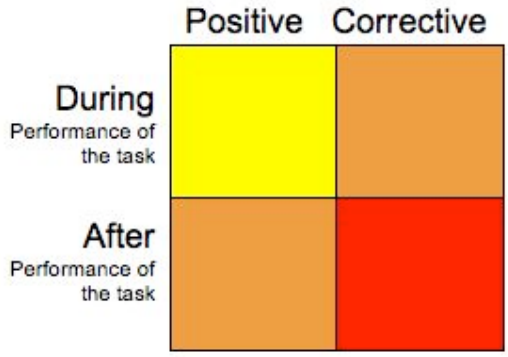
Using Feedback During Student Practice

The PBET Workshop has always stressed the importance of providing feedback for the trainee while practicing. For example, we talk about the importance of practice with feedback for the development of both *competence* and *confidence*.

The PBET Workshop has also emphasized that feedback must be both positive and corrective. During the Workshop, the point is made that many equipment trainers find it easier to remember to provide corrective feedback, but harder to remember to provide positive feedback. So, for a long time, we have asked Workshop participants to "overdo" the provision of positive feedback during the "pilot" training exercise with Legos because we hoped they would remember the silly exercise and make an effort to improve the giving of positive feedback to their students when back in their role as equipment trainers.

Box 1: Chart Typically Drawn During The PBET Workshop to Describe Total Feedback to Be Considered



Nevertheless, the Workshop has not given clear instruction and practice in the matter of feedback. Worse, by oversimplifying, the Workshop may have misled some participants.

This bulletin seeks to clarify the purposes and proper implementation of feedback.

Using Feedback to Ensure Competence

Giving students proper feedback, at the right time, can

1. Speed-up acquisition of new skills, and
2. Improve long term retention of new skills.

However, this depends upon the type of task being taught and the timing of the feedback.

Not all types of tasks respond equally well to the behaviorist model for learning. The behaviorist model is best described by the "Blue Folder" used during the Workshop which describes the role of positive reinforcement, negative reinforcement, punishment, and extinction as operations that affect behavior and learning. We emphasize the behaviorist model in the Workshop because, for many of the participants, maintenance training is their preeminent focus. The behaviorist model works quite well for teaching procedure-type tasks which make up the bulk of maintenance courses.

But equipment training also includes many tasks that involve problem-solving, for example, troubleshooting machine failures and developing production recipes/parameters for the equipment. The cognitive model for learning works best for these types of tasks. This model of instruction is best described by Ruth Clark (*Building Expertise*, 2nd ed, 2003).[1]

Cognitive learning theory is about how people store information in long term memory and how they process new information in working memory. If a task involves problem-solving, students need:

a. A basis for processing, that is, appropriate information in the same domain (subject/topic area) organized in small sub-categories or chunks. Good trainers facilitate students' ability to recall complex information, like the theory of operation, by using *multiple examples* of problem situations in both the content presentation and demonstration sections of a lesson.
b. To have cognitive processing challenged and stimulated. Good trainers stimulate cognitive processing during practice by providing different examples of one type of problem, and/or different conditions under which to work the problems.
c. Time to process during practice. In short, immediate positive or corrective feedback is detrimental as it interrupts or curtails processing.

If a task involves a hands-on, step by step procedure, the research is a bit more specific thanks to the world of sports. Many studies have been done involving effective coaching strategies involving motor learning and performance. I believe these have a very close application for trainees learning calibrations and assembly type tasks. There is also a difference: athletes are training for fluency (automaticity) whereas maintenance technicians are (generally) training for competence (performance with reference materials).

Early studies of feedback had focused only on the immediate results of feedback, the effect while *acquiring the skill*. Those early studies showed that frequent, immediate feedback improved performance rapidly. This led many trainers to provide their students with lots of immediate verbal feedback.

Box 2: Some Definitions

Intrinsic feedback – Information about performance that is provided by one's own senses from the experience itself; Examples: "That felt heavy," "I see I have a leftover screw."

Extrinsic feedback – Information about performance that is provided by an outside source such as: the comment of a trainer, an error message displayed on the machine, the beep on a computer-based training program.]
Syn.: *augmented feedback.*

Knowledge of results (KR) – Extrinsic feedback, usually verbal, that informs the performer of the outcome of the attempt to perform. Some KR is redundant, as in, "You broke the wafer!" Such feedback is irritating to learners since they already know this from intrinsic feedback. Some KR is not redundant, like, "Your description of the function of the scavenger is not adequate; it did not substantially match the description required by Table X." *Analogous to Box 1: "feedback* after *the performance"*

Knowledge of performance (KP) – Extrinsic feedback, usually verbal, that informs the performer about the technique or process used by the performer during the performance of the task. Examples: "Have all of the safety requirements been observed during your first 3 steps?" "The Block Diagram will get you the information you want faster than the approach you are using now." *Analogous to Box 1: "feedback* during *the performance"*

Later research has looked at the impact of feedback given during practice by comparing the immediate resulting performance during the period of acquisition to the resulting performance after a delay of a day, a week, or a month. In other words, does providing feedback during practice also provide long term retention, that is, how well *does feedback support learning?* Some surprising results of the studies are described in a paper by Timothy D. Lee, Stephan P. Swinnen, and Deborah J. Serrien[2] – here I have summarized just two of the findings:

a. Consider three alternate ways of providing positive and corrective feedback to students during a practice session: (1) instataneous feedback about their performance upon completion of a step, (2) delayed feedback, that is, following an 8 second delay upon completion of a step, and (3) delayed feedback, like #2 only that performers were asked to give a verbal estimate of how they felt they did prior to hearing the feedback from the instructor. What is the result for each?
    i. With respect to acquisition of skill during practice (speed and accuracy): Results will be about the same for all three types of feedback.

ii. With respect to long term retention of the skill: Best retention will be for those who received delayed feedback following an opportunity for the student to provide an estimate of his/her own performance. Worst retention will be for those who received instantaneous feedback. A comparatively intermediate retention will occur for those students who receive delayed feedback with no self-estimate preceding the feedback.

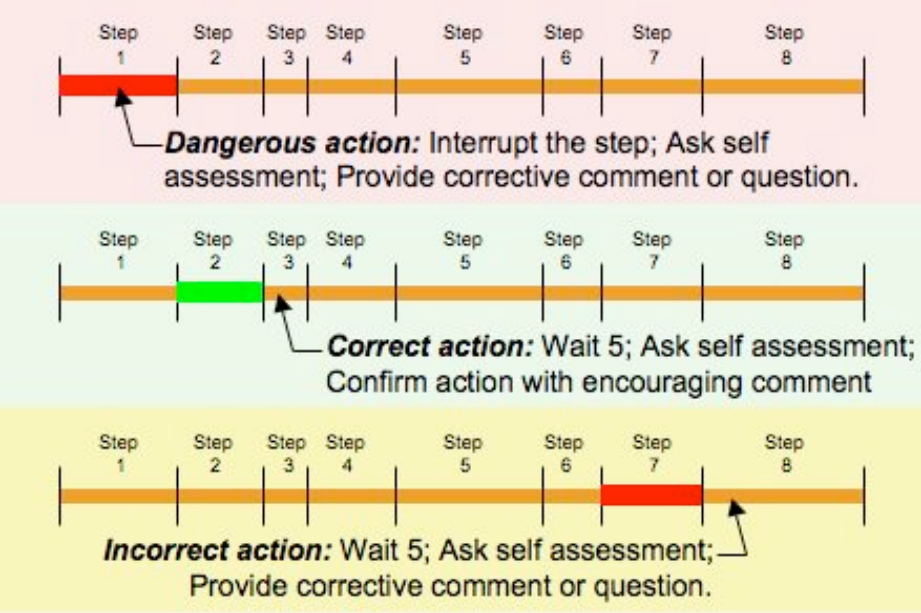
iii. Mr. PBET's Comment: Apply to equipment training as follows (see Box 3):

(1) Student action is dangerous to self, others, or equipment: Interrupt immediately. If circumstances permit, allow time for reflection, eg., "Do you know why I stopped you just now?"

(2) Student action is correct: Wait 5 seconds following the the trainee's performance of the step. Ask, "How do you think that went? (or similar). Wait a few seconds following their self observation. Then, "You got that aperture plate on exactly like the procedure requires. You did well." Such positive feedback comments are not necessary after every step! But should be applied at random a few times during a practice activity.

(3) Student action is incorrect but not causing any damage or danger: Wait *at least* 5 seconds following the trainee's performance of the step. It is possible the student will self-correct; if that happens, you can happily revert to # (2) above. If that does not happen, ask, "How do you think that went? (or similar). Wait a few seconds following their self observation. Then, add your corrective feedback as needed. For example, "Does looking at the values on Table 4 give you a different idea about what to do?" or "What does the procedure require in step 12?"

Box 3: Three Ways to Provide Feedback-
Depending on the Trainee's Action During a Step of the Task He/She is Practicing
Each line below represents passage of time while performing a certain 8-step task.



b. If the task is made up of a required sequence of individual subtasks, consider two different ways of leading a trainee through practice: blocked order and random order. Blocked order would mean repeating a single subtask until competency before moving to the next subtask. Random order would mean practicing one subtask for a while then jumping to other subtasks and then, going back to previous subtasks, until finally competency has been attatined in all subtasks. So, what is the impact of practicing each subtask in sequence ("blocked order") versus practicing the subtasks in random order?
    i. Blocked order: Faster acquisition to competence but poorer long term retention.
    ii. Random order: Slower acquisition to competence but better long term retention.
    iii. Mr. PBET's Comment: Again these results were based on studies where repeated practice ("drills") are required for fluency. So apply the conclusions here to those few tasks where fluency (which requires multiple practice) is needed. For the most part, our equipment training works with 1-3 practices per task, with one practice being most common (because we are normally working toward competency, not fluency).

There is More to Building Competence Than Feedback During Practice!

Although we have discussed how feedback during practice contributes to building competence, that is only one of the things in the design and delivery of training that contributes to competence. Think big picture; beyond feedback, here are some of the other things that ensure competency:

1. Lessons should be based on tasks discovered during job analysis; not based on product features or theories. Don't skip analysis!
2. The conditions of the practice must closely resemble the conditions of the objective. In other words, the design of training must be job-based (the objectives are based on real tasks found at real job places, right?). So, among other things,
    a. examples used for practice should be as close to real tasks on the job as possible.
    b. equipment used during practice should be the same as the equipment used on the job.
3. Demonstrations of a task should promote cognitive processing to promote attention and retention. How do you do this?
    a. Involve the observing trainees by asking questions: "what should I do next?" "Why was that important?" etc
    b. If two partners are working together, have one perform and the other observe. Have the observing student (who is essentially watching a demonstration) provide commentary. In so doing, the observer is "processing" what is being demonstrated.
4. Training should be conducted right before it will be needed on the job. If you don't use it, you lose it.
5. Create a learning environment that is like the job environment. For example, it is better (if possible) to have one room that includes the equipment and the class study center, than to have a classroom separate from the equipment.
6. Separate the tasks or parts of tasks that must be memorized or performed fluently for special treatment. Generally, in equipment training, competence means the ability to perform accurately with the aid of reference materials. But when competence means more than this and a task must be done accurately, quickly, and without references (i.e., fluently), one should design a lot of extra practice, and ideally the practice sessions should be spaced over several weeks, or at least over several days.

Using Feedback to Ensure Confidence

In addition to competence, confidence is essential. Why is this important? Among other possible consequences, individuals that get "signed-off" on all the course tasks, yet do not feel confident about these tasks will avoid performing them when they get back to work.

There are many aspects to the training program that can build confidence, but here are some aspects relative to feedback:

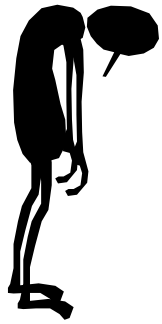
- Feedback should be focused on what the individual has already accomplished, not on what the individual still needs to accomplish:
  - Right: You made fewer defect identification errors today than during any previous practice.
  - Wrong: You have a long way to go before you can be a certified quality inspector.

  Another way to say this is: focus on gains rather than shortfalls.

- Positive and corrective feedback should be focused on the task, not on the person:
  - Right: If you hold your fingers like this, it should go better next time.
  - Wrong: You just don't have the knack for adjustments like this.
  - Right: If you keep the manual open, and follow each step, one at a time, it will keep you from missing some of those critical steps.
  - Wrong: You could do it if you wanted, if you *really* tried.
  - Wrong: How can you expect to get signed-off if you don't pay attention?
  - Right: Which parameter is missing? Take a minute to re-read steps 3-7 in the procedure.
  - Wrong: You are fantastic!
  - Right: The accuracy of level you have attained on this set up is fantastic!

  Focusing on the task can include comments about aspects of the performance that were below standard along with information about how to improve the performance.

Box 4:
"You… you… failure!"
This is not effective!



- Feedback requires corrective help where needed, but try to provide an individual with a higher proportion of comments about what has gone right. Too many correctives compared to positives can *feel* like criticism (personal).

- Give individuals a chance to figure things out for themselves, then provide positive feedback for self-correction; keep in mind all that was said earlier in this paper about cognitive processing.
  - Wrong: Wait! You're switching to a tool that won't work well and could create unacceptable particles in clean-room conditions.
  - Right: [Pause] I noticed that you started to use the XYZ tool but chose to continue with the one designated in the procedure. You made the right choice.

- Part of feedback may include helping trainees to understand that difficulty (effort expended, strength expended, pain endured, emotional arousal) should not be confused with ability. It is a common, if inaccurate, conclusion to think: "I just can't do this. I have spent 2 hours and I have only written 3 lines of code that work. [or similar]" Let trainees know that difficulty is normal even while doing your demonstration of the task.

So always look for ways to build confidence in the performer. I strongly recommend the chapter on "self-efficacy" in Robert Mager's book, *How to Turn Learners On… without turning them off.*[3] Several of the suggestions above were taken directly from that chapter, but there is much richer detail provided in the book.

Summary

The PBET Workshop has always taught that feedback during practice was important. Be certain that what you do is research-based.

Don'ts:

- Do not give instantaneous feedback.
- Do not give feedback at every step of every task.
- Do not ever make feedback personal, i.e., about the performer.
- Do not be apathetic; appropriate, well-timed feedback is essential to performance improvement.

Do's

- Do provide positive and corrective feedback after allowing for cognitive processing (5-8 seconds).
- Do encourage cognitive processing with questions before giving your positive or corrective information.
- Do provide random feedback; at the same time be sure each trainee is getting some feedback.
- Do focus your feedback solely on the individual's *performance*.
- Do try to provide more positive informational feedback than corrective information; look for the correct techniques, processes, steps, decisions.
- Do not distinguish between hands-on practice and a hands-on test. They are the same: Practice 1, Practice 2, Practice 3, etc – whatever it takes to perform without the necessity for corrective feedback.
- Do make the "sign-off" an occasion for a positive experience.

If you remember and implement these things, you will have made a big step toward building competence and confidence in your students.

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[1] Obtain *Building Expertise* Here: http://astore.amazon.com/mrpbetstore-20

[2] Download Paper From Here: http://www.rugbycoach.com/club/skills/cognitive.htm
"Cognitive Effort and Motor Learning" by Timothy D. Lee, Stephan P. Swinnen, and Deborah J. Serrien.

[3] Obtain *How to Turn Learners On… without turning them off* Here:
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