Designing Learning Objectives that are measurable

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(Notes: For readability, the term 'he' is used throughout to indicate both 'he' and 'she'. The actual presentation included live demonstrations of various measurement techniques.)

1. Introduction to 'Learning Objectives'

'Learning Objectives' are as old as learning itself. We use them wherever an individual must prove that he can recall (and better still, has *understood*) facts or procedures following a study session. Study *without* learning objectives may well result in learning but who will know how successful it has been?

To be effective, learning objectives must be:

- achievable using the materials available (or from pre-requisite experience)
- unambiguous and measurable
- and their achievement (or the reasons for failure) must be displayed clearly to the learner

So, an example might be the basic training of a paramedic. During classroom training, a session may have the learning objective: '*To be able to rapidly locate and accurately measure the pulse of an infant*'.

The training session might include the study of diagrams of the body, reading explanatory text, watching a live demonstration and practising the technique under supervision. When the learner believes he is competent in the task, he asks to be assessed. Without help from the trainer he then demonstrates that he can fully perform the learning objective. The trainer assesses how well he has achieved it.

Of course, in the *classroom* this works well since a *human* is assessing the learner's performance. How confidently and swiftly does he locate the strongest pulse point? How accurately does he time the pulse rate? These are subjective issues being measured in a *practical* task, the sort of training and assessment which will always be carried out in this way.

However, as discussed later, if the learning objective had been carelessly written it could have made it difficult or even impossible to reliably measure its achievement.

An objective of *'To be able to locate and measure the pulse of an infant'* includes no consideration of the speed or accuracy of its execution.

In a classroom the trainer can use his discretion to assess knowledge and performance but when we are designing training programs which will be followed alone, at a computer, we face a tough challenge to construct learning objectives that really are measurable. Quiz questions are easy to produce . . . True/False, Multi-choice, matching items between lists, etc. but as we will see these techniques are only measuring the recall of information and not the wider skills of *using judgement*.

The paramedic example above has a single learning objective achieved with a single, monitored task. However, a learning objective may be a relatively broad assessment whose achievement requires a pass level in a multi-question quiz. For example, a commercial learning objective is defined as '*to be able to demonstrate a clear understanding of the needs of our customers'*. Having completed the training module, the learner then takes a 40 question quiz in which they score 88%. If the definition of 'achieving competence' in this case had been set at 75%, we can then say that they have achieved the learning objective.

This paper explores techniques for creating a range of learning objectives which enable e-learning programs to measure various commercial competencies. Of course, e-learning itself places constraints on exactly *what* can be measured and the learning objectives must be carefully created to still remain achievable.

2. What is *competence*?

If we can prove through testing that we have satisfied a learning objective then we can claim that we are 'competent', at least in that one topic. In order to provide examples of measurable learning objectives, consider the wide range of knowledge and skills required by staff in an organisation, from trainee to expert.

There are broadly four phases of development which an employee passes through. If we are to train staff with an e-learning approach then each phase requires different types of learning objective and different measurement techniques to prove competence. These are referred to later as 'competence phases' and are supported by examples of possible measurement techniques.

Phase 1 - *Basic understanding of the organisation and their place in it*
When an employee joins a company, he needs to understand the structure of the organisation, how the company runs and their own place in it, the marketplace it operates in, their products/services, the competition and much more.

Training at this stage is usually by an induction course. An e-learning program would be seeking to measure basic understanding and the recall of facts.

Phase 2 – *Acquisition of the knowledge needed for their job*
The employee then starts the task of learning the job. This may call for detailed technical product knowledge, familiarity with every aspect of a product, getting to know suppliers and manufacturers, and so on. It's a process which never ends. Again. an e-learning program would essentially be measuring their recall of *information*.

Phase 3 – *Development of skills to perform the job effectively (applying the knowledge)*
It is true that through all our years of primary and secondary education, we are absorbing information and most of the testing we face is simply to confirm that we can recall it. But for an employee to acquire knowledge alone is of no value to an organisation – a database will do that. He also needs to be able to use that knowledge to carry out tasks, in other words, to develop *skills*.

To measure how well skills have been acquired, the e-learning program needs to present tasks to be completed, rather than facts to be recalled.

Phase 4 – *Development of wisdom (applying the skills to maximum effect)*
The highest level of performance concerns not just being very skilled at a task but being able to use sound judgement in applying those skills. Such wisdom comes not from a training program but from long term practice and experience.

E-learning programs can provide cost-effective practice and in some cases, may be able to measure a person's judgement.

3. Matching competence measurement techniques with learning objectives
The nature of our learning objectives will be constrained by the types of measurement we can perform. The learner's PC specification, speed of connection, authoring system used, browser plug-ins, etc, . . . all of these factors will affect what is possible.

a) Measuring *Knowledge*
This is obviously the most straightforward to measure and the types of e-learning test typically include questions such as:

- True/False and Yes/No
- Multi-choice (one or several selections)
- Match items in one list with items in another
- Clickable images (selecting one or more 'hot spots')
- Drag words/phrases to fill spaces in a text passage
- Typed entry (free text words or phrases – but care is needed to accommodate mis-spelling and alternative terms)

At this level we are asking the learner to recall, recognize, match and name information. Our measurable learning objectives will therefore be of this type:

> "Demonstrate a sound knowledge of the model T4000 generator specification"
> "Identify the six major isolation switches in an electrical sub-station"
> "Name our five major competitors"
> "Match specific customer complaints with the responsible department"

Examples of such tests were demonstrated in the presentation.

b) Measuring *Skill*
Of course, many tasks require a certain degree of manual dexterity in actually handling components or equipment in order to prove competence. For example, the rapid cleaning and assembly of a rifle or the correct insertion of a saline drip into a patient. Other tasks (so called 'soft skills') such as interviewing techniques, require face-to-face practice and assessment. For these tasks, the popular term 'blended learning' recognises the fact that e-learning has its limits and will often be supported by traditional training sessions and workshops, involving other people.

Having said that, there are still possibilities where e-learning can allow the learner to practise performing *tasks* (rather than simply recalling *knowledge*) and for the program to also track and measure their actions. A 'task' may require the learner to carry our research and use various resources provided (such as referring to an electronic service manual or taking measurements) before taking the action they feel is most appropriate.

Designing such a measurable task requires far more effort than simply testing for knowledge. However, the *completion* of the task can itself be a learning activity provided that feedback and assistance are available within the program if the learner gets into difficulty or needs guidance. Thus the investment has a dual role: training *and* competence assessment.

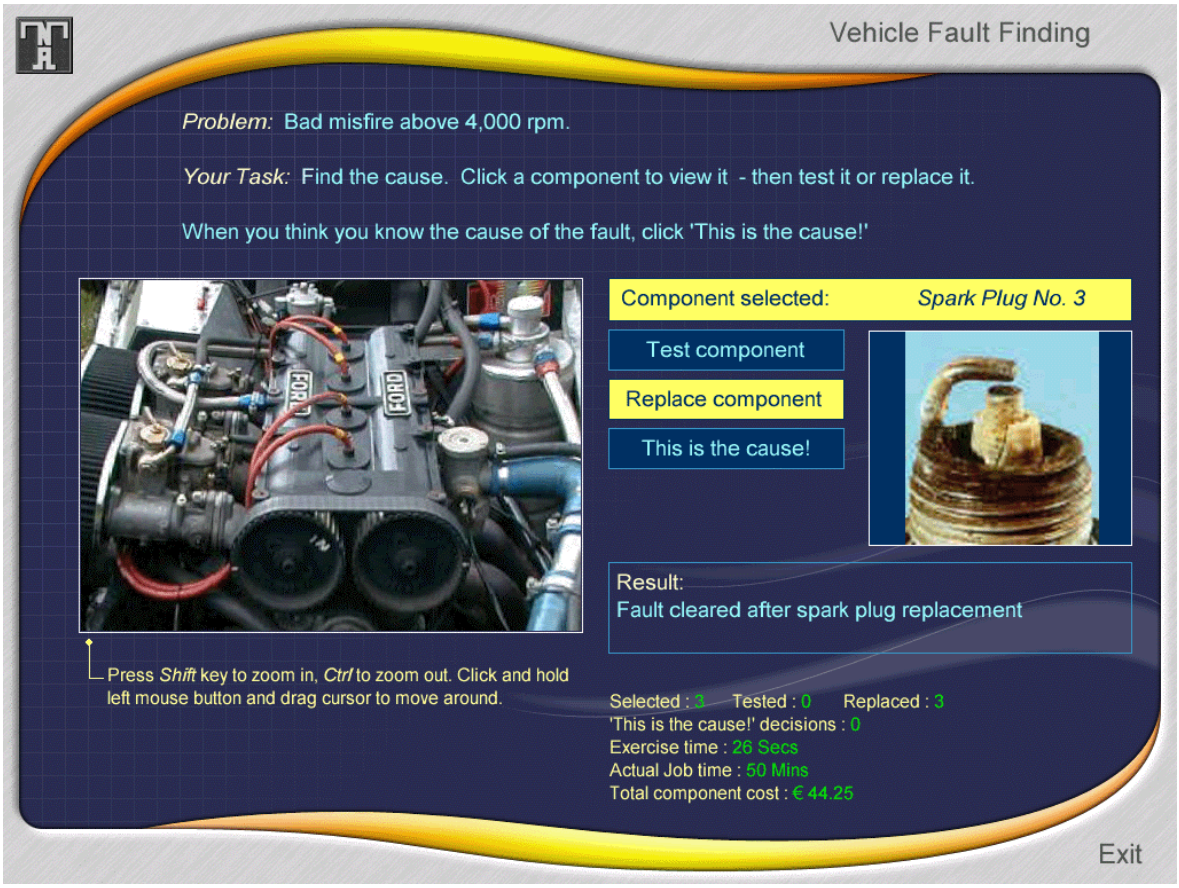
Consider the following example: A company provides roadside breakdown assistance to motorists and employs a large number of mobile engineers. New staff need to be trained at their local depot using e-learning programs and they must pass an assessment of their fault diagnosis skills before becoming operational. The Service Manager's ideal learning objective would be that the learner must '*demonstrate that they can locate the cause of an engine misfire as quickly and as economically as possible'*. The terms 'quick' and 'economical' will mean nothing as far as a program is concerned and so these must be specified for each task. An obvious electrical fault (a loose wire for example) may not take a competent engineer more than 10 minutes to locate and fix with no need for spare parts;

conversely, an obscure problem in the engine management system might take an expert 45 minutes at a cost of perhaps $200 in parts. Some testing is required in order to ‘calibrate’ the training program with valid averages of time and cost for each task posed.

The example we looked at in the presentation presented an interactive view under the bonnet of a vehicle, using a technology called ‘QuickTimeVR’. The task they face is to find out which component is causing an engine mis-fire.The learner may ‘zoom’ into the image of the engine and pan freely around. Clickable ‘Hot spots’ have been placed on components such as spark plugs, HT leads, pump, generator, etc.

This exercise tracks the actual roadside task time spent (eg: replacing a spark plug adds 8 minutes to the *elapsed time* for the job) as well as the *cumulative cost* of any parts used during fault-finding. The learner may select items, examine them, test them and replace them. Every action is logged to the progress database. The total cost of parts replaced is also shown.

A learner who adopts a 'replace it anyway' attitude may fix it in a few minutes but at huge cost, destroying the profit margin on the task. This opens up the possibility of measuring the *quality* of someone's performance in terms other than just being 'right' or 'wrong'



Whilst principally being a measured assessment of skill, this program could equally well serve as a training module in its own right. With the addition of a ‘Help me’ facility to give advice and prompts and interactive feedback, the exercise could be used to let learners ‘play’ safely and cost-effectively, see the outcomes of their decisions, restart the exercise (or a new one) and try again. When they feel they are ready to be measured, they run the exercise in ‘measurement mode’ and this time their actions are recorded.

Tracking and reviewing task results

The data recorded for each test session may be passed to a learning management system (LMS) for review and comparison.

Over time, a rich set of performance data will be accumulated which will give real insight into the skill level of the staff. The data might include for example the following:

Test: 23	Locate engine mis-fire (Part 1)								
Name	Best Task time	Components			Attempts	Last used	Time to date (mins)	Competent?	
		Tested	Replaced	Cost ($)					
Davis, J L	8	1	1	8.50	1	11/01/2002	8	**Y**	
Lopez, H	9	1	1	8.50	1	17/02/2002	9	**Y**	
Cray, W V	10	1	5	176.50	1	09/02/2002	10	**N**	
Smith, S J	12	2	1	8.50	2	22/04/2002	19	**Y**	
Donahue, M	15	2	2	22.00	2	04/12/2001	28	**Y**	
James, O M	16	2	3	78.00	2	16/01/2002	33	**N**	
Siinclair, D	19	2	2	55.00	2	15/05/2002	38	**N**	
Villeneuve, A	55	7	1	8.50	1	13/01/2002	55	**N**	

The decision on whether a learner has achieved competence is made by the program. Competence is considered (say) to have been reached if their best task attempt (maximum of 3 attempts allowed) has been completed in under 20 minutes and at a cost of no more than $25.

So, four individuals have achieved competence under these terms. Student ‘Cray’ was fast but profligate in spending $176.50 whereas his cautious colleague ‘Villeneuve’ spent the minimum in reaching the correct conclusion but took almost an hour doing it. Both have failed to achieve the learning objective.

There is no limit to the data which may be recorded for such exercises, for example, the sequence in which components were examined and replaced, the elapsed time between actions, a list of all these components, etc. It would then be possible to review and reconstruct the exact process each learner followed.

This approach has enabled the Service Manager to set a measurable learning objective for what, on the face of it, may have seemed an illusive set of skills. Similar techniques could be devised for other types of skill training, practice and assessment, including the use of multimedia to enrich the experience and add even greater reality. The learner could actually listen to the engine mis-fire, as they would on a real call-out.

c) Measuring *Wisdom and Judgement*

The previous example suggested a way in which a learner could demonstrate a skill using a measured task. Obviously, the people who complete the task in the shortest time and at the least cost are using a degree of judgement, gained through experience, but the test is principally one of using available information and procedures to arrive at a conclusion.

Our final category of ‘competence’ is concerned with the *wisdom* that an employee brings to a task. Given two employees having identical levels of skill and knowledge, one will outperform the other because they will apply superior judgement. We would normally assess such judgement in the workplace or in role-playing training sessions. The question is: can we also create measurable learning objectives for assessing *judgement* and delivered via e-learning?

For our example, let us suppose that you operate a successful chain of exhaust, brake and tyre replacement centres. You want to implement self-study training (e-learning) for trainee Area Managers to cut out the cost and wasted time of travelling to a central training centre. You put together an e-learning program rich in content . . . audio and video interviews, case studies, the background to the way company operates, etc. But how do you measure their competence, at a distance?

Consider the following as a possible assessment of judgement for this job. You present the individual with a '*So what would you do?*' challenge which they must deal with. You will present a scenario and a range of possible choices, some suitable and some not. You will have set in advance in the marking system what a 'model' response would be from an experienced Area Manager. The individual will earn marks for a correct action in its correct sequence. They will lose points for selecting *inappropriate* actions.

This is the scenario: "*It's 9.15 on your first morning as Area Manager for DaxiaCom Co. There's a telephone message from a worried Gary James, supervisor at the Southampton centre. A customer had two new tyres fitted on Saturday and last night a tyre burst causing her to swerve into a tree.*

Her husband, a journalist, has three cracked ribs and the car is a write-off. She is furious and has contacted the police, her solicitor and her insurance company.

There is also a reporter and camera crew from TV SouthEast in reception asking for a live interview with you. ***So what would you do?"***

Resources
You provide various pieces of 'evidence' which the individual may review. These could include the original telephone call from the depot supervisor, a report on the tyre and a photo of the damage, a copy of the company's policy on making press statements, etc.

These are the possible actions you might offer them :

a) Refuse to meet the TV crew and send them away
b) Call your company's solicitor for advice
c) Phone the customer to offer your apologies
d) Call your Press Relations officer and explain what has happened
e) Drive to the Southampton centre to interview Gary James
f) Close the Southampton centre until further notice
g) Agree to the TV interview but deny all liability, pending an enquiry
h) Call for details of the tyres fitted and suspend all sales of this make
i) Close all centres in your region while this make of tyre is removed
j) Trace all customers who have had this tyre fitted in the past 6 months and phone them to offer a free replacement
k) Arrange to meet the customer as soon as possible
l) Trace all customers who have had this tyre fitted in the past 6 months and write to them to offer a free replacement
m) Refuse to meet the TV crew but refer them to the company's Press Relations officer
n) Call your immediate boss, the UK Operations Director to brief him/her
o) Refuse the TV interview but write a statement for them apologising for the incident and assuring the public that there is no widespread safety problem
p) Identify the fitter who worked on the car and suspend him
q) Contact your company's insurance company and brief them
r) Send flowers and a letter of apology to the customer's home
s) Contact the police and request an inspection of the tyre and wheel

The individual selects the actions they would take and the order in which they would take them. Next to each action you invite them to add any textual comments, expanding on their thinking, perhaps with a qualification. These comments are not marked but will give you additional insight into their reasoning.

As they work through the assessment, the on-line database would save all their decisions, scores, the text they entered next to each action, the number of times they clicked on each resource (audio, reports, etc) and the total time they spent completing the whole assessment. The report you receive may be sorted in whatever order you prefer: by highest score first, fastest completion, surname, etc.

For example, sorted by 'score achieved':

Employee name	Position	Score %	Date	Total time Mins.	Employee No
Peter Robinson	1	96	14/02/2002	102	TR00023
Melanie Porterklaus	2	95	11/12/2001	87	TR00237
Graham B Smythe	2	95	04/03/2002	167	TR00008
Rachel Glover	3	92	22/08/2002	72	TR00280
Richard Bishop	4	91	23/08/2002	23	TR00126
Etc, etc					
Mark Thules	280	7	14/11/2001	90	TR00212
Valerie Gray	281	7	17/10/2001	128	TR00276
Tim Malaprop	282	5	02/04/2002	487	TR00055
Bill Jones	283	2	29/07/2002	11	TR00029

This style of assessment is also very useful as a recruitment filter. It would also be a good idea to invite the participant to comment at the end of the exercise . . . are there any actions not listed which they would have taken, etc.

Finally, if the exercise is being used as a training program then the participant will need feedback on their decisions, to highlight where better actions could have been taken and why. It is important to let the participant know that you realise there are no completely 'right' or 'wrong' answers with this type of assessment but that you are seeking their personal view on an approach.

Who knows, perhaps they will come up with a superior set of actions . . . as a future Area Manager, the last thing you want to do is to inhibit their creative mind.

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