British Army E-Learning: Mathematics Skills Revision – Game On!

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ABSTRACT

This paper describes a synchronous e-Learning Mathematics Skills Revision (MSR) course, developed for students of the Royal Electrical and Mechanical Engineers (REME). The courseware takes about 10 hours to complete and is SCORM conformant. MSR has 2 parts: in the first, students work individually, but with optional on-line instructor (e-Moderator) support, at courseware comprising 9 remedial tutorials, each incorporating multiple choice practice and assessments; in the second, students work in a collaborative and competitive game format, again facilitated by an on-line instructor, where they apply their recently revised mathematics skills to a virtual world simulation of a military logistics problem. MSR has been evaluated with some 240 students with positive results. Drawing upon this detailed quantitative and qualitative evaluation, an number of issues are explored, including: (1) the locus of learning efficacy, with particular reference to student self-esteem and motivation; (2) instructional design constraints imposed by SCORM conformancy; (3) e-Moderator skills and on-line facilities; (4) e-Learning courseware production, using a combination of in-house and out-sourced suppliers; (5) e-Pedagogy and Serious Games, where it is argued that the latter actually add little or nothing to e-Pedagogy, notwithstanding the success of MSR in particular, and current worldwide interest and heightened expectations for Serious Games in general.

ABOUT THE AUTHOR

Dr David Swift, **CSci, CPsychol, AFBPsS, MIBiol, MRAeS** is Principal Psychologist to the Director of Individual Training (Army) (DITrg(A)). His role is to provide academic based advice to his uniformed colleagues within DITrg(A)'s Training Advisory Group and the broader Ministry of Defence (MoD) community, including the Director of Equipment and Support (DE&S). Dr Swift's core specialism addresses the specification and evaluation of training equipments, ranging from simulators to e-Learning. Prior to joining the MoD in 1988, Dr Swift worked in academia, also in the field of training.

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BACKGROUND

This paper describes the development and evaluation of a SCORM conformant e-learning course, which features a Serious Game and synchronous e-Moderation, for use in a military context. The present author assumed overall responsibility for project management and instructional design for the courseware.

The UK's Defence Training Review (DTR) (2001) recommended that 80% of appropriate specialist training courses should deliver at least a quarter of their material by e-Learning within 5 years of the implementation date. While this date was subsequently deferred by 3 years, it was with this policy recommendation in mind, that Lt Col Terry Knee of the Royal Electrical and Mechanical Engineers (REME) Training Group, initially identified e-Learning as a potential remedial training intervention for a group of students at the REME School of Electrical & Mechanical Engineering (SEME). These students were considered to be 'at risk' of failing their Trade Training tests, beginning with the Common Foundation Module (CFM), due to their relatively low standard of academic attainment immediately prior to undertaking Army technical trade training.

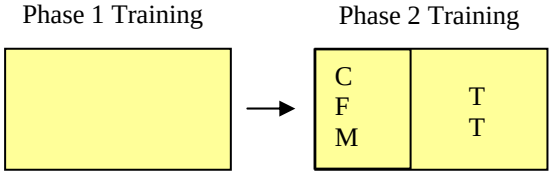
At that time, DITrg(A)'s TAG sought to develop a 'concept demonstration' of an e-learning Learning Management System (LMS) and Learning Content Management system (LCMS) which would inform subsequent pan-Army e-Learning implementation, in response to the DTR recommendation.

By working together, the DITrg TAG concept demonstration of an LMS could be 'grounded' within a trial of an e-Learning solution to REME Training Group's real problem with students' low training entrance standard.

THE TRAINING CHALLENGE

The British Army makes a distinction between 'Phase 1' and 'Phase 2' training. Phase 1 training refers to a basic 11 week Common Military Syllabus for Recruits (CSM(R)), which is undertaken by all recruits. Phase 2 training is the employment or special to arm training designed to equip the soldier to take his or her place in a field unit. To avoid potential confusion, Pathfinder Trial Phases 1 and 2 shall henceforth be referred to as 'Pathfinder 1' and 'Pathfinder 2', respectively.

The problem of student entrance standards, alluded to above, is associated primarily with REME Phase 2 training, which is the responsibility of SEME, and whose training is delivered by VT Group plc under the aegis of a Private Finance Initiative. A simplified representation of the REME training 'pipeline' is given at Figure 1, below:



Where:
CFM = Common Foundation Module
TT = Trade Training

Figure 1. The REME Training Pipeline.

The CFM is used both as a means of developing students before Trade Training and as a filter – those who do not pass CFM do not proceed to Trade Training. The CFM addresses underpinning knowledge and skills, including mathematics, science, engineering hygiene and health and safety, as required for students to complete specialist Phase 2 Trade Training in a safe and efficient way. Training methods and media used on the CFM include instructor led classes, using traditional media (charts, books, etc) and workshops equipped for 'fitting and filing'.

Historically, there has been a problem of an unacceptably high proportion of students failing both the CFM and Trade Training final examinations. The challenge for the trial was thus to improve first time pass rates on the CFM by raising the initial standard of educational attainment of students.

AIM OF THE TRIAL

In light of the above, the aim of the trial was stated as follows: *'To produce a managed learning*

environment that will act as a demonstrator project for the REME Training Group Phase 2 student entrance standard problem and a scaleable exemplar for the development and deployment of e-learning in the Army'.

Doctrinal Basis of The Trial

The interventions comprising the trial may be said to conform to Director Educational and Training Services (Army)'s Advice for Personal Development in response to Personnel Doctrine (Hanlan, 2003):

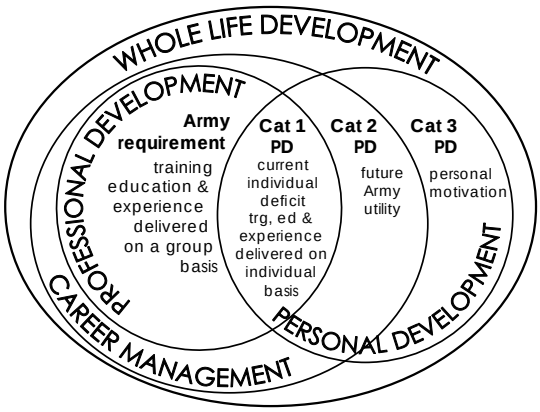


Figure 2. Army Whole Life Development Model

The focus of the trial addressed a Category 1 ('current individual deficit') with directed study of various types, including e-Learning, but allowed scope for volitional e-learning under Category 3 ('personal motivation'), as shall be described later in this paper.

METHOD

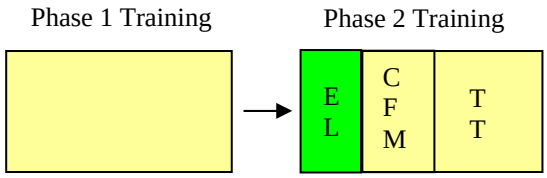
Experimental Design

The concept of the trial, articulated by the author, was for a remedial e-Learning intervention in which elementary mathematics and science modules would be undertaken by students working individually, followed by a 3D virtual world simulation of a battlefield scenario in which students would work both individually and collaboratively on tasks in which they would apply the mathematics and science which they had learnt. It was soon realised that the students were at too junior a level to incorporate anything relating to maintenance or requiring knowledge of battlefield tactics and so a 'time and distance' problem would be used. Again, for reasons beyond the scope of this paper, only the elementary mathematics and science modules were developed for what retrospectively became known as Pathfinder 1 and students of all ability levels were given exposure to e-Learning during the trial. A second phase of the trial, Pathfinder 2, incorporated a Serious Game within the courseware. The trial was used to develop e-Learning concepts for inclusion within updates to the *Army e-Learning Guidelines* (2005).

It was particularly hoped that e-Learning would assist the weaker students by reducing the social stigma of failing in front of others experienced in conventional classroom instruction, by allowing extensive private practice at a student's own pace and by providing a learning environment similar to one known to be popular with, and already familiar to, the age group of the students, i.e. the internet. Accordingly, the author invited Major Elizabeth Jones, using her developing expertise as an Occupational Psychologist in training, to explore students levels of self esteem during the trial.

It was also hoped that the e-courseware would be made available for volitional use (i.e. at the students' own choice and in his or her time) through hosting it on 9 Army Education Centre's classroom at the SEME site (cf. the Personal Motivation category within the Army's Advice for Personal Development policy, described earlier). In the event, for reasons beyond the scope of this paper, this was not possible on Pathfinder 1.

A simplified representation of the experimental design, showing the position of the e-Learning intervention, is given at Figure 3, below.



Where:

EL = E-Learning
CFM = Common Foundation Module
TT = Trade Training

Figure 3. Experimental Design of the Trial.

In Pathfinder 1, each of the commercial organisations were only part funded for their involvement; each contributed some effort free of charge as a 'loss leader' to enter the potentially vast military e-Learning market and as a commitment to the continuous improvement of their respective products/services. While the bulk of the funding for this trial came from the Army, without the contribution from industry the Pathfinder 1 trial would either have been delayed or might not have happened at all.

In Pathfinder 2, e-media was created by the

Adjutant General's Design Studio and the commercial organisations were fully funded by the Army.

e-Classroom

An "e-classroom" was created for the trial, comprising a dedicated classroom equipped with 16 x PC based workstations for students, plus two for the e-Moderator, all networked together (Figure 4, below):

Figure 4. Pathfinder e-Classroom.

The physical presence of the e-Moderator at one of the terminals within the room also allowed an implicit custodial role to be carried out, e.g. checking that students were not communicating orally with each other, and also allowed the Army to meet legal requirements for Duty of Care of the students.

Courseware Design and Development

The Mathematics Skills Revision (MSR) courseware was divided into two parts, to be undertaken in sequence: (1) Multiple Choice (MCQ), covering 9 remedial modules; (2) a Multi-Player Game, featuring a virtual world simulation.

Pathfinder 1 was undertaken by 4 organisations: (1) REME Training Group, (2) DITrg(A)'s TAG, (3) VT Group plc, and (4) Online Courseware Factory (OCF) Limited (later renamed Any Three Ltd). The primary responsibilities of these organisations were as follows: REME Training Group and DITrg(A)'s TAG provided finance, designed and analysed the results of the trial and quality assured the e-courseware. VT Group plc provided instructors and classroom facilities and developed the Pathfinder 1 courseware; OCF provided expertise in e-Learning technologies - choice and configuration of LMS, etc.

In Pathfinder 2, the Adjutant General's Design Studio undertook e-Media design, including reworking the "look and feel" of the revision modules and creating the Computer Generated Imagery (CGI) for the Serious Game.

The CFM examination comprises 20 questions covering a variety of mathematical and scientific subjects. An initial task was to pinpoint where failures were occurring within the CFM. SEME instructors identified 'mathematics', vehicle 'electrics' and 'transmissions' as persistent areas of difficulty for student. The instructors' judgments were given quantified support and further granularity by the collated results of first time failure rates across the 20 questions comprising the mathematics and science elements of the CFM.

Using this analysis to target the e-Learning intervention, and further guidance from the SEME instructors as to where problems occur within the question areas, VT Group plc's courseware developer (Mr Colin Baines) created the following 9 modules for the Pathfinder 1 trial:

- Arithmetic.
- Algebra
- Fractions.
- Indices.
- SI Units.
- Areas and Volumes.
- Angles.
- Graphs.
- Times Tables.

The instructional design for the revision modules required each to have the same instructional sequence or modes:

- In-Test.
- Introduction.
- Tutorial
- Practice.
- Out-Test.

A screen-shot showing an example of the final form of Graphical User Interface used for the Revision modules is at Figure 5, below:

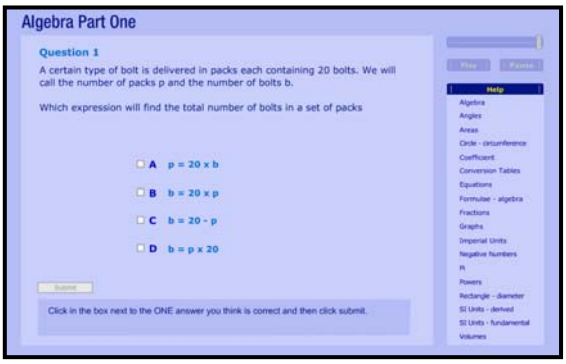


Figure 5. Screen-shot from Revision Module (Pathfinder 2).

An attempt was made to incorporate 'Self Assessment Computer Analyzed Testing' (SACAT) items against each question within the revision modules.

SACAT is the invention of Dr Darwin Hunt, of Human Performance Enhancement, Inc., and it comprises a development of conventional multiple choice items by also requesting the respondent to indicate his or her degree of confidence in the their answer and a modest reward in terms of their score, delivered by proprietary algorithms, to those students who demonstrate insight in this matter.

SACAT has been shown to improve both the acquisition and retention of knowledge and to reduce sex differences, amongst other benefits (Hunt & Hassmen, 1996). Clearly, a respondent who is very confident that he or she is right, but is in fact wrong, could be a menace in a safety critical environment such as the one in question; conversely, a respondent who is right but is very unconfident of his or her answer, cannot use their knowledge, i.e is useless.

A concept image of the Pathfinder 1 courseware, incorporating a Likert scale slider for estimating respondent confidence, is shown at Figure 6, below (cf. Figure 5, above).

Figure 6. Screen-shot Concept Illustration Showing SACAT Enhanced Courseware (Revision Module).

The mechanism by which SACAT works is still imperfectly understood, but it appears to be a meta-cognitive skill which can be acquired through practice (Hunt, personal communications).

Importantly, SACAT was not able to be implemented within the e-courseware due to the technical constraint imposed by SCORM conformancy: the pairing of question answer with a confidence rating was deemed to require 2 Shareable Content Objects (SCOs) open simultaneously. Although a theoretical solution was formulated (Hedley Hamilton, personal communication), trial programming did not allow sufficient time for its implementation. It remains a fascinating possibility for improving the otherwise somewhat impoverished learning achieved by conventional multiple choice questions in the context of e-Learning.

The Serious Game (SG) – "Exercise PATHFINDER" – was intended to provide further contextualization and realism for students to apply their recently revised mathematics skills in a virtual world simulation of a logistics problem.

The total number of students in any one session was determined by the size of the CFM cohorts. The 16 students were divided into 4 teams of 4; members of teams were not permitted to sit adjacent to each other in order to reduce the possibility for direct verbal or non-verbal communication.

The problem at the core of the game, chosen by the present author, was based upon a simplified "Artificer Dilemma", whereby a truck had to be loaded with supplies and a route selected which would get the truck to an airfield against a time constraint.

Each route had various pros and cons, such as a weak bridge which would not support the weight of a fully laden truck, necessitating either time consuming unloading and reloading or a selection of a different route.

Team members would use their mathematical skills, working individually and collaboratively, though always with the potential for assistance by the e-Moderator, to appraise the options before collectively agreeing a route and load.

A Team Leader, designated by the e-Moderator, was responsible for collating inputs from the team and for submitting the team solution to the problem.

The team would then watch a simulated implementation of their solution, which would either succeed or fail. Teams would typically complete the problem at different rates, but an element of competitive learning was introduced by all team members having the opportunity to watch and critique all four teams' solutions run simultaneously towards the end of the session.

The Graphical User Interface (GUI) for the game had the following functional layout (Figure 7, below):

/…

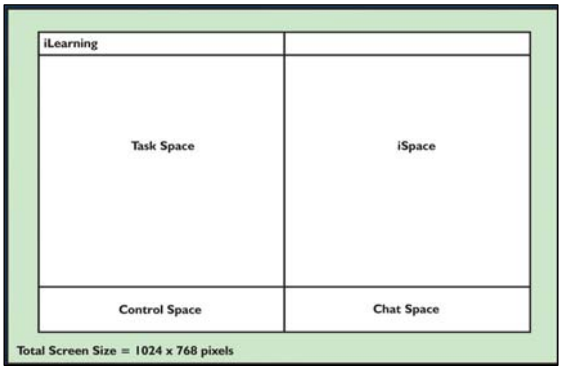


Figure 7. Schematic of Serious Game GUI.

The four functional areas or "spaces" of the SG GUI were as follows: the *iSpace*, or Information Space, is used to obtain technical data about the problem; the *Control Space* contains a mini-map, to assist orientation within the *Task Space,* where the task is scoped and implemented; finally, a *Chat Space* is available for students to communicate electronically with each other and/or the e-Moderator.

Figure 8, below, gives an example of how the SG GUI appears to the user:

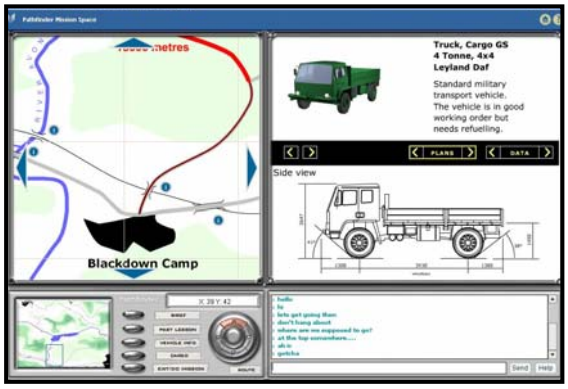


Figure 8. Screen-shot of Serious Game Graphical User Interface.

Initially the present author had envisaged a fully 3 dimensional virtual world being created for implementation of the task in the Task Space. In the end, however, it proved both more practicable and more "game-like" to retain the overhead map in the Task Space and show progress of the vehicle along the chosen route as a moving dot. During task implementation, the animated map was augmented by Computer Generated Imagery (CGI) of the vehicle shown in the iSpace. Between hazards, this took the form of a standard image of the truck in transit; however, as the vehicle approached a hazard a specific animation was shown which would reflect the success or failure of the team's solution. For example, if a team had overloaded a truck, the animation would show the bridge collapsing as it tried to cross it (Figure 9, below):

Figure 9. Screen-shot of Serious Game Computer Generated Imagery.

Trial Subjects

The trial subjects were 240 beginning Phase 2 (CFM) students, predominantly male and with an average age of 17 years; they were allocated in roughly equal numbers for each phase of the trial (Pathfinder 1, n =124; Pathfinder 2, n= 116). The CFM examination results of 894 students from previous courses functioned as a Control Group in Pathfinder 1.

Hearts & Minds Sessions

Two 'Hearts & Minds' sessions were run by DITrg(A) and REME Training Group in order to introduce the Pathfinder e-Learning to those affected by it and to attempt to elicit their support.

The first was for instructors and the emphasis was upon explaining e-Pedagogy and responding to their fears that e-Learning was simply a way to make conventional instructors redundant. On the latter point, trials allow such individuals to experience e-Learning in a less threatening context than wide scale implementation and to 'buy in' by allowing them to influence the development of courseware and scope for 'blended solutions' in its ultimate mode of use. Delays in central funding to the DTR e-Learning initiative mean that many of those who are unwilling or unable to make the change to become an e-Moderator will have retired before full implementation, for those that are willing and able to make the change trials allow them to make the initial step towards securing their future employment.

The second was for senior officers in the chain of command affected. Here the emphasis was upon the DTR policy directive and the use of their organisations resources.

e-Moderator Training

The requirements for e-Moderation, in combination with those of the game (exercise), had required purchase of a multi-player gaming engine and a networked classroom support and monitoring system. These allowed the e-Moderator to watch, share or control aspects of student's workstation; display 'thumbnail' views of all the student workstations in the e-classroom; view multiple student screens simultaneously; provide private one-on-one support to a student; and create defined groups of students enabling tasks performed by them to be input by only one student (i.e. the designated group leader).

E-Moderator training was undertaken by OCF Ltd and this focussed upon teaching the instructors how to operate the software for purposes of e-Moderation and engage in simple software related troubleshooting.

Conduct of the Trial.

Each phase of the trial was conducted over an approximately 3 month period. On the basis of earlier Pilot Tests, students were given 2 days e-Learning (the most able students could complete all 10 modules in as little as 2.5 hours, the least able would not quite complete all the modules in the full 2 days). The 2 days e-Learning was additional to the time allocated to the CFM. In phase 1 of the trial (though not in phase 2), the modules were deemed not suitable for student collaborative learning, and so e-Moderation was individually based.

Figure 10. Students using the e-Classroom.

Data collection was achieved primarily by direct observation and a standardised questionnaire.

RESULTS

The overall results for Pathfinder 1 are shown in Figure 11, below.

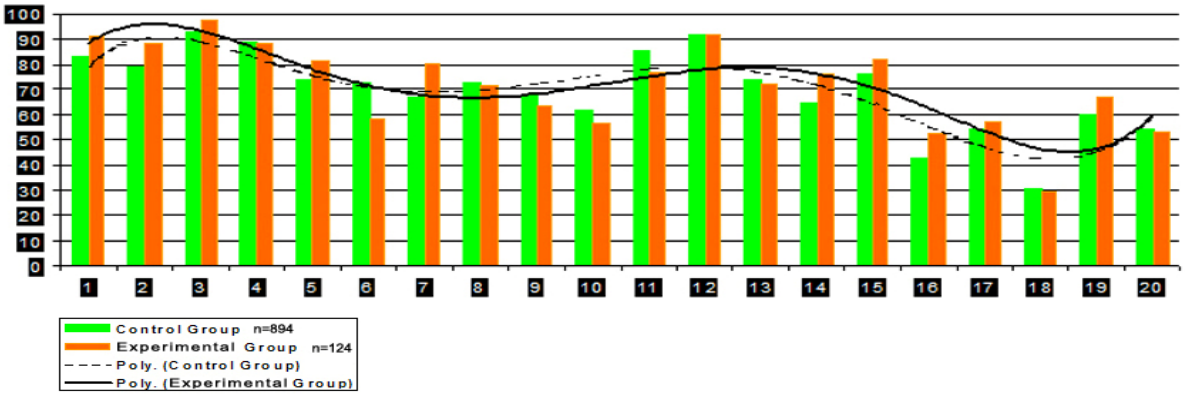


Figure 11. Graph Showing % First Time Pass Rates for Control Group and Experimental Group CFM Students on Pathfinder 1 Trial.

These show that there were no significant differences in performance between those who received only conventional instruction and those who received conventional instruction plus two days e-learning. Clearly, this was a somewhat disappointing result. Two factors may go some way to explain why. First, administrative constraints did not allow the e-courseware to be freely available to students throughout the CFM, as had originally been planned. Hence any improvement in mathematics skills may have been dissipated by the time of the CFM

final examinations. Second, Pathfinder 1 did not make use of dedicated e-media designers, as a cost savings measure. This proved to be a false economy because the e-courseware looked somewhat less than state-of-the-art and also contained numerous useability issues (cf. Figure 12, below, with Figure 5, above).

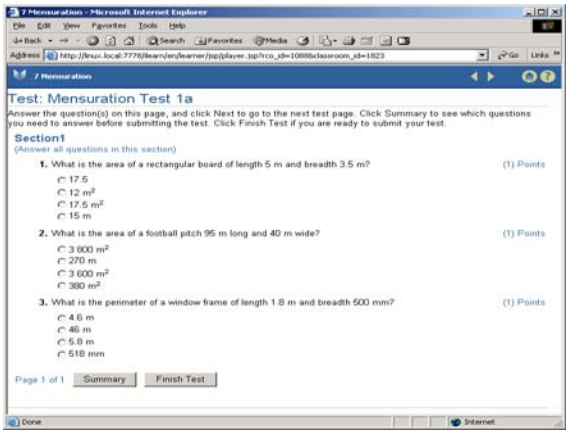


Figure 12. Screen-shot from Revision Module (Pathfinder 1).

This may have reduced student confidence in, and acceptance of, the courseware – an interpretation supported by comments made by students in a standardised questionnaire.

Major Jones' research in Pathfinder 1 (personal communications) revealed that mathematics self-efficacy and underlying learning confidence increased significantly during the e-Learning programme, but mathematics knowledge, computer self-efficacy and CFM learning confidence did not. Students motivation to transfer their e-Learning knowledge to the CFM and students' reactions to various aspects of their experience of e-Learning during the trial were also shown to be significant

Since the administrative constraints applied throughout the trial, no attempt was made to correlate e-courseware performance with CFM pass rates in Pathfinder 2. Student performance on the "In-Test" vs "Out-Test" for each module were measured and compared. The results for Pathfinder 2 (the most advanced version of the modules) are given in Figure 12, below. These show improvement in student performance on all modules, with only one anomalous result within a sub-module. Students showed a mean improvement of 17% across all modules, and over 40% on selected modules.

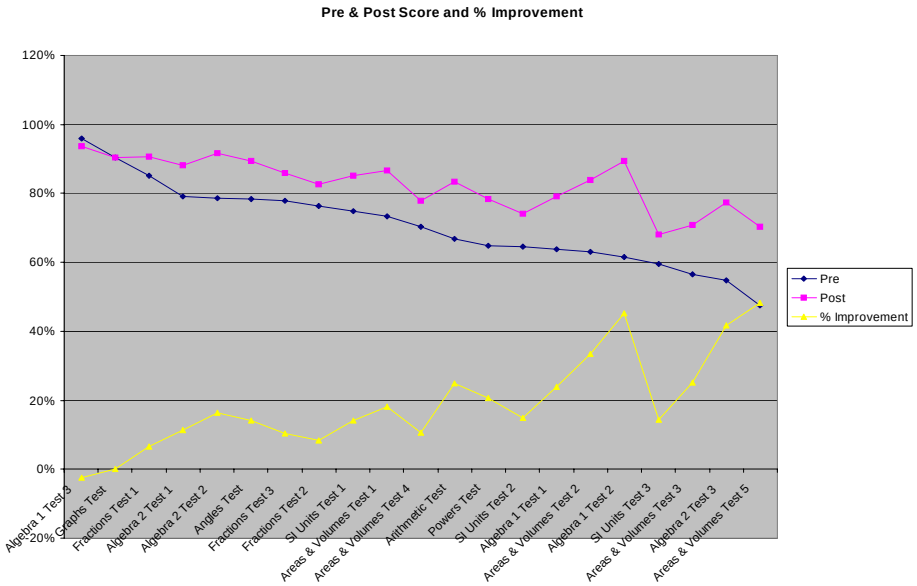


Figure 13. Graph Showing Pre- vs Post-Test % Improvement on Revision Modules (Pathfinder 2)

The assessment model for the SG was outcome based and was designed to ensure that, in the context of a cooperating group, the student has achieved mastery on all the pre-requisite objectives for the game and indicates if an objective(s) has not been achieved if failure results. The SG was designed to allow more than one route to achieve the aim, but which would allow qualitative evaluation in electronic After Action Review.

Unsurprisingly, given the custom and practices of today's young adults, students made extensive use of the Chat Space. This raised issues of comprehension by the e-Moderator, due to students' predilection for "texting", and decorum , until students were informed that their messages could be overseen by the e-Moderator ("flaming", use of obscenities, etc)!

An example of within-team chat is as follows (names altered):

Chalmers: n
Cotton: tell me
Cotton: ill cry
Christian: ill cry 2
Chalmers: WORK IT OUT, loser
Cotton: I cnt dats y im askin u
Celia: chalmers how do you work out time from speed and distance
Chalmers: dst!!!
Christian: chalmers
Christian: celia said you smell
Celia: help me
Chalmers: distance = speed x time
Celia: so how do you work it out
Chalmers: time = distance/ speed
Chalmers: muppet!
Celia: ah cheers m8
Celia: christian u stink
Christian: av done this ol wrong am gon 2 kill maself am gon 2 go radge
Chalmers: someone plz tell me how much a box weighs b4 I start throwing stuff?

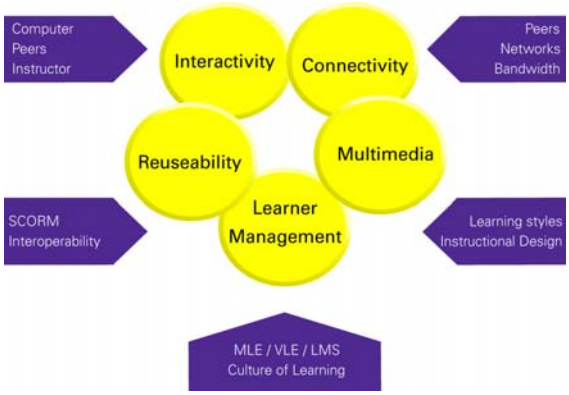
The standardised questionnaire, administered to a sub-set of the subject population (n = 157), revealed near unanimous (90%) preference for the mathematics being taught by e-Learning rather than by conventional methods of instruction. This finding was supported by direct observation of the students and by structured interviews with a sub-sample of the student population. Thus, for example, students were seen to return early from their lunch break in order to be able to play the SG sooner than they otherwise would and to clap and cheer when viewing the multi-group "shoot-out" at the end. In interviews, numerous students claimed to have enjoyed the SG and to have found it a motivator for completing the revision modules. It was also made clear to e-Moderator and the present author that some of the less able students appreciated the privacy that e-Learning gave to them relative to conventional methods of instruction and that they would have made elective use of the courseware if it had been available out of working hours, as had been intended.

DISCUSSION

Many specific lessons were learned regarding practical aspects of running an e-Learning trial were gleaned from the trial. While these are beyond the scope of this paper, some broader points are as follows.

The promise of cost savings through re-use of e-courseware was a major initial driver for the UK e-Defence e-Learning initiative. The development of cost models and positive Return On Investment (ROI) projections for e-conversion of courseware for the specific case of UK Defence proved less straightforward than in the commercial sector. The resulting delay led to the emergence of a "cottage industry" where small groups experimented with e-Learning technologies: the Pathfinder trial described here may be seen as an example of such.

This delay in centralised funding for the development of e-Learning courseware, including provision of a single LMS and LCMS, led to a number of unexpected benefits (Crome & Swift, 2004). These may be summarised by stating that the user community was able to become a more "intelligent customer" for e-Learning by trial led developments, such as Pathfinder. Such insights were included in the *Army e-Learning Guidelines* publication (MoD, 2005), later adopted tri-service within the UK. More specifically, the Hearts and Minds sessions of the Pathfinder trial, described earlier, required a clear delineation of e-Learning from more conventional forms of Computer Based Training (CBT). From an initial characterization a model with 6 cardinal features was developed – Figure 14, below.



Where
MLE = Managed Learning Environment
VLE = Virtual Learning Environment
LMS = Learning Management System
SCORM = Shareable Content Object Reference Model

Figure 14. Model of e-Learning (Crome and Swift, 2004).

Similarly, the Pathfinder trial prompted the requirement to delineate different "levels" of sophistication in e-Learning, in recognition that the highest level – corresponding to the model above and as exemplified by the Pathfinder e-courseware – would be neither affordable nor necessary in every application.

Again, from Pathfinder 1, the development and Quality Assurance (QA) of e-Learning courseware would seem to require input from 4 sets of distinct,

yet overlapping, domains of expertise, as shown at Figure 15, below (Swift, 2004).

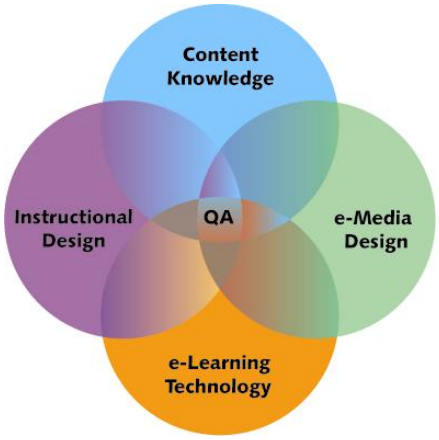


Figure 15. Diagram Showing the Four Functional Domains of e-Courseware Development.

Variations on this model are now commonplace, though it should be explained that *e-Learning Technology* refers primarily to the choice and configuration of the LMS, LCMS and their integration, a help desk and e-Moderator training in their use. The requirements articulated in the Content Knowledge and Instructional Design domains typically far exceed the functionality of the LMS and require purchase and incorporation of additional software, as was the case with Pathfinder (described below).

For all but the smallest of e-courseware development projects *Project Management* should also be included as a discrete functional area, as the present author found out to his cost while trying to combine this role with also trying to provide the lead on the Instructional Design on this project!

The intersection of the functional domains involves far more than QA, vital though that is, with each domain actively contributing to, and influencing, the other. One of the expedient discoveries made during Pathfinder was that the Army's (graphic) Design Studios, then typically used for the generation of report covers and power point presentations, held the potential within a short space of time for the in-house creation of e-Media, including CGI. Since the trial, their development of capability in the latter has proceeded apace, as shown by Figure 16, at top of next column (cf. Figure 9, above):

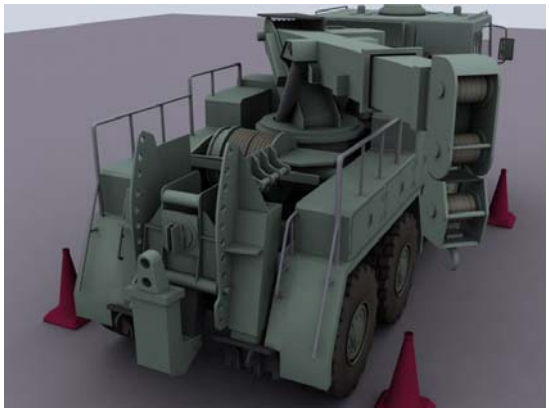


Figure 16. Screen-shot Showing In-house CGI of Foden 6X6 Recovery Vehicle.

While the Pathfinder trial proved capability for in-house production of e-courseware, QA at commercial standards proved impossible. Such can only really be done by a programmer comprehensively reading code as well as extensive user trials. The approach taken, of necessity, with the Pathfinder trial was for the present author and colleagues from DITrg(A) and the Adjutant General's Design Studio (AG DS) to attempt every permutation and combination of options within the MSR e-courseware. This has still left occasional "glitches" in the software, as revealed by student feedback.

This notwithstanding, MSR was developed for a tiny fraction of the cost typically required for e-learning in a commercial context. Thus, the total cost of the MSR e-courseware was approximately £110,000, or £11,000 per hour (averaged between the Revision Modules, 7 hours, and the SG, 3 hours). The cost of the trial was much greater than this – approximately £½ M - because it included costs for the rental of the LMS and LCMS (both now included within the UK Defence Learning Portal (DLP)), purchase of additional e-Moderator related software, technical support, trial administration, etc.

The requirements for e-Moderation, in combination with those of the SG, required purchase of a multi-player gaming engine and a networked classroom support and monitoring system. These allowed the e-Moderator to watch, share or control aspects of student's workstation; display 'thumbnail' views of all the student workstations in the e-classroom; view multiple student screens simultaneously; provide private one-on-one support to a student; and create defined groups of students enabling tasks performed by them to be input by only one student (i.e. the designated group leader).

It was found that the e-Moderator was successfully able to moderate 4 groups of 4 individuals simultaneously.

While some of the positive student reaction to the e-courseware and their improved performance may be discounted due to the mere novelty of the approach and a desire to please the trial organisers, it may reasonably be concluded that the e-courseware was both popular and successfully taught the mathematics, as judged within its own metrics.

At least part of the appeal of the MSR e-courseware to students may be attributed to the inclusion of the SG. This is not surprising: the motivation of a sizeable proportion of young adults to play recreational computer games is universally acknowledged. While SG probably cannot hope entirely to match the degree of commitment engendered by their recreational counterparts, if even 10% extra student motivation to learn could be harnessed by their use, then a very significant improvement in student learning would likely be achieved: much military knowledge is both difficult to acquire and/or not intrinsically motivating at the time it is learnt - this was an important part of the rationale for including a SG within MSR (Swift, 2005).

The work described here is part of a burgeoning worldwide interest shown in SG over the last few years, as reflected by the increasing emphasis placed upon them within major training equipment fairs, such as I/ITSEC and ITEC, and by dedicated conferences, most notably, the Serious Games Summit held annually in Washington DC. Extravagant claims have routinely been made for the training efficacy of SG and there has been much ritual trashing of instructional design. This notwithstanding, there is *still* little or no agreement about how a SG may rigorously be delineated from many apparently similar forms of training by simulation.

In terms of motivating students to learn, the dilemma may be summarised by an exchange which took place within a debate between Dr Jan Cannon-Bowers (arguing for the importance of instructional design in educational games) and Mr Marc Prensky (arguing for the training efficacy of SG without instructional design) at the SG Summit in 2005 (Jerz, 2005). Thus, Prensky cited with approval a remark from a game developer: "Whenever you add an instructional designer to the team, the first thing they do is suck the *fun* out!". From the audience, Ricardo Rademacher retorted that you could turn that statement around: "Whenever you add a game designer to the team, the first thing they do is suck the *education* out!". This latter is exactly the present author's concern, despite the popularity and apparent teaching success of the SG within MSR. In similar vein, Dr Cannon-Bowers argued that without instructional design the danger is that formal training could become hit or miss and that "fun" is neither a necessary, nor a sufficient condition for learning to take place – though it may be a desirable attribute in many contexts, provided it can be achieved without compromising the efficacy of the training.

The MSR SG was designed when literature on the subject was relatively sparse and the team did not avail themselves of many of the formal techniques, such as storyboarding, now routinely used. This notwithstanding, the MSR SG seems to reflect many of the features of successful recreational games.

The present author considers his early decision in the instructional design of MSR to divide the courseware into two parts, to be undertaken in sequence, viz. revision modules on specific topics, followed by SG, to have been vindicated by the success of the Pathfinder trial. It may prove to be a general principle that SG are best used for the consolidation and practice of knowledge and skills, rather than for their initial acquisition.

Since the Pathfinder trial, the SG has been further improved. For example, it is now possible to have additional routes and for the e-Moderator to create scenarios derived from geospecific terrain. Additional vehicles have been added and many parameters may now be altered, e.g weight of individual crates to be loaded, load bearing capacity of bridges, height of tunnel.

The MSR e-courseware has been released in hard copy, pending its upload onto the UK Defence Learning Portal (DLP). MSR is currently being evaluated by 3 training establishments allied to Arms & Services Directorates and the revision module component has been incorporated within a mobile Electronic Performance Support System (EPSS)/e-Learning device, for use by British Army Recovery Mechanics (Jarvis & Swift, 2006).

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