EXPLOITING EFFECTIVE LEARNING AND TEACHING METHODS, TOOLS AND RESOURCES FOR THE DISTANCE OR "OUT-OF-CLASSROOM" LEARNING OF DATABASES

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ABSTRACT

Keywords
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This paper synthesises evaluated theory and practice from the TLAD conferences, the OU and other sources to present effective approaches to distance learning.

In an appropriate strategic context, ICT-based methods and resources can be applied to achieve particular learning outcomes. Methods that can be exploited include presenting knowledge, moderating forums and facilitating development activities.

The provision of a rich variety of learning resources is essential to this strategy. However, a searchable database of peer-reviewed resources for the databases (and other) academic communities has yet to be established.

An application of this approach is described for learning outcomes related to database design, SQL and other topics.

1. INTRODUCTION

The aim of this paper is to present effective ICT-based pedagogical methods, tools and resources, and to illustrate how these might be applied to support the learning of databases for distance and "out-of-classroom" learners.

Teaching, Learning and Assessment in Databases, Sunderland 2005

Distance learners in this context can include learners registered on on-campus courses, but for a variety of reasons (such as learning style preferences or work commitments) may not actually be on-campus or "in-class" very often.

It should be emphasised from the outset that whilst the focus is on distance learning, these approaches can complement (or blend with) physical on-campus face-to-face methods and access to resources. Moreover, depending on the learning outcome, it may be more appropriate to apply these ICT-based methods in an on-campus context. They can also efficiently provide an alternative choice to on-campus learners.

With the aim of trying to provide as rich a learning experience as possible for all learners, whether distance or on-campus, the notion of "converging" the learning experience of on-and-off campus learners is discussed further in [1].

The paper aims to synthesise evaluated theory and practice from primarily the following three sources in order to present this approach to the learning and teaching of databases to distance and "out-of-classroom" learners:

1. Experience gained from applying this approach to both distance and on-campus database modules.
2. Theory, practice and experience gained as a distance learner on the Online Education and Training course (OET)[1] in 2002-03.
3. Evaluated output from the Teaching, Learning and Assessment of Databases conferences (TLAD, including TLAD03 and TLAD04).

The Open University (OU) is probably the best known and respected distance learning provider in

[1] Postgraduate Certificate of the Institute of Education, University of London

the UK, if not internationally. This paper therefore also draws upon, where feasible and applicable for most campus-based institutions and students in the UK, approaches taken by the OU as discussed by Waugh at TLAD04 [2].

The discussion (led by Davis) on distance learning at TLAD04 [3] indicates the expansive body of knowledge and issues in this area, and so this paper attempts to keep strictly to the focus reflected by its title.

A contextualising learning and teaching strategy is established in section 2, followed by a review of evaluated methods, tools, and resource provision in sections 3 and 4. Section 5 then shows how these methods can be applied to core topics and activities found (as evident from TLAD) on most database modules. Key conclusions are drawn in section 6.

It is important to emphasise that this paper does not present any particularly new or innovative methods or approaches. It simply attempts to draw upon the "tried and tested" within an overall strategic framework.

Further details of these approaches applied in practice can be found via the DATABASE portal as indicated in the header to this paper.

2. An Enabling Learning and Teaching Strategy

The aim of this section is to establish a learning and teaching strategy context to underpin the discussion in this paper. It is not the intention to promote this strategy over any other that may be more appropriate for the particular institutional context.

A key aim of the strategy is to facilitate alternative learning approaches and resources, where possible, to accommodate potentially diverse distance and "out-of-classroom" learner groups.

2.1 A Learner-Centred Model

Figure 1 is a refinement of a model proposed by the author in [1]. It is derived primarily from a review and analysis of current theory and practice of ICT-based and online learning approaches.

This learner-centred model suggests four key elements to learning - peer learners, tutors, learning and teaching methods, and resources. These elements underpin interrelated forms of learning including "facilitated", constructivist, active, and resource-based.

A key feature of this model is the fundamental underpinning of the learning process and experience by an ICT infrastructure.

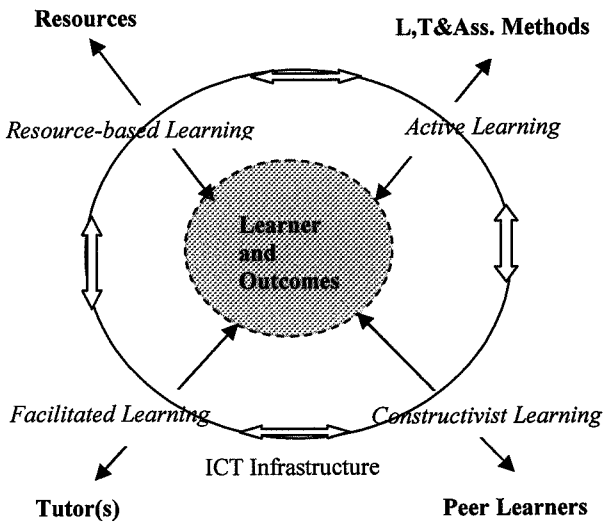

Figure 1 - ICT-Based Learning and Teaching Model

When applied in a distance learning context, the role of these elements needs a sharper focus than might be the case in face-to-face teaching. Understanding the learner group, the tutor role, the quality and clarity of the resources and encouraging learner-to-learner interaction are all arguably even more important for distance learning.

2.2 Learning Cycle, Module Narrative and Learning Activity Design

There are a number of OU approaches that are worthy of consideration for inclusion in any strategy.

According to Waugh [2], the OU draws heavily upon a *"read, think, do, reflect, extend"* learning cycle, within the context of a module (or OU "course") narrative. This approach has also been applied to some extent by the author in recent years, although it has not proved realistic to provide the substantive narrative of many OU courses. A traditional and realistic choice of narrative is to base the course on a textbook, although this may not provide a sufficiently "plural" view.

Waugh also argues that *"for isolated students any examples used must be universally understandable, or explained and documented in great detail"* and *"even basic assumptions need to be documented in great detail"*. The author's own experience supports this view. However, most HE Institutions do not have the "production team" resource of the OU, and need to adopt efficient means to achieving this quality such as the reuse and sharing of online resources.

Furthermore, Waugh argues for *"no follow through"* and to *"reset database content"* for a series of activities. In other words, making each activity independent of achievement in the previous activity. This is also quite common practice as evidenced in a number of TLAD papers.

2.3 DBMS and Development Tools

There are, as we know, a number of potential DBMS and development tools, both commercial and open-source, for learning and teaching purposes. One possible strategy is to provide one supported (probably commercial) option, along with indicating acceptable alternative (normally open-source) options. These alternative options may well be better suited to the needs (including perhaps work-based context) of the distance learner.

Furthermore, the strategy could allow students to choose a modelling notation and corresponding tools to suit their course context. For example, it might be possible to accommodate either UML or "crows-foot" style notations.

2.4 Work-Based Learning

There is greater potential in comparison to the OU to exploit the work-based learning opportunities on courses where the student is expected to be in professional IT/computing employment.

It may be possible to enable the learner to construct acceptable work-based activities subject to specific requirements being met (and perhaps guided by examples of tutor-constructed, problem-based scenarios). This approach would need to be carefully designed to enable meaningful and realistic peer and tutor support.

3. Methods and Tools

This section discusses some teaching methods, and corresponding tools, that have been deployed by the author to help distance learners to achieve various cognitive learning outcomes. These methods are consistent with the strategy outlined in section 2. Application of these methods and tools for specific database learning outcomes is described in section 5.

There are other potential methods eg using a virtual classroom, video-conferencing and other synchronous approaches. However, this discussion is limited to approaches that the author would argue are realistic, effective, and provide maximum benefit for minimum cost.

3.1 Online Presentation of Knowledge

A key teaching method consistent with the "read ... extend" cycle of the strategy discussed in 2.2 is the presentation of knowledge, in a narrative context, for initial and further reading.

A wide variety of presentational media (plain text, slides, animated slides, slides with audio etc) can be effectively and efficiently deployed, and can accommodate different learner preferences.

There are, of course, a number of proprietary and open source office tools available to easily produce many of these presentational forms.

In TLAD03, Stringer [4] described the application of video technologies for database course delivery. However, it is not easy to justify and muster this level of resource in most institutions (except the OU?), and perhaps sharing peer-reviewed video and other learning resources is a way forward.

It is arguably worthwhile, though, investing resource to produce a video that introduces the course, and gives the learner some idea of who is tutoring them! A short video was produced for a distance Database Systems module, and the consequent student feedback was positive.

3.2 Facilitating Application Development Activities Online

Collaborative application development activities, including analysis, design and implementation, present a significant challenge to both the learners and tutor. Database design, for example, is not normally an easy to acquire skill even in a fully supportive face-to-face learning context.

One approach is to provide a carefully designed set of case study/scenario based activities as indicated in section 2.2. This should be well supported by example design, code and other learning resources, and forums/FAQs as discussed in 3.6.

A key need is to enable design, code and other application artifacts to be worked on in a collaborative (and individual) manner, and to also enable the tutor to provide formative feedback. This can be achieved by creating shared folders on externally accessible servers or in the virtual learning environment (VLE).

Furthermore, either external access to individual schema accounts, or a team account, would enable a collaborative implementation of a database.

The provision of application development tools in line with section 2.3 of the strategy should also be considered.

3.3 Moderating of Online Discussion Forums to Promote Construction of Knowledge and Understanding

An online discussion forum to enable group discussion of topics, issues and attitudes, leading to contributions to knowledge. can be a valuable method. There needs to be a clear rationale for the forum, and it must be carefully planned in respect of aspects such as group size and structure of the activities.

The OET course showed that group sizes between 10 and 15 (say), structured rotation of questions (for example) and linking to assessment are important to consider in order to achieve optimum levels of online participation.

A forum tool is normally available in the VLE, but if this is not the case there are other freely available tools to choose from (with caution) on the internet.

3.4 Online Assessment of Knowledge

There is substantive evidence, including Harrison at TLAD04 [5], that shows the potential of both formative and summative online assessment.

However, research by the author has not yet unearthed any "open source" question banks[2]. The Database Place has 6 online quizzes of around 20-30 questions including an "Introduction to Database Systems" and "The Entity-Relationship Data Model", although this is only available to those who purchase Connolly or Elmasri (for example). W3Schools has an online 20 question SQL quiz.

Nevertheless, in the absence of question banks and the resource to establish robust summative testing, creating short, focused assessment quizzes in the VLE can be an effective method for assessing basic knowledge of learners (and monitoring their participation in the module).

In the spirit of sharing resources, Gill Harrison provided the author with a sample test of questions covering modelling, SQL and other core database topics. These have been implemented in the VLE.

3.5 Facilitating Online Access to Tools for Learning Specific Topics

Various tools, and tool frameworks, to support the teaching, learning and assessment of databases have been presented at the TLAD conferences. Some of these tools might be classified as intelligent tutoring systems (ITS), and are adaptive to the learner. They can therefore offer an attractive, self-paced alternative for both distance and on-campus learners. The results generally appear promising, although perhaps their potential in the wider community remains largely underexploited. These tools ([6] to [10]) include:

1. A software system to support the teaching of the use of relational database systems (Cooper, Macrae. TLAD03) *followed by:*
2. A framework and toolset for the development of software teaching tools (Cooper. TLAD04)
3. VIRTURA - a virtual tutor for relational algebra (Davis, Fitzpatrick. TLAD03)
4. A computer based environment for the study of relational query languages (Beynon et al. TLAD03)
5. A family of SQL, entity-relationship modelling and normalisation tools discussed in "Online Fun with Databases" (Leimich, Ball. TLAD03). This includes SQLTutor, an adaptive, problem-based, teaching tool for SQL. It is available to those who have purchased Connolly & Begg or Elmasri.

Apart from SQLTutor, the current status and access to these tools is, however, unknown.

There are other potentially useful tools on the web, but these may have unacceptable quality, longevity or commercial implications.

3.6 Facilitating Online Forums and FAQs to Promote the Sharing of Technical Knowledge for Development Activities

FAQs and knowledge bases, contributed to by both tutors and learners, is also a useful resource for distance learners. This is particularly the case for implementation and other development activities discussed in 3.2.

4. Learning Resources

Resources such as notes, animated presentations, videos, case studies, activities, question banks and tools underpin the methods discussed in section 3.

This section therefore reiterates the importance of the sharing and reuse of learning resources, and reports the outcome of a TLAD04 "encouraged" Higher Education Academy (HEA) application for funding to develop a resource database.

4.1 Sharing of Resources

The strategy discussed in section 2 relies on the provision of a range of good quality learning resources. Furthermore, the achievement of all types of learning outcome, whether knowledge-based, cognitive or practical, will depend substantially on learner access to, and synthesis from, a wide range of learning resources.

The importance attached by the OU to the quality of resources is shown by a review process that includes 3 to 5 people! This is generally not realistic though in a context of a module leader developing[3] (and presenting) a course in relative isolation.

The provision of a wide range of high quality resources can therefore only realistically be achieved (surely?) by a process of tutors contributing to, peer reviewing, sharing and reusing resources. This reuse should then greatly enhance the overall learning and teaching experience.

The 10 year HEFCE strategy for e-learning published in February 2005 [11] includes the objective:

[2] HEA-ICS held a no. of "question bash" events in 2003 to explore the creation of shared banks – but not in databases unfortunately.

[3] It is interesting to note that the OU development and presentation teams are different.

"Promote the sharing of learning technology and resources across the HE sector and between sectors"

and measures of success such as:

"Subject communities are able to share materials in ways that enhance their ability to produce customised high quality courses. They are supported to work collaboratively in designing materials, which are effectively quality assured and widely disseminated"

Moreover, actions include:

"JISC and the academy to provide a range of programmes that enable HE staff to create digital resources, populate resource banks and identify issues associated with the sharing of digital resources"

and:

"JISC to provide technical advice on hosting and managing online learning resources, practical metadata systems, searchable databases and repositories, and developing user interfaces"

4.2 Outcome of HEA Application for Funding

Following last year's TLAD04 conference, a collaborative proposal (Southampton Institute, Bradford and Glasgow Universities) for HEA funding to develop a database was unsuccessful. This was, however, in the context of only 10 out of 50 projects that gained funding.

Feedback on the whole was positive, but questions were raised of how wide the support would be (although the proposal did reference the survey that indicated 95% of respondents from the TLAD databases community would use it). The possibility of central development was suggested by a number of reviewers. This would enable the intended potential of the application to be of benefit to other subject areas. Maintenance, evaluation and dissemination (although covered in the proposal) were raised as concerns by individual reviewers.

The response to the application did however indicate that:

"The subject network for ICS have recently developed a new on-line searchable and browsable database to cover all aspects of the computing curriculum and are now ready to populate this with suitable material. The database has been designed with suitable metadata to support peer review and extraction of materials within a specific area (eg databases)".

Although not yet available, this seems just what we want!

The author also responded positively to working with the ICS to identify resources to support the teaching and learning of databases, although this has not yet progressed.

5. Application to Database Topics

This section discusses the application of the methods discussed in section 3 to learning outcomes relating to DBMS, database design and SQL implementation. (These topics would also be discussed within an overall narrative context).

Probably all six methods discussed in section 3 could be applied to these outcomes, particularly 3.1. However, the discussion is limited to key methods.

Furthermore, a database of currently over 250 learning resources underpins the application of these methods, and the learning of distance and on-campus students, on four (soon to be five) database modules at the Institute.

5.1 DBMS

Consider a "knowledge and understanding" learning outcome such as:

Identify and explain functions of a DBMS.

Essential reading of DBMS in plain text (with diagrams) is provided online *(method 3.1).* This includes Chapter 1 of Database Systems by Connolly & Begg (which has been provided in an electronic form under the HERON agreement), and some introductory notes on databases provided with the permission of Garvin, Jackson & Byrne.

Knowledge and understanding of DBMS is then tested by a quiz implemented in the VLE *(method 3.4).*

5.2 Database Design

Consider a "cognitive skill" learning outcome such as:

Design a relational database using a modelling tool.

This arguably is a greater challenge from both the learning and teaching point of view.

Essential reading on data modelling and database design is provided in a variety of media including text and animated slide presentations *(method 3.1).* This includes online "An introduction to Modelling" courtesy of the University of Texas.

The distance learners undertake a design activity in groups using shared folders *(method 3.2).*

Currently, SSADM Select is made available for download (with supporting notes). An FAQ provides further technical support. This knowledge is (currently) captured from peer-to-peer learner support in a discussion forum, and from email responses to individual student queries *(method 3.6).*

Students are also referred to the quizzes on entity-relationship modelling in the Dataplace Place, and

next year the recently implemented quiz discussed in 3.4! *(method 3.4).*

DB Designer (optimized for mySQL, but no support for UML) is an alternative design tool choice. However, students are advised that an FAQ is not yet available.

5.3 SQL Implementation

Consider a "subject-specific practical skill" learning outcome such as:

Implement SQL for data definition, retrieval, manipulation and control.

Learning SQL and other practical skills can also be a challenge for many learners without face-to-face peer or tutor support.

The learner is provided with a rich range of resources to support the learning of SQL. These include presentations, examples, exercises/model solutions, SQL language references and a SQL syntax summary *(method 3.1).*

SQLTutor and SQLCourseTutor are suggested as possible alternative tools for students who prefer this approach to learning *(method 3.5).*

FAQs and a forum are also provided for technical support *(method 3.6).*

Internet access using iSQLPlus to Oracle accounts is provided (through the firewall) for all our students. Read access to the schema for the exercises is also provided, or downloadable scripts for those who prefer to work on their own installed databases at home. mySQL and, exceptionally, Microsoft Access are suggested as alternative choices for home use *(method 3.5).*

5.4 Database Research Activity

In order to accommodate student choice, and the width and depth of the databases subject area, an appropriate learning outcome might be:

Research and apply (in the context of a given case study) a selected database topic.

One approach is to require the students to contribute to online discussion forums for an advanced topic that extends from the core topic covered that week (refer Figure 2). The aim is for the student to be able to make an informed choice of one of these six topics, and to have initial research available, when the main activity starts after week 6 *(method 3.3).*

Based on the approach suggested by Pincas [12], the cohort (across two courses taking the module) are split into discussion groups of 10. Each member has to post, and reply to, one message per weekly forum, and summarise at least one discussion forum. Advice on headers and netiquette is also given, and the forums moderated. This activity contributes 20% to the overall assessment, and is largely self and peer-assessed based on the quantitative and qualitative online evidence.

Week	Topic	(1)	(2)	(3)
1	Static Java-based Access Methods	39	3.9	3
2	XML Databases/Datatypes	46	4.6	6
3	Accessing Databases through XForms	58	5.8	6*
4	Loading External Data into Databases	27	2.7	1
5	Using Excel as an OLAP Tool	33	3.3	2
6	Implementing Objects in Object-Relational Databases	35	3.5	4

* including one thread of 16 messages

(1) Total message inc. some summaries (2) Messages per student (3) Significant discussion threads of 4 or more messages

Figure 2 – Discussion Forum Message Statistics

The statistics in Figure 2 provide a quantitative measure of the participation in this activity this year for one discussion group (ie of 10). A funded independent evaluation undertaken by the Institute's research group (by questionnaire and focus group) also revealed highly positive student feedback of this approach.

6. CONCLUSIONS

Key conclusions are:

1. Methods, tools and resources can be effectively deployed to achieve learning outcomes for distance and "out-of-classroom" learners.

It is worth emphasing here that, whilst secondary research sources referred to in this paper suggest the effectiveness of many of these methods, there is arguably a need for more primary evaluative research. However, one perhaps has to try to achieve a balance of allocation of resource between development and evaluation.

2. A learning and teaching strategy for distance learners is needed.

The important implication here is that simply applying approaches that seem to work well in an on-campus context will often fall down in distance tutoring. There needs to be sharper focus on the quality and clarity of resources, encouraging participation, peer interaction etc.

3. There is a clear HEFCE objective for the academic community to work collaboratively on, and share, quality assured learning resources. However, the provision of a database of shared learning resources, particularly for the databases community, has yet to be fully achieved.

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