to build on. In other words, adult learners want to know, "What's in this for me, why do I need to learn this?" Providing a reason and a context for the instruction helps motivate the student to learn the required knowledge and skills.

Contextual learning occurs when students connect information in such a way that it makes sense to them in their frame of reference (their own inner world of memory, experience, and response). Contextual learning allows students to carry out activities and solve problems in a way that reflects what they'll be doing in the real world. Hands-on training exercises reinforce contextual learning because students are able to take what they've learned and apply it to jobs for which they are being trained. An abstract description of how an internal combustion engine works, for example, becomes more understandable when students can then follow-up by interacting with real pistons, cylinders and crankshafts.

Clarification of Terms

There are several terms associated with training. Simply put, *learning* is a process of gaining knowledge and skills or expertise (Knowles et al, 2005, p. 17). *Knowledge* refers to cognitive competence and information assimilation (e.g., understanding how an electro-mechanical relay functions). *Skill development* involves gaining psychomotor competence (e.g., being able to replace or rewire a relay). *Performance* is implementing the knowledge and skills that have been gained (e.g., being able to diagnose a faulty relay).

Procedural knowledge is knowing how to execute the procedures necessary to perform a given task. Procedural knowledge underlies cognitive and motor skills (many of them automated), such as how to use a typewriter by touch, operate a computer, disassemble and reassemble a rifle, drive an automobile, ride a bicycle, or play a game (Druckman and Boark 1991, p. 24).

Skills are acquired mainly by doing or practice and are not learned quickly. Using the example above, learning the fundamentals of how an electro-mechanical relay functions can be taught through lecture; however, by applying electrical current to an actual relay and physically observing electrical connections being made and broken, the learner is better prepared to replace a relay and later diagnose relay related failures. Using lecture alone to progress students through the various levels of learning, skill development and performance is difficult, if not impossible, regardless of how skilled or talented the lecturer may be. Classroom instruction simply cannot teach a technician how much force is required to remove a fastener securing a relay, the feel of removing an electrical connector or relay cover, or how to repair a wire connector if it comes apart while replacing a relay. These tasks are only learned by doing. It goes unquestioned that to become a skillful baseball player you need to practice catching and hitting. Similarly, to become a skillful technician you need to perform the real world tasks of replacing relays, starters, alternators, etc.

Retention of skills, or the lack thereof, is typically measured by the extent to which they can be performed, rather than by the extent to which they can be recalled. In fact, at high levels of skill, where many of the procedural components of a skill become automatic or unconscious, people often become unable to describe in any detail what procedures they are carrying out and in what order (Druckman and Boark, 1991, p. 24). This “automaticity” expands the ability of experts to perform and learn, but commonly makes it difficult for them to teach their skills to novices, or to perform well on written tests. This phenomenon helps to explain why some expert technicians have failed pen-and-paper certification tests recently developed for transit bus technicians.

The major goal of any training program is to prepare students to perform effectively on post-training tasks in a real-world setting. Learning with actual equipment in a hands-on setting better prepares students for the tasks that await them. When confronted with a faulty relay, for example, the student who received classroom lecture training and successfully memorized terminal markings for a particular relay may become disoriented when a different brand relay has other markings. The student who learned by doing, however, is more likely to have the ability to remove the relay cover and identify functions of the various terminal connections regardless of vendor markings.

Motivation: The Beginning Point of Learning.

Learner motivation is critically important. Studies show that if learners do not value the new content being taught, there is little hope for retention or transfer to the workplace. As Malcolm Knowles emphasized, adults learn best when convinced of the need for knowing the information (1990).

Relevance is an essential motivator; learners are motivated when they can see the usefulness of what they are learning and can respond to the adage, “What’s in this for me?” The answer may not always be clear in a classroom setting where lecture often comes across as abstract and foreign, thereby causing students to lose interest and daydream about other things. Conversely, contextual learning that engages students through visual and hands-on exercises tends to encourage the learning process. Learning how a turbocharger works becomes more relevant when students can see a cut-away or one installed on an engine and visualize the path of air and exhaust traveling through it.

Another way to instill relevance to stimulate learning is by building a “mental scaffold” to prepare learners for new instruction. A simple graphic showing how the parts of instruction are related to the whole provides learners with a roadmap by which to navigate through a large amount of material. This is especially useful for novice learners who have little previous knowledge of the subject. Continuing with the turbocharger example, a graphic of wind causing blades of a windmill to turn will help students understand how engine exhaust gases move the blades of a turbocharger in similar fashion. Likewise, a cut-away of an actual engine or representative drawing can effectively illustrate how the up-down motion of engine pistons converts power to the crankshaft and then the flywheel.

The act of creating a basic framework for the learner at the beginning of instruction is a way to focus the learner and to introduce content. The organization of knowledge should be an essential concern so that the direction from simple to complex is not from arbitrary, meaningless parts to meaningful wholes, but instead from simplified wholes to more complex wholes (Knowles, 1988). Organization of knowledge in the beginning stages of instruction also serves the even larger purpose of memory retention and retrieval upon completion of instruction.

As stated earlier with regard to contextual learning, people simply learn better when they can build on what they already understand. Activating *prior knowledge* in the long-term memory relevant to the new content will optimize the integration process underlying learning (Clark, 2008, p. 55).

Another way to build motivation before students even begin the learning process is to use recruiting efforts to present public transit as offering high-tech opportunities and as a positive force in society to improve the environment and reduce traffic congestion, in addition to providing essential transportation services. Just as some students are drawn to being mechanics through an interest in motor racing, others with more altruistic values, and a desire to compete in high-tech fields can be drawn to a career in transit maintenance.

Non-Sequential Learning

Learning can take place sequentially or non-sequentially. When sequential learning is enforced, students receive training in a specified order and cannot advance to the next module without having completed the previous one. However, altering training from its traditional sequence of presentation can be more effective in certain cases, allowing greater flexibility to present material in an order that best achieves the desired result.

For example, it may be beneficial to provide a brief overview of theory to introduce a complex topic, and then return to provide more detailed theory after some practical experience has been gained. Multiplexing is a relatively new technology that reduces the amount of electrical wiring in vehicles and allows electrical faults to be more easily diagnosed. It also allows control functions to be programmed without adding new wiring and switches, such as making the headlights go on automatically when windshield wipers are deployed. A traditional sequential approach to multiplex training would be to provide detailed theory upfront describing the intricacies of data networking, ladder logic, and the sophisticated electronic processing that takes place within the multiplexing system.

Using a non-sequential approach, a minimal amount of theoretical instruction on multiplexing would only be provided in introductory terms, followed immediately by hands-on instruction where students review the operation of multiplexing installed on a training mock-up board or on a vehicle. Here students will see what the multiplexing control modules look like, how and where they're installed, the data cabling that connects the various system modules, and the built-in troubleshooting lights that indicate whether a circuit is functioning or not. Once the student has placed basic theoretical information in context, then the instructor can go back and provide more detailed theoretical information. In fact, advanced theoretical, diagnostic and programming training could take place well after the technician gains some experience working with multiplexing.

It is important to emphasize that learners can only absorb so much material at one time, and as described earlier, will lose interest if what they've learned is not relevant to real world applications. *Cognitive load* is a term that refers to the load on working memory during instruction. Because working memory capacity is limited, it's important that the attention of learners is focused on aspects related to the learning goal. This is especially true when learners are new to the content and the content is complex, as in the case with electrical and electronic applications. Trainers can maximize learning by minimizing irrelevant cognitive load and maximize productive material. Keeping cognitive load germane to the learning goal is critically important for novice learners.

To avoid cognitive overload, initial training may cover only *how* to perform a task, leaving the full explanation of *why* the task is performed that way until after the learner has accumulated some hands-on practical experience. Using the multiplexing example, technicians can be taught "how" to replace a multiplexing module after someone with more experience has diagnosed it as defective without understanding "why" it needs replacing. Doing so gives the technicians first-hand experience with handling the equipment, allowing them to see individual components in the context of a much larger system. The supervisor can then verify the installation and provide additional insight into the failure.

Trainers from the sequential school of education may have a difficult time understanding this concept, believing that learners should have full knowledge of the entire subject before being allowed to work on individual pieces of a larger system. However, technicians that start off by becoming simple parts changers are in a better position to learn the nuances of technical systems and become proficient at troubleshooting than those given countless hours of sequential classroom training with little or no contextual reference. Important exceptions include rail and hybrid bus applications where students need to thoroughly understand high voltage electrical and complex electronic aspects of equipment to prevent safety incidents.

Reinforcement through Active Learning

Once students grasp the first pieces of information, the instructor must pursue the transfer of this new knowledge from short-term memory into long-term memory. Information that is rehearsed becomes encoded for storage in the long-term memory (Gage and Berliner, 1988). Instructors can support this rehearsal by incorporating active learning (Gage and

Berliner, 1988). Active learning, in which learners take a participative role rather than a passive role, facilitates both learning and retention (Campbell, 1988; Perry and Downs, 1985). Further, learning on the job provides a context that helps assure that training will match the real-life world in which training must eventually be applied. This type of contextual learning, which many technicians and instructors understand to be the case anecdotally, is supported by the work of Jean Piaget, John Dewey, Carl Rogers, David Kolb, and others. According to John Dewey, who was quoted at the introduction to this paper, all genuine education comes through experience (1938, p. 13).

When it comes to acquiring advanced expertise in troubleshooting and dealing with unusual situations, learning by doing is the primary and most powerful method of instruction (Gott and Lesgold, 2000). The learning-by-doing instructional environment produces technicians with both accelerated and adaptive expertise, as compared to the time needed to acquire similar expertise using traditional learning methods. With these accomplishments the Gott and Lesgold study found how best to teach apprentices to prepare them for performance in high-tech, information-age workplaces.

Observation, Coaching and Practice

Traditional apprenticeship is based on a thorough integration of hands-on experience with classroom instruction. Apprenticeship, which has proven quite successful in teaching physical skills, typically involves three key components for learners who already have workplace experience:

1) the instructor performs the task while the apprentice watches (*observation)*;

2) the apprentice then attempts to perform the task with the instructor offering supervision and guidance (*coaching)*; and

3) the apprentice assumes an increasingly larger burden for performing the task (*practice)*.

Observation. During the observation phase the apprentice participates as a spectator, observing an expert executing the target skill.

Coaching. Coaching refers to the guidance that the expert provides while apprentices attempt to perform the task on their own. Coaching physical skills involves two key features. First, the coaching or feedback is given in a continuous fashion. The form of guidance provided in traditional apprenticeship is often physical demonstration, not just verbal instruction.

Second, the master or mentor provides support in the form of reminders and help necessary for the apprentice to perform an approximation of the composite task. The degree of support provided depends on the extent of help the apprentice needs. As the apprentice improves, the support can be diminished. The expert, therefore, must monitor the apprentice's “zone of proximal development” (Vygotsky, 1978). The zone of proximal development is the distance between the developmental levels at which learners can perform a task alone and the level at which they can perform it with some assistance.

Practice. As they say, “practice makes perfect.” The apprentice continues to perform tasks with the master present pursuing the goal of making the students' performance approximate the expert's performance as closely as possible. In traditional apprenticeship, coaching is fairly constant and continuous throughout the practice period.

Expertise is acquired gradually over time, built through deliberate practice, rather than routine practice. The rationale for deliberate practice is that "effective improvement of performance requires the opportunity to find suitable challenging but attainable training tasks that the performer can master …typically monitored by a teacher or coach who provides feedback" (Ericsson, 2006, p. 692). The role of a mentor in training is an essential one. Performing technical tasks for the first time can be rewarding, especially when the fear of failure is removed because the mentor is present to point out and correct any miscues.

Having a knowledgeable mentor observe and guide the process of on-the-job training (OJT) builds the confidence needed to develop required experience and allows learners to tackle more demanding tasks. During deliberate practice, good performers concentrate on specific skills that are just beyond their current proficiency levels (Clark, 2008, p.11). Although tasks can become routine as more experience is gained, new challenges are presented when finding novel ways to do the job more efficiently or when an unexpected snag is overcome by applying creative solutions. Again, getting students involved with real world tasks quickly with oversight from a mentor or instructor is far better than doing passive seat time in a classroom. In the process of repairing and maintaining equipment, technicians often encounter unexpected problems that simply cannot be duplicated or resolved in a classroom setting.

While OJT has many positive attributes, to be effective it must be done in a structured way with clear objectives, through defined exercises and follow-up. Simply placing apprentices alongside veterans to "watch them work" is not a useful approach to OJT.

The three-step approach to training of observation, coaching and practice described above mirrors the Nine Events of Instruction identified by education researcher Robert Gagne (Gagne, 1985):

1. Gain Attention
2. Inform learners of the objective
3. Stimulate recall of prior learning
4. Present the content
5. Provide learning guidance
6. Elicit performance (practice)
7. Provide feedback
8. Assess performance
9. Enhance retention and transfer to the job

Impediments to Learning by Doing

There are two reasons why learning by doing is not our normal form of education (Schank, 1995). First, it is difficult to implement without "doing devices" – the actual equipment or fully functional simulations of it. As Dewey said: "… enactment in practice requires that the school environment be equipped with agencies for doing ... to an extent rarely attained." It is far easier to construct a classroom setting with chairs, tables and a lectern than it is to provide interactive devices. Despite this, many in transit have purchased training modules such as component cutaways and interactive training “boards” where subcomponents that make up an entire system such as braking are placed in working condition on a display board. Not only are the devices helpful to illustrate how each individual part functions within the overall system, they can be rigged with faults to become highly effective diagnostic training tools. Students use the skills taught in class to troubleshoot and repair planted faults on these boards.

Some transit agencies that participate in maintenance “roadeos” – competitive events designed to test the abilities of bus and rail technicians – use training boards and other interactive, hands-on training equipment to prepare team members for competition. One method used to obtain this equipment is to make it part of the vehicle procurement process. Another is to take worn or defective components such as entire engines and transmissions, cutaway certain sections to gain a better view of what’s inside, and use them to illustrate function and provide assembly and disassembly experience to new learners.

In addition to hands-on training equipment, several training instructors make effective use of photographs and illustrative graphics to make technical points in class. The old adage “a picture is worth a thousand words” applies to technical training. An illustration of pedaling a bicycle where one leg exerts pressure downward while the other gets a “free ride” upwards is more effective at describing how a crankshaft and connecting rods interact in an engine than trying to do it verbally. Through the Transportation Learning Center’s courseware sharing project, many of these graphics and illustrative tools developed by instructors can be exchanged with others.

The second reason why learning by doing is not our normal form of education, according to Schank, is that educators and psychologists have not really understood why learning by doing works, and thus detest insisting upon it. They can't say exactly what it is that learning by doing teaches. And while they admit that it teaches skills needed in the real world, they are concerned about facts, committed to what they know -- the "drill-them-and-test-them" school of educational thought.

Another reason for keeping the status quo is inertia. Many transit instructors use curriculum and training approaches handed to them over time and see no need to change. However, given the complexities of today’s equipment and the findings of years of educational research, it’s time for many instructors and transit leaders to break with the past and institute learn-by-doing approaches. As baby-boomer technicians retire and other industries compete for a limited pool of replacement workers, outdated educational approaches will not help the recruitment process and leave transit short-staffed. There is a strong need for effective instructor development to assist technical instructors to move away from traditional lecture to more interactive, hands-on based instruction.

Yet another impediment to effective approaches to hands-on learning stems from a particular belief held by executives and other policy makers, many of whom succeeded in traditional college classroom settings. They assume that everyone learns in the same way as they and their college-educated peers did – by books and lectures first. It comes as no surprise, therefore, that 70 percent of the training budget in US workplaces goes to 30 percent of employees who already have a college degree.

The Case for Learning by Doing

Learning in the context real world experiences is the natural venue of learning by doing. It makes sense that the best way to teach anybody is to let them work on a job that requires the skills we are trying to teach. Natural learning occurs best when it's done on an "as needed" basis. In such learning situations motivation is never a problem, we learn because something has caused us to want to know. But classroom lecture presentations often produce little in the way of natural motivation, especially with regard to technical training. One could easily make the case that all technical instruction should be hands-on where motivation for learning is easier to achieve. For example, the case for wearing personal protective equipment (PPE) such as goggles and gloves is more convincing in a shop setting when the instructor runs a metal rod against a grinding wheel with sparks and metal pieces flying off in many directions. The motivation for using PPE on the job now becomes real. Having sample PPE in the room also allows students to gain real life experience properly fitting the equipment. All of this could be taught through lecture, but it would have been nearly as effective.

Real life learning takes place in the workplace, "on the job." The reason for this seems simple enough. Humans are natural learners and they learn from everything they do (Schank, 1995). If you want employees to learn their job, then, it stands to reason the best way is to engage them directly in the work. Doing so also gives students a true sense of what the occupation is really like. The term "technician" is a more accurate title and may sound better than "mechanic," but in reality the job of maintaining and repairing transit buses, trains and related equipment is hard and dirty work. Students not well suited to this work are better off becoming aware of this in real world settings as soon as possible, thereby giving them an out to pursue another occupation.

Students are better served by instructors who teach them to do things, rather than telling them how to do it. If you want to become an athlete, practice your sport. If you want to become a mechanic – repair and maintain equipment. Learn-by-doing methods should not, however, come at the expense of neglecting to present factual information about theory of operation, safety and other matters. However, that information is best presented in a hands-on setting where factual information is placed in context with real world tasks. In some cases, the information is also more effective when presented in non-sequential format, pulled in as needed to reinforce contextual learning.

Instructional System Development (ISD), which supports learn-by-doing methods, is a series of processes to address decisions about exactly "what, where, how and when" to teach the skills, knowledge and attitudes needed to perform every task selected for instruction (U.S. Department of the Air Force, 1993). The use of ISD can assist organizations in identifying when it is most effective to present content using sequential or non-sequential formats. Traditional chain of command organizations, including the United States Navy and Air Force, have adopted ISD to increase the effectiveness and efficiency of instruction. Through the implementation of ISD and current learning theory, the U.S. Navy has determined that lecture should be reserved for large group presentations lasting less than 30 minutes, and that the most common method of instruction is interactive. (U.S. Department of the Navy, 1992)

Learn by Doing vs. Community College

Learning that takes place in the context of worker's job or job they would like to hold is much less abstract than most college courses and is better suited to the active learning styles of many adult learners. While community colleges play important roles in education, their application to technical training has certain disadvantages when compared to OJT and hands-on training. For one, community colleges typically experience dropout rates in the 50 percent range. People who have not thrived in classrooms earlier in their educational experience are not likely to be enthusiastic about returning to a traditional classroom environment.

Additionally, earnings for workers not headed toward a four-year college degree are often higher as a result of receiving workplace-based training than those attending community college. Whereas completing an Associate's degree increases worker wages to 33 percent more than a high school graduate, a worker participating in a training program organized to focus on a specific industry sector experiences a 73 percent earnings gain. Better yet, a graduate of a joint labor-management apprenticeship program experiences an 88 percent wage gain, more than two and one half times the earnings gain from a community college degree (Transportation Learning Center, 2010).

Joint Labor-Management Partnerships

You cannot teach what you do not know (Gott and Lesgold, 2000). This principle applies in multiple ways and strongly supports the involvement of subject matter experts in every aspect of training system development. In particular, expertise from the field and the industry at large is needed to ensure the training is meaningful in the context of learning and real world problem-solving. Expert guidance is also needed to ensure coaching provided during problem-solving is truly appropriate to the specific contexts in which it is given.

In cases where transit agencies include training as part of the competitive procurement process, some vendors have been known to provide instructors that simply "read from a script" and have no direct practical experience. In other cases transit agencies hire instructors that are not fully capable of performing that role.

A sensible way to ensure that training is effective is to approach training as a joint labor management effort where both sides agree to the subjects that need to be taught and how training is best delivered. The American Public Transportation Association (APTA), the Transportation Learning Center, and major transit labor unions including the Amalgamated Transit Union (ATU) and the Transport Workers Union (TWU) have worked in partnership to develop standards that define training subjects and learning objectives.

This paper is a start in the direction of developing standards for establishing *how* those subjects are taught. Expert technicians with many years of on-the-job experience and expertise are well placed to work with management to provide valuable input into how training can be made more effective.

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For additional copies and information contact:
Transportation Learning Center
8403 Colesville Rd. Suite 825
Silver Spring, MD 20910
Tel: 301-565-4713
Fax: 301-565-4712
Email: info@transportcenter.org
Web: www.transportcenter.org