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ORIGINAL ARTICLE

Seven key decision factors for selecting e-learning

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Abstract E-learning is increasingly being adopted as a routine instructional media, and has moved from a niche solution in the defence and aerospace industries, to one that is adopted across the vast majority of industries and within education worldwide. E-learning is not however suited for all types of learning outcome or for all instructional situations. In this paper we describe a new instructional media selection model which enables the assessment of suitability of e-learning to a particular learning outcome. Following a review of media selection theory, seven key decision areas were identified. These consideration areas are; Learning Task, Media Attributes, Grouping Strategy, Learning Context, Learner Characteristics, Instructional Management and Cost Effectiveness. The paper focuses on the identification of the key decision factors for selecting e-learning and the development of detailed guidance within each decision area to enable an assessment of suitability of e-learning to be made. Finally we outline the dependencies and interactions between decision areas to illustrate the compromises inherent in instructional media selection, and to produce a model of these inter-relationships.

Keywords Media selection · E-learning · Training options analysis

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1 Introduction

E-learning is a collective term used to describe training delivered by electronic means, including web-based systems and computer and communications technologies, anywhere and at any time on demand. (UK Defence E-Learning Strategic Vision and Policy 2003.)

E-learning is currently undergoing its biggest change since desktop computing revolutionised business–and offered new opportunities for delivering instructional materials. The advent of the Internet, the web browser (with plug-in technologies such as Macromedia Flash) and streaming media has increased the potential economic value of computer moderated instruction ('e-learning') by adding world-wide connectivity, anytime availability and support for web-based communication of data to and from the learner. This has ushered in a global market for e-learning and lead to a widespread adoption of Learning Management Systems (LMS) to handle student enrolment, progress tracking and results recording. E-learning has moved from a specialist niche, to a business worth $6.5 billion globally in 2003 and predicted to grow to $21 billion by 2008 (Global outsourcing quoting an IDC report. Article available from: http://www.globaloutsourcing.org/content/Processes/2005/105061801.asp).

E-learning is not suitable for all learning tasks and is not necessarily the cheapest instructional media to use in a particular situation. In addition many organisations are discovering that introducing e-learning has wider ramifications than had been anticipated. Moving learning from the classroom to the workplace, making learners responsible for their own study and moving instruction from class delivery, to individual delivery are three examples of the changes associated with e-learning. These changes may have positive impacts in some areas and negative impacts

in others—an appreciation of the potential areas of impact is thus critical in playing to the strengths of e-learning while minimising areas of weakness. The media selection model developed, enables an assessment of the suitability of e-learning to a particular learning task and presents a framework around which to analyse the potential impact of e-learning in a broader organisational and situational context.

2 Media selection criteria

Media selection decisions can be divided between Strategic and Tactical decisions (Caladine 2003). Strategic decisions apply to decisions that affect available media types within the overall training system, whereas tactical media selection decisions are made by learning designers as part of the Training Options Analysis phase of instructional design.

Many large organisations have now identified e-learning as a key method for delivering instruction in the future—one example is the UK Ministry of Defence which in the Defence Training Review of March 2001 stated that, 'we propose that 80% of appropriate classroom-based specialist training courses incorporate a minimum of 25% e-learning within 5 years' (DTR Report 2001, paragraph 75). Policy statements such as this act at the strategic media selection level and are usually accompanied by the adoption of an LMS as a piece of enterprise architecture operating as a 'service' to host e-learning courseware produced by (or for) the component elements of the organisation.

The seven factors that comprise the media selection model are primarily to support tactical media selection decisions, though by evaluating the interactions between the seven decision factors the model can inform strategic media selection decisions at an organisational level. The consideration of cost within tactical media selection models varies. Some media selection models separate cost factors from instructional delivery factors (which include learning context, student characteristics and instructional management characteristics) (Lee and Owens 2001). Alternatively, costs can be considered as a learning context factor (i.e. part of the constraints that operate to the context of instructional delivery) (Smith and Ragan 2005).

Media selection factors are not wholly dependant on the intrinsic properties of the instructional media (also know as media attributes) and what they directly support. Media selection decisions are co-dependant with a number of factors outside those directly concerned with media attributes—which together characterise the instructional situation. These instructional factors are collectively referred to as [instructional] delivery and management strategies. The relationships between the variables are summarised in Fig. 1.

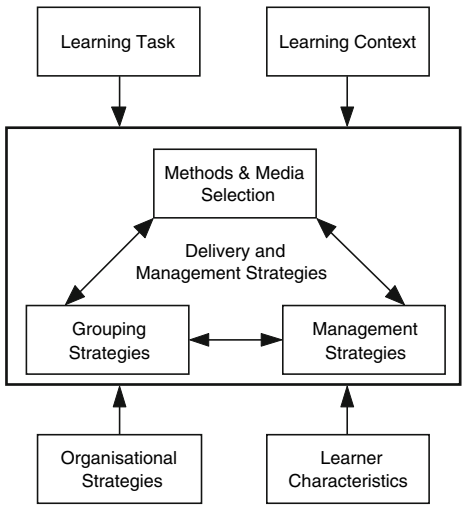

Fig. 1 Delivery and management strategies (diagram adapted from Smith and Ragan 2005)

Methods and media selection are integrated with the selection of student grouping (also known as the grouping strategy), and the instructional management strategy (also simply referred to in this context, as the management strategy) (ibid).

The grouping strategy concerns whether students are best taught in a group or whether individualised instruction, where students work at their own pace (though not necessarily alone) is more appropriate.

The management strategy concerns itself with scheduling lessons, production and allocation of required resources, assessment handling, production of management information and evaluation of the effectiveness of the system. The superset of all instructional management strategies and the resources and systems that underpin it comprise what is referred to as the management of training system.

Delivery and management strategies do not exist in a vacuum, nor can be imposed without consideration of other influencing factors. The requirements of the following factors will constrain which delivery strategies are appropriate:

(1) Learning Task—what are the characteristics of the learning task and what are the required instructional conditions?
(2) Learning Context—where will students learn, what constraints exist and what practical factors (e.g. cost) have an influence on delivery choices available?
(3) Organisational Strategies—determine how instruction is sequenced, what is presented and the forms of interactions that are designed. The classic nine events of instruction (gaining attention, statement of objective, recall of prerequisites, stimulus materials,

learning guidance, elicitation of performance, feedback, assessment of performance, retention and transfer) (Gagné 1972) are lesson level organisational strategies.

(4) Learner Characteristics—what are the entry behaviours and prior knowledge of the learners?

Any decision to convert a classroom course will need to consider the factors above in addition to intrinsic media factors. Sometimes it is the variability within a factor that has a strong influence on another—for example a high variability of learner previous experience (learner characteristic) or skill level makes adaptive instruction a preferred choice. This tends to favour an individualised grouping strategy, which then has an impact on the methods and media that can be selected. The decision on the choice of media and method must in turn be supported within the management strategy of the organisation (i.e. can the organisation manage students being at different part of a course given timetabling restrictions?)

3 The seven key decision factors

The seven key decision factors were derived by reinterpretation of the previously discussed elements, from a media selection perspective. Organisational strategies were removed as these are concerned with design considerations of using instructional media, rather than selection considerations for instructional media. To the factors remaining, cost effectiveness is added; a non-instructional factor but essential in making real-world decisions. Media attributes are also added as the factor that actually expresses what each media can support in alignment with the demands of the learning task. Each decision area can be characterised by a specific question:

1. Learning task considerations—is the learning task suitable for e-learning?
2. Media attributes—does e-learning support the necessary media attributes and interactions required for the instruction?
3. Grouping strategy considerations—is the learning task capable of being handled through individualised instruction?
4. Learning context and practical considerations—is e-learning possible given the context of the delivery situation and other practical considerations?
5. Learner characteristics—do the learners have the necessary skills, attitudes and motivation to conduct e-learning?
6. Instructional management considerations—is e-learning supportable within the wider organisational and cultural context?
7. Cost effectiveness—is e-learning a cost effective medium for delivering instruction?

When evaluating a course or number of courses for suitability for conversion to e-learning one will invariably find that some Training Objectives (TOs) are suitable for e-learning delivery whereas other TOs are not—just as there are many courses where a portion of the course is taught in a classroom (theory), but other components are practical and have to be practiced ‘in the field’, in a workshop, laboratory or in other situations which have external constraints that make them unsuitable for e-learning conversion.

This leads to a situation where the cost effectiveness of a complete or partial (blended) e-learning solution cannot be determined until learning task considerations and specifically the conditions of demonstration of the TOs have been examined in detail. Each of these decision areas is discussed in detail in the following section.

4 Elaboration of key decision factors

4.1 Learning task considerations

Suitability of learning task is the most critical consideration and is considered first as it impacts both on the student grouping strategy that can be used and the media attributes that must be supported by the instructional medium. It is often the case that some sections of a course are potentially suitable for conversion to e-learning where others are not (this is due to different TO’s making different demands on instructional media and the attributes that they are capable of supporting).

The limitations of e-learning to act as an instructional medium for certain TOs are characterised by the following situations:

1. E-learning does not support the types of instructional stimulus required during instructional delivery (e.g. TOs requiring gustatory, olfactory or haptic stimulus).
2. E-learning cannot support the conditions of demonstration of the TO. Limitations in this area mainly involve the type of interaction that must be supported:

a. Psychomotor skill practice dependencies—if a standard PC with conventional peripherals is not capable of reproducing the environment for psychomotor skill practice this rules out e-learning as a complete stand-alone solution. E-learning in these situations may still be useful to teach the executive subroutine of a psychomotor skill.
b. The TO or instructional method requires direct human demonstration interaction, communication or relies on

a high degree of adaptive feedback and judgements that may be informed by tacit rules (such as judging the technical execution of a painting).

The key consideration is the type of interaction involved. Maintaining the power pack of an armoured vehicle will require a high degree of psychomotor interaction with the equipment; whereas operating a keypad of a radio is primarily a cognitive skill (one doesn't actually have the press the buttons for real to learn to operate it). The primary consideration is what the TO requires (and defines) as the conditions of demonstration.

TOs are broken down into a number of domains of learning (also known as types of learning outcome). The breakdown of learning objectives into knowledge, skills and attitudes is part of the learning task considerations. Knowledge based objectives (which include declarative knowledge, concepts, procedures, principles, problem solving and cognitive strategies) are commonly handled through e-learning and well-suited to it (Driscoll 1998). Figure 2 shows the commonly used 'KSA' characterisation of learning objectives.

Psychomotor skills can be partially taught through e-learning—as the 'executive subroutine' of a psychomotor skill is an intellectual skill (Smith and Ragan 2005). Just as books on playing golf exist and instructional videos on rock climbing have instructional value, so e-learning can be used to teach the intellectual components of the skill. However to actually learn a psychomotor skill the opportunity for skill practice must exist. The question then becomes does a computer environment support the necessary opportunity for that practice? If the skill involved the control of a piece of equipment through a PC-type interface one could make the case that it could. On the other hand, practising rock climbing will require the real situation or a good facsimile of it, such as an indoor climbing wall.

Cognitive skills and perceptual skills can be taught through e-learning providing that support for the necessary practice environment can be provided—this may be in the form of gaming or emulation, supported within an e-learning context.

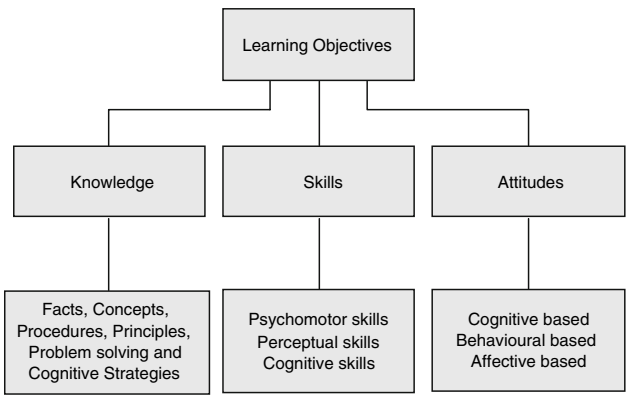

Fig. 2 Breakdown of learning objectives

Attitudinal objectives are comprised of a cognitive component, a behavioural component and an affective component (Smith and Ragan 2005) Attitudinal skills are classed according to which of these three components is dominant. Teaching attitudinal objects requires that the student know how to perform the skill (cognitive), is able to demonstrate it (behavioural) and have internal motivation to behave in that way (affective). Attitudinal learning is based on the principles of persuasive messages, [role] modelling and dissonance (acting counter to one's private attitude) (Fleming and Levie 1993). Research indicates that persuasive messages put across face-to-face are more effective than through mediated communication (including CMC), and that active participation and interaction produces more attitude change than passive reception of information (ibid). For these reasons face-to-face 'traditional' learning is preferred under ideal situations—especially as the opportunity for the practice of attitudinal objectives should exist. E-learning can represent persuasive messages and allow role modelling, through the use of video. Where e-learning has some potential limitations is in the realm of skill practice (e.g. practising safe driving behaviours), and the ability to support dissonance—which is essentially in the realm of student–student interaction or student–facilitator interaction, and is best supported through direct (unmediated) communication.

4.2 Media attributes

Media attributes (intrinsic media characteristics) describe the capabilities and types of stimulus and interaction that are supported by a particular instructional medium. Instructional media can be characterised by their support for transmission of stimulus information and their support for interactions (Caladine 2003). Stimulus information (also characterised as transmission of information) includes text, still images, moving images, support for colour, audio, haptic or kinaesthetic input. Instructional interactions may be categorised as; (1) interaction with the instructional materials themselves (e.g. completing the self-test questions in a workbook and checking the answers), (2) interaction with other learners and (3) interaction with the learning facilitator (the term learning facilitator is used to characterise a number of roles e.g. teacher, lecturer, demonstrator).

Some forms of instructional delivery may encompass more than one of these roles—for example a human instructor may act a vehicle for transmission of information (i.e. in a lecture), while also asking students questions and responding to them (interactions with materials). The

intrinsic characteristics of an instructional medium must be sufficient to support the transmission of information required, and support for interaction required by the learning task (Dick et al. 2001). In other words, if an instructional task requires moving images to be presented, then the instructional medium should be capable of transmitting moving images. Likewise if an instructional task requires teamwork, then a form of learner–learner interaction will be required.

4.2.1 Transmission of information

Transmission of information is characterised by the types of stimulus that can be transmitted to the learner, these are also known as the media attributes of the instructional medium. In an e-learning context these include text, still and moving images and audio. Other types of instructional information provided can include; motion, tactile sensation and physically modelled environments. E-learning as an instructional media has the ability to embed or control other instructional media, for example; provide links to printable documents or provide access to video.

4.2.2 Support for instructional interactions

Support for interactions concerns whether the instructional medium can adequately support practice through interaction in a sufficiently realistic setting. Interaction may take a number of forms (i.e. interactions between the learner and the instructional materials, interactions between the learners and interactions between the learner and the learning facilitator). In this sense learning can be conceptualised as the designed provision of materials (transmission of information) and interactions towards an intended goal (Caladine 2003). The requirements for different types of interaction are driven by the learning task. Beyond the basic provision for interaction, the learning task also drives the quality of interaction required. Some learning tasks require a level of interaction that requires personnel to be physically co-located (e.g. psychomotor skills such as throwing or grappling in the martial arts), in other situations email, audio links or an online discussion group may be sufficient and appropriate.

Instructional interactions may be characterised in a number of ways—by the entity being interacted with (student, facilitator, and instructional materials), the types of stimulus information sent and received (e.g. audio for audio conferencing or text for email), whether the interaction may be synchronous (such as video-conferencing) or asynchronous (such as email). These factors contribute to whether the instructional interaction may be direct or indirect, for example one could imagine a telephone tutorial group for teaching and practicing French would be feasible, whereas teaching or practising yoga over the phone would not.

Other ways of characterising instructional interactions is whether they can be recorded and played back to illustrate correctness (or lack of), or consequences of action. In this context recorded interactions may constitute transmission of information.

E-learning supports interactions either internally (as in interaction with the materials in the course) or through Computer Mediated Communications (CMC) technologies, such as email—enabling messages to be passed to others. CMC also referred to as collaboration technologies, support learning interactions with other learners, or the facilitator. Examples of collaboration technologies include email, discussion forums, chat, voting, application sharing, audio and video conferencing (Horton and Horton 2003).

The media attributes of e-learning are limited by the current level of technological development and are likely to evolve considerably in the future (this is illustrated by the advances in the last few decades—photorealistic images were first seen on desktop PCs in the 1980s, audio support became common with the MPC2 standard in the early 1990s). E-learning with its support for a wide range of embedded media—video, animation and sound—makes it very well equipped for transmission of information. The provision of designed interaction within the instructional medium also allows for a good level of interaction with the instructional materials, and allows for non-linear delivery or adaptive delivery based on student actions (e.g. the design of remedial sequences if the student fails to complete an assessment satisfactorily).

Input technologies have been traditionally limited to keyboard, mouse (and joystick) recent advances make character recognition, and voice recognition supportable with some minor inconveniences. Specialist input devices (e.g. haptic gloves, VR headsets) may be used for specialist training applications although the cost of proving specialist peripherals limits the flexibility of learning context (i.e. learn when and where you like) that is inherent to most types of e-learning delivery. Interaction in an e-learning context may either be pre-programmed into the courseware, or may be with a human facilitator via CMC. Interaction stimulus may involve synchronous or asynchronous audio and/or video or text.

Most feedback within courseware is pre-programmed according to matching specific response criteria, though it is possible to match multiple criteria simultaneously this still fundamentally limits the richness and depth of interaction that is supportable. Current weaknesses in e-learning exist in the area of adaptive feedback this is due to a lack of AI type functionality that can be coded within e-learning development tools. Even when this technology becomes available it is likely to be initially expensive and time

consuming to originate. The idea of a computer marking an essay is still a few years away.

The support for collaboration tools/CMC enables support for learner–learner interaction and learner–facilitator interaction, which helps substitute for the (potential) removal of a human facilitator. There are positive and negative learning implications for transferring from a direct, to a computer mediated form of communications, which are outside the scope of this paper. The quality of the instructional experience (independent of message) deriving from interaction is determined by: (1) the type of stimulus can be sent and received (text, audio, video, etc.) (2) the media quality of that stimulus (frame rate, audio quality, etc.) (3) whether the stimulus is synchronous or asynchronous and the latency of response.

It should be noted that new potential dependencies are introduced with CMC—these include issues such as:

- Are learners be able or confident to use this form of technology? (learner characteristic).
- Is the organisation equipped to support this form of activity? (instructional management consideration).
- Cost factors (cost effectiveness consideration).
- Will the network support the required bandwidth? (learning context factor).

4.3 Grouping strategy considerations

The grouping strategy determines whether students must be trained in a group (two or more students) or can be trained individually (this is termed individualised instruction). Converting conventional classroom training to e-learning potentially involves altering how the students are organised—transforming delivery from group delivery to an individualised strategy, where each student has the opportunity to work individually with the learning material. The grouping strategy determines part of this consideration; is an individualised strategy appropriate for the content, organisational context and learners?

Some learning tasks will require a minimum size of group to generate the conditions of practice required by the TO (e.g. teaching aircraft exit procedures for four-way parachuting will require a minimum of three students and one instructor). Some learning tasks by their nature demand a grouped delivery strategy, this may stem from the conditions of practice only being satisfied within a social group—developing leadership or teamwork would be a good example as is learning that is dependant on group-problem solving. In other situations the instructional method to teach, practice or assess a skill may demand a group (an example would be assessing escape and evasion skills where the student is pursued by a set of personnel representing enemy forces).

Not all forms of e-learning imply individualised instruction—e-learning courseware is an individualised form of instructional delivery, whereas synchronous virtual classroom (SVC) can support a grouped delivery strategy which does not demand that students are physically co-located. In a situation where e-learning is being introduced and a grouped strategy is being maintained the synchronous CMC will have to support the required stimulus types at an acceptable level of fidelity.

4.4 Learning context and practical considerations

Learning context is the physical situation in which instruction is delivered, and also includes the instructional design and development lifecycle that enables one to get to the point of delivery. Learning context can be thought of as the environment that enables the instructional stimulus and interactions that the learning task demands. For example, to learn how to conduct procedural tasks in weightlessness during extra-vehicular activity, NASA astronauts wear spacesuits and use a mock up of the space shuttle immersed in a swimming pool.

The primary learning context considerations are summarised in Fig. 3 below:

E-learning must be supported through hardware, software and potentially connectivity to the Internet or an intranet. Delivery environment issues include; the number of computers at the point of delivery, availability of the necessary hardware and software, sufficient licences on the LMS and adequate connection bandwidth.

Learning context does not just include the final delivery environment, but also involves how we get to the delivery environment—and so involves issues such as procurement, design and development as well as delivery/operation and provision for maintenance. Critical considerations involve; budget, personnel, personnel skills, facilities, equipment and production capabilities. Lead time to procure and develop e-learning is another consideration, as is the stability

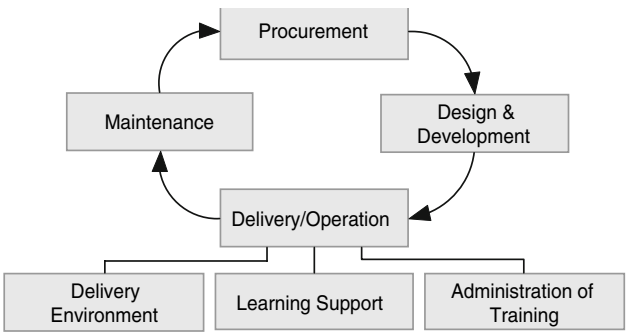

Fig. 3 Learning context considerations

of the learning content—e-learning is relatively expensive to develop but cheap to deliver.

Changing the way that training is conducted may also have cultural impacts—if the student is no longer removed from the work environment there may be a tendency for operational demands to override allocated training time. This may result in training not being conducted in a timely manner.

4.5 Learner characteristics

Learner characteristics are a critical consideration when performing media selection, because learner characteristics impact on whether certain types of stimulus can be processed (e.g. non-readers cannot process text) or certain types of media used (one would not want to present e-learning to someone who was totally unfamiliar with computers). Some of these issues may be avoided in the instructional design stage by selecting alternative channels of communication (e.g. voice as a replacement for text), providing that the instructional media supports multiple types of instructional stimulus. E-learning in this respect is quite strong as it supports text, images, animation, video and voice. At its most basic, consideration of skills such as literacy or the ability to use a computer, are essential when accessing e-learning.

4.6 Instructional management considerations

Instructional management is a property of the organisation delivering the training—the basic consideration is whether the organisation is able to integrate e-learning efficiently within the wider training system; and operate, maintain and evaluate e-learning solutions over a number of years. Introducing e-learning brings about changes to how courses are developed, supported and managed. There are many cultural and organisational enablers that will help to improve the effectiveness of operation of a piece of e-learning, post-delivery. Changes in the role of the instructor, potential learner isolation, potential changes to a highly regimented training environment (which can follow if you are going to allow students to learn when and where they like) and alteration in the details of training administration and evaluation are all factors that can be addressed by a clearly defined instructional management strategy for e-learning.

From an instructional management perspective adding e-learning to the range of available instructional media, may necessitate changes in instructional management—this may involve new instructor roles and skills, differing methods of training administration, new evaluation opportunities.

4.7 Cost effectiveness

The final decision factor to consider is the cost effectiveness of e-learning. When considering cost effectiveness a key principle to consider is the 'no significant difference effect' that applies when considering types of instruction media. As long as an instructional media can support the learning task and grouping strategy required, the choice of instructional media does not make a significant difference to how much students learn (Russell 1999)—the actual design of instruction has the most significant impact on the effectiveness of a piece of instruction. When performing cost-effectiveness calculations one can compare a range of candidate instructional media that would be potentially effective and perform a Return on Investment (ROI) analysis (Horton 2000). For example, we can compare e-learning with a classroom solution.

ROI for e-learning is calculated from the total cost savings from conversion to e-learning divided by the additional one-off course design and development costs incurred with producing e-learning. This is calculated as follows:

$$\mathrm{ROI} = \frac{(\text{Total Costs for classroom training}) - (\text{total costs for e-learning})}{(\text{development costs for e-learning}) - (\text{development costs for classroom training})}.$$

One method of calculating total costs is to break down costs that are:

1. Incurred developing the course (one off course design costs).
2. Incurred delivering the class (e.g. cost of the classroom, instructor salary).
3. Incurred as a per student basis (e.g. student handouts, student travel).

Total costs are calculated by summing, per-course costs (which include course maintenance costs), with the per-class costs multiplied by the number of classes and

per-student costs multiplied by the number of students. Total cost divided by the number of learners over the project course lifetime generates a cost per learner, which is a useful metric to use if e-learning is being used to expand the number of students being trained.

Having calculated the ROI of e-learning, the next step is to calculate the annual savings to operating costs. This figure then enables the calculation of the payback period for the investment (i.e. when the up-front build costs for the e-learning are offset by annual cost efficiencies for delivery). Finally the payback period for the investment must take place within the course delivery lifetime of the course.

5 Interdependence of decision factors

The seven components of the media selection model have been discussed individually, however it is useful to examine how these factors influence or determine each other. This model can be used as a framework for analysis in strategic media selection to predict the impact of the introduction of a new form of instructional media to an extant training system. The seven key areas are highly interdependent, the key dependencies as illustrated in Fig. 4.

5.1 Learning task and media attributes

The learning task is the primary driver, both grouping strategy and media attributes are driven directly by the requirements of it. As we have outlined, instructional media attributes must be able to support the conditions of demonstration of the TO for any instructional media to act as a complete solution. In the context of e-learning, e-learning (and/or embedded CMC) must be able to reproduce the stimulus and interactions that the instructional task requires at an appropriate level of fidelity. Support for skill practice through interaction is a critical consideration and necessitates external dependences if such practice cannot be performed through a computer interface. Attitudinal objectives may have skill practice dependencies and in the affective domain may benefit from direct non-mediated human interaction.

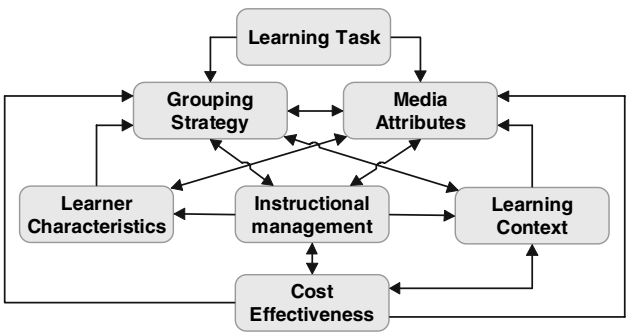

Fig. 4 The interrelation of media selection factors

5.2 Learning task and grouping strategy

Some instructional tasks by their nature necessitate a grouped strategy—teamwork is a good example. It should be noted that a grouped delivery strategy does not imply co-location of students or instructor. Whether direct human contact is required by the instructional task is a different matter—for example teamwork between forward air controllers and close air support pilots could be taught through e-learning/CMC—provided the quality and type of interactions (including the types of stimulus) were replicated in an instructional situation. In general terms if teamwork is intermediated through technology it is theoretically possible to teach this through e-learning.

5.3 Media attributes and grouping strategy

As has been stated earlier e-learning does not necessitate an individualised learning strategy—the SVC is an example of a group (grouping strategy) supported through CMC technologies providing the necessary transmission of information and support for interactions (media attributes). Grouping strategy and media attributes are co-dependant—if a grouping strategy requires a form of interaction then the technology must be able to supply the required functionality. Conversely new technologies offer new potential grouping strategies. Grouping strategy and media attributes are co-dependant—in that if a grouped student strategy is required by the learning task, the instructional medium must support the appropriate types of synchronous or asynchronous interactions. Conversely, the media attributes of an instructional medium determine which grouping strategies are available.

5.4 Grouping strategy and learning context

Grouping strategy has a profound impact on learning context factors, and many of the cost savings associated with delivering e-learning are derived from changes in learning context (e.g. student travel and accommodation associated with moving to a training location). In a practical traditional sense, the grouping strategy determines where and when instruction may take place, just as learning context determines what student groupings are possible.

There are many potential delivery benefits from moving to an individualised strategy, these can be characterised by the temporal and spatial separation of learners, specifically: (1) remote delivery, (2) ‘on-demand’ or just-in-time

delivery, (3) flexible delivery, (4) self-paced delivery and (5) adaptive delivery. From the organisation's perspective there may be advantages in an individualised student grouping—these concern resolving issues or inefficiencies with existing student grouping, primary considerations include resolving issues of instructor availability, ineffective/insufficient class size, very large class size, availability of trainees, or the irregular arrival of trainees over time. An individualised delivery strategy enables the learning environment in the case of e-learning to become the workplace (providing the necessary computers are in place) or home. E-learning courses are often taken in a multiplicity of learning contexts, a suitable computer and connection to the Internet being the only core learning context requirements in many cases.

Moving to an individualised strategy allows the learner to interact more directly with the instructional materials, and allows the physical separation of students from the learning facilitator. Maintaining the necessary facilitator interaction and support generally requires CMC in some form.

The learning context determines both media attributes and grouping strategy—if personnel are scattered across the world, remote delivery must be supported (media attributes), if the learning is 'on-demand' then an individualised strategy is required.

5.5 Grouping strategy and instructional management

Instructional management must support the grouping strategies that are required by the learning task, just as the availability of instructional resources impacts on how students can be potentially grouped. Instructional management is co-dependant with grouping strategies used within the organisation—grouping strategies impact on course scheduling, instructor numbers, the role of the instructor and types of student support provided. Once instructional management is adapted for a specific form of delivery, there will be a degree of institutional inertia that will predispose grouping strategies that the organisation can most effectively support (i.e. if the organisation has classrooms there will be a natural tendency to deliver instruction through them).

Individualised instruction, whether e-learning or a traditional correspondence course will require different forms of instructional management (e.g. instructors may have to answer emails rather than spending time delivering training materials). Introduction of new roles requires new skills and may necessitate new ways of working to accommodate the changes required. Many potential advantages offered by e-learning may not materialise if instructional management is not in alignment. For example there is no point having flexible course delivery if one is constrained by the wider scheduling of the curriculum.

5.6 Learner characteristics and grouping strategy

An individualised grouping strategy may involve the separation of students from their peers or separating a learner from a human instructor. This may have positive and negative effects.

Learner characteristics can influence grouping strategies if the social component of learning is seen to be beneficial, or if we have a situation where we want to separate or 'stream' a student group by aptitude, or prior knowledge. In a heterogeneous student group self-paced and adaptive delivery, resulting from an individualised strategy offers many advantages to the learner. Primary positive factors include; the accommodation of a wide range in learning rate, skill level or experience within the student population, and delivering different content for different job roles. The ability to stop and 'rewind' content is also critical in some situations. These advantages may manifest as increased confidence and increased motivation to learn.

Another primary consideration is student motivation and expectations of success—by potentially removing the student from a social group and removing direct contact with a human instructor some students may become demotivated (especially those with low academic self-esteem and this may result in poorer performance).

5.7 Media attributes and learner characteristics

Media attributes have an impact on required learner characteristics (e.g. computer literacy), just as learner characteristics impact on design decisions relating to instructional media (such as the use of audio for personnel with a low reading ability). The interaction of learner characteristics and media attributes means that learners must have the core skillset, motivation and confidence to use the technologies that support the instructional experience. Conversely the attributes of the learner inform design decisions in which forms of media are used.

5.8 Media attributes and instructional management

Instructional management competencies will drive the adoption of particular forms of learning while new forms of learning (especially when driven by centralised policy) will necessitate new skills, processes within instructional management. In these situations a degree of change management is required. Instructional management also ensures that best practice is followed in mapping sound instructional design principles to the advantages offered by new forms of technology. Media attributes such as requirement for student support via email will necessitate changes in instructional management or the role and skills

of the instructor, just as new instructional management approaches make new types of interaction possible.

5.9 Instructional management and learner characteristics

Instructional management has an impact on learner characteristics—both in terms of the entry requirements for courses, and student selection. The messages and level of instructional support are provided by instructional management have a critical impact on student motivation and reflect the organisations support (or lack of it) for certain forms of learning (e.g. being expected to do e-learning in one's own time, while doing a classroom course in work time). The integration of different forms of learning in this context is critical—as an example giving an early completer of a piece of self-paced learning 2 days extra menial duties as a reward, because course scheduling does not allow for anything else, might send out the wrong message.

5.10 Instructional management and learning context

Instructional management also determines the learning context over the long terms to the extent that decisions are made to build classrooms of a certain size and equip them with certain types of equipment. To an extent all training organisations are restricted in moving from one way of doing training to another—if one has classrooms there always seems to be a temptation to use them.

5.11 Learning context and media attributes

Learning context determines supportable media attributes—in an e-learning situation if we don't have connectivity or speakers (which are context factors) we can't support media attributes like email interaction or audio. Where training is delivered at remote locations learning context factors such as limited bandwidth may directly impact on media attributes like the frame rate of video.

5.12 Cost effectiveness and grouping strategy

Cost-effectiveness considerations impact on aspects of grouping strategy such as the student–instructor ratio that can be supported. This can in turn impact on the quality of instruction and the performance of the personnel who have been trained.

5.13 Cost effectiveness and learning context

Cost effectiveness and learning context are co-dependant in that available resources determine whether an e-learning solution is possible (i.e. it may be cost effective, but you may not have the money or resources to procure a solution). Conversely learning context such as number of students, course lifetime, degree of content revision, support costs, etc. directly feed into cost-effectiveness calculations. Cost effectiveness also drives the media attributes that can be used—costs of procuring video for example or the richness of experience that may be supported.

5.14 Cost effectiveness and instructional management

Cost effectiveness and instructional management meet in the procurement and development of a training solution. Effective instructional management in this context means that the organisation is an 'intelligent customer', and only proceeds with e-learning when it is both instructionally suitable and cost-effective. Cost-effectiveness also impacts on level and type of instructional management support that can be provided to students on an ongoing basis.

5.15 Cost effectiveness and media attributes

The final interaction is between cost factors that determine the media attributes within e-learning for example we might find it instructionally advantageous to include a 10 min video to illustrate a point, but might not be able to include it from a cost perspective. E-learning is often implemented as a way of saving money, and this can lead to the danger that media attributes that might be beneficial to instruction are sometimes omitted on the basis of cost.

6 Conclusion

This paper describes and proposes a new conceptual framework to analyse media selection and specifically the suitability of e-learning to a particular learning task. Reinterpretation of existing models of instructional delivery and management strategies, from a media selection perspective, allows seven key e-learning media selection decision areas to be identified. These are learning task considerations, media attributes, grouping strategy, learning context, learner characteristics, instructional management and cost effectiveness. Suitability of e-learning in each of these areas should be established prior to selecting e-learning as a candidate instructional media for a specific learning task. Significant interactions and dependencies between the decision factors exist, and these to some extent account for the complexity of media selection decisions. The seven key decision factors can be applied at the tactical or strategic media selection level, and the inter-relationships between decision areas provide a basis to analyse strategic changes that may result from the introduction of new forms of training media. Although written from an e-learning

perspective this framework is generic, in that could be applied to any form of training media by consideration of the specific attributes of that media, and how they relate to the characteristics of learning task in question.

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