
TRAINING FOR TRANSPORTATION TECHNICIANS

Which Delivery Methods Work Best?

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Introduction

This paper explores the question, what ***is the most effective way to train transportation technicians?*** The most common method is classroom lecture where instructors talk and students just listen and desperately try to grasp all of the conceptual information delivered to them in rapid succession. At the other end of the spectrum is the 'sink or swim' approach where students are thrown into the job to work alongside veterans to pick up their good ... or bad methods. Somewhere in the middle is a better, blended approach, where classroom lecture is continually complemented by interactive hands-on demonstrations and followed by structured on the job training (OJT) and mentoring.

Learning is Complex

Many theories have been developed throughout the years on how learning takes place and how technical skills are acquired. The bottom line is that learning is a complex subject with each approach having its own advantages and disadvantages. Nonetheless, experts agree that effective instruction must fit the needs of the learners. The task of tailoring instruction to learners' needs is challenging, however, because individuals have different needs and preferences when it comes to how they're trained. Teachers in particular have a difficult task because they must take into account foundational knowledge, experience levels and training preferences of their learners and adapt instructional methods to achieve the desired learning outcome. In short, there is no one best way to conduct training for everyone.

Nevertheless, research findings point to approaches that are helpful in designing and implementing training especially for maintenance technicians, who tend to be tactile and who favor hands-on approaches to training.

What's in it for Me?

Regardless of the subject, studies show that motivation is critical for learning to take place. If learners do not value what's being taught, there is little hope for their retention or transfer of the information they've learned to the workplace. Information presented during training needs to contribute to something they can use to build on. In other words, learners want to know, "What's in it for me?" For technicians the question becomes, "How will this information help me do my job?"

The approach of applying training to carry out activities and solve problems in a way that reflects what workers will be doing in the real world is called as *contextual learning*. Hands-on training exercises reinforce contextual learning because students are able to take what they've learned and apply it to the jobs for which they are being trained. An abstract textbook description of an electrical relay, for example, becomes more valuable to students when they can put this new knowledge into context as a switching device that can be used to control lights and other electrical devices in the workplace.

Too often technical training is taught in a detached way, with students learning formal scientific laws but not their practical use. For example, Ohm's Law, which describes the relationship between voltage, current, and resistance in an electrical circuit, is in many cases taught as detached pieces of declarative knowledge to be memorized and then regurgitated on a test. A contextual approach to conveying Ohm's Law would provide students with a physical demonstration of how Ohm's Law works in practice to solve real

world problems; for example, why a starter motor turns over slowly when an electrical cable is corroded.

Mental Scaffolding

Another way to motivate students to learn is by building a 'mental scaffold' to prepare them for new instruction. A simple graphic showing how the parts of instruction are related to the whole provides learners with a roadmap to help navigate through a large amount of material. This is especially useful for novice learners who have little previous knowledge of the subject. When providing instruction on internal combustion engines, for example, a cut-away of an actual engine or representative drawing can effectively illustrate how the up-down motion of engine pistons converts power into the circular motion of the crankshaft and flywheel.

Non-Sequential Learning

Learning can take place sequentially or non-sequentially. In *sequential learning*, students receive training in a specified order and cannot advance to the next module without having completed the previous one. In contrast, *non-sequential learning* alters the traditional sequence of presentation to enhance the learning process. This technique is useful in that it provides flexibility to the instructor and student to customize their approach to the material. In some cases, for example, it may be beneficial not to overload students with too much theory in advance, but to return to it after some practical experience has been gained.

Multiplexing is a relatively new technology that reduces the amount of electrical wiring in vehicles and provides other advantages. A traditional sequential approach to this training would be to provide gobs of detailed theory upfront describing the intricacies of how a multiplexing system works. A non-sequential method would provide just a minimal amount of introductory theoretical instruction followed immediately by hands-on application where students review the operation of multiplexing installed on a training mock-up board or on an actual vehicle.

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Learners can only absorb so much material at one time and are likely to lose interest if what they've learned is not immediately identifiable as relevant to real world applications. This is especially true when subjects are complex, as in the case with electrical/electronics. To avoid information overload, a non-sequential learning approach might provide initial training addressing only *how* to perform a task, leaving the full explanation of *why* the task is performed that way until the learner has accumulated hands-on practical experience.

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 removing and replacing parts 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 do exist, including rail and hybrid bus applications in which students need to

thoroughly understand high voltage electrical and complex electronic aspects of equipment to prevent safety incidents.

Benefits of Learning by Doing

Students are better served by instructors who teach them to do something rather than tell them how to do it. 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.

Once students grasp the first pieces of information through verbal instruction, it is up to the instructor to make sure this new knowledge gets transferred into the student's long-term memory. Instructors can accomplish this by incorporating active learning where learners take a participative role rather than a passive role, which best facilitates both learning and retention.

Studies prove that learning is best achieved through a close coordination between interactive classroom and structured hands-on activities. Learning that takes place in the context of the worker's job or the job they would like to hold is much less abstract than standard college courses and is better suited to the active learning styles of many adult learners. While community colleges play an important role 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 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.

Apprenticeship: Tell, Show and Coach

Traditional apprenticeship is based on the thorough integration of hands-on experience with classroom instruction, earlier outlined as most effective for most adult learners.

Apprenticeship, which has proven quite successful in teaching physical skills, typically involves three key components for learners who already have workplace experience:

- 1) Tell students how something is done
- 2) Show them how it's done
- 3) Coach them while they do it.

In the first phase of instruction, the teacher describes how something is done, for example how to rebuild an electrical starter motor, aided by as much visual display as possible. An illustrative drawing and individual parts of the starter placed on a table serves as the 'mental scaffolding' needed to describe the functional relationships of the various parts.

In the second phase, the master or mentor disassembles the motor, tests individual parts, replaces worn or defective parts, reassembles the starter, and tests its overall function. Students are then asked to do the same with the instructor coaching, answering questions and providing feedback. Having a knowledgeable mentor observe and guide the rebuilding process of on-the-job training (OJT) builds the confidence needed to develop experience and gain expertise. As they say, “practice makes perfect.” The apprentice continues to perform tasks with the mentor present with the goal of making the students' performance approximate the mentor's performance as closely as possible. In traditional apprenticeship, coaching is fairly constant and continuous throughout the practice period.

Once the apprentice has rebuilt a few starter motors and is familiar with the internal parts, they are in a better position to understand and retain detailed theory describing the interaction of magnetic fields and current-carrying conductors. Using non sequential methods to engage students with real world tasks is far better than passively listening to lecture. In the process of repairing and maintaining equipment, technicians often encounter unexpected problems that simply cannot be duplicated or resolved in a lecture-only environment.

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

Roadblocks to Learning by Doing

There are three primary reasons why learning by doing is not our typical approach to training. First, "doing devices" – the actual equipment or fully functional simulations of it - are needed. It's much easier to construct a lecture setting with chairs, tables and a lectern than it is to provide learning devices such as component cutaways and interactive training modules. One could argue that all training should consist of some illustrative and interactive hands-on instruction. Describing braking systems, for example, is better achieved through use of a display board where the function of individual components can be demonstrated and even rigged with faults to assist with diagnostics.

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In another example, wearing personal protective equipment (PPE) such as goggles becomes more convincing in a shop setting where the instructor runs a metal rod against a grinding wheel with sparks and metal pieces flying off in many directions. The demonstration places the need for PPE in context, something that could not be done as effectively through lecture alone.

The second roadblock to learning by doing is inertia, or the simple desire to maintain the status quo. Far too many 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 of them to break with tradition and update their teaching methods and lessons to be relevant to their

students' – and the industry's - changing needs. 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 will certainly leave transit short-staffed.

A third 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.

Call to Action

Most would agree that students are better served by instructors who teach them to do things, rather than telling them how to do it. The focus of training athletes to become better baseball players is to get them to hit and catch. The focus of training technicians should therefore be on getting them to 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 can best be presented in hands-on settings 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.

While some agencies have placed a great deal of emphasis on balancing training approaches that keep students motivated and cause them to learn and develop needed skills, others are stuck on hopeless lecture-only methods. In cases where training is provided through new vehicle procurements, some vendors provide instructors that simply “read from a script” and have no direct practical experience. Furthermore, technicians may not get to apply any of the “scripted” training for months or years afterwards when vehicles typically begin to develop problems. Much of this training ends up being a waste of time.

Given diminishing budgets, how can the industry assure that what training is provided is done effectively? A sensible approach is to continue the joint labor-management approach already in progress in which both sides participate in the process. 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) are already working in partnerships to develop standards that define training subjects and learning objectives.

Now that most training subjects have been clearly identified, a logical extension of that work is to engage expert technicians, instructors and managers in a joint labor-management process that defines how those subjects are best taught. Having highly effective training programs in place is especially important since technicians are under increased pressure to pass certification testing. In many cases the training they receive, or lack thereof, is not capable of putting in place the knowledge and skills needed for them to acquire certification. As part of any requirement to acquire certification, joint committees could establish the duration of training, intervals for refresher training, and the best teaching approach to provide classroom, hands-on and structured OJT training.



TRANSPORTATION LEARNING CENTER

The Transportation Learning Center builds constructive labor-management partnerships to strengthen transit's workforce. The Center is the only nonprofit organization that receives support from the Department of Labor, the Federal Transit Administration and the Transit Cooperative Research Program.

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