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INFORMATICS KNOWLEDGE MAPPING AND CURRICULUM DESIGN: A CLEAR ROLE FOR IFIP AND UNESCO

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Abstract

In the past, IFIP & UNESCO have supported the co-operation of the World Informatics communities in designing curricula (IFIP-UNESCO [5], [6]), conducting workshops on strategic planning (UNESCO [8], UNESCO-RINSEAP [17]), implementing (UNESCO RINSEAP [14]) and managing (UNESCO [15], [16]) Informatics-supported teaching and learning programs.

The need for such internationally co-operative initiatives today has not diminished . Only with agreed curricula and quality criteria to evaluate courseware can useful co-operation take place in the creation and sharing of computer-based learning material.

1. Introduction

In reviewing the Proceedings of recent International and Australian National conferences (UNESCO [15], [16], ASCILITE [1], UNESCO RINSEAP [18]), project reports ([2]) and summary papers ([4], [12]) on the application of Informatics in the support of Teaching and Learning, an

academic administrator seeks to answer some fundamental questions to obtain a clear understanding of the problem area.

With the desire to formulate a *Vision* for the role of Technology in Education, *Strategies* for successfully harnessing Informatics to support effective and efficient Teaching and Learning, *Tactics* for identifying and obtaining the resources necessary to implement the desired strategy, and *Operational Plans* to transform the goals and directions agreed into usable courseware, reviewing the literature leads to some clear conclusions, but also many open questions. Amongst these questions are two:

Question 1: In the presence of the uncertainty which arises out of complexity, are there any useful steps which can be taken by all Countries, States or Educational Institutions (depending upon the National educational approach), to ensure that the benefit from the application of computer-based courseware is maximised and the cost minimised?

Question 2: If there are such steps, could organisations with an International focus such as IFIP and UNESCO contribute to accomplishing those steps for the benefit of the global community?

Consideration of these issues leads to some clear conclusions and some open questions. Conclusions include a holistic framework for considering all factors effecting the development of courseware and also a number of problems which surround this field. A number of Open Questions is also identified.

2. A Holistic Framework of Multi-Media Courseware Production

A framework for understanding the multi-dimensional interplay between the factors affecting the production of computer-based courseware to support efficient and effective Teaching & Learning (T&L) in a given subject domain must include at least the following elements:

•1. The intended learning outcomes for the program: these flow from a thorough understanding of the roles to be played by students in their professional or subsequent learning spheres

•2. The entry knowledge, skills and attitudes (K,S,A) of students and their preferred learning styles

•3. The T&L optional modes (discovery learning, analogical learning, sequential page turning, problem-based learning, practicum, discussion group, etc) which might reasonably be used for proceeding from the entry capabilities to the desired outcomes, and the relative cost and effectiveness of each mode

•4. The assessment instruments which are to be applied to evaluate outcomes
•5. The software and hardware tools to which students and faculty have access for development and execution of the courseware
•6. The people, process and technology issues that underpin the courseware production process
•7. The capabilities of the academic staff to make effective use of the available technology
•8. The level of human technical and subject-area support available to ensure best use of the available technology and courseware, and
•9. The technological environment in which the programs are to be run [11].

The following section presents a holistic model which includes at least all these factors.

3. General Model for Courseware Production

3.1 Model Summary

The following model provides a holistic overview of the factors which relate to the definition and creation of courseware, in any medium, for the support of an educational program.

The model offered here is an amalgam of several established ones, here numbered *Models 1, 2 & 3.* For each of the major process elements of the overall model (*Model 1) , Curriculum Development, Staff Development, Equipment Development and Course Material Development (Model 2),* the process of implementation may be seen as comprised of the classical management steps of *Plan, Organise, Staff/Motivate, Implement, Monitor/Control* (Model 3).

This overall model recognises that each process will require activities of planning (at the strategic, tactical and operational levels), organisation (determining organisation structures, implementation processes, etc) and the other steps. Essential in this model is the requirement that each contributory process, and the use of the courseware finally delivered to users, be subjected to a phase of monitoring/measurement which leads on to process changes and improvements (controlling activities).

The *key resources* that need to be available for each process element will differ, or if the same, may be most conveniently grouped in different ways, but the management steps for each are those outlined in *Model 3* above.

3.2 Curriculum Development

In this model the process commences with definition of the behavioural objectives that students are to achieve: the knowledge, skills and attitudes (K,S,A) that are to be the exit capabilities of the students. Without a clarity of vision as to what needs to be achieved, and the (optional) path(s) which can be taken to accumulate those achievements, no further progress can be made.

These overall objectives are broken down into sequences of contributory objectives then the knowledge, skills and attitudes to be acquired at each stage are defined, and finally the teaching/learning activities which need to be undertaken to achieve each of these capabilities are specified. Created at this stage also are definitions of the criteria to be used for assessment of the achievement of the objectives defined.

The result is a curriculum which can be used as the starting point of courseware construction.

IT IS IN THE DOMAIN OF CURRICULUM SPECIFICATION THAT IFIP (AND UNESCO) CAN MAKE THE GREATEST CONTRIBUTION TO CO-OPERATION IN THE CREATION AND PROMULGATION OF SHAREWARE. OTHER THAN THERE IS AN AGREED CURRICULA FRAMEWORK IN EACH SUBJECT DOMAIN OF INTEREST, EFFORT IN BUILDING AND RETICULATING COURSEWARE WILL BE GREATLY DIMINISHED IN EFFECTIVENESS AND EFFICIENCY.

IN CASE IT BE SUGGESTED THAT THIS IS TOO LARGE AN AGENDA FOR IFIP-UNESCO TO UNDERTAKE, OBSERVE THAT THE WORLD SCIENTIFIC COMMUNITY IS CURRENTLY MAPPING A SIMILARLY COMPLEX DOMAIN, THAT OF THE HUMAN GENOME. THE BENEFITS TO BE GAINED FROM ACCOMPLISHING THIS KNOWLEDGE MAPPING TASK MORE THAN MATCH THE SCALE OF ITS DIFFICULTY.

3.3 Staff Development

In this activity, the knowledge skills and attitudes essential for the active involvement of staff in the construction of curricula to make use of computer-based - for example, Multi-Media - Technology need to be defined and provided. This is a program of “train the trainers” and needs to include elements of access to hard/soft equipment appropriate to the desired exit capabilities of the staff members.

3.4 Equipment Development

The steps to be undertaken here are basically those of equipment specification, acquisition, installation, acceptance testing, maintenance and operation, upgrading and retirement. Such steps need to be cognisant of the required reliability of the final system and of the technological infrastructure in place to support the desired equipment domain. Such infrastructural issues relate not only to equipment environments - and here "equipment" refers to both hardware and software - but also to the availability of staff to reliably operate and maintain the equipment.

3.5 Courseware Implementation Model

The process of construction of the courseware should be seen as analogous to the construction of any software, with perhaps more emphasis being given to the Human-Computer Interaction (HCI) aspects. One widely regarded model which is resource-focussed, is that of *"People, Process, Product* and *Technology / Other*". In this model,

•*Product* refers to specification of the product requirements which needs to be complete, unambiguous, implementable, cost-effective, etc

•*Process* refers to the detailed steps to be applied in implementing the software,

•*People* refers to all the Stakeholders in the outcomes of the courseware, including the creators, the final users (students/teachers), the academic administrators, and so on, and

•*Technology/Other* refers to all those other factors such as the implementation and delivery hardware/software platforms which are likely to effect the efficient design, implementation and delivery of the courseware product.

Application of this model enables the use of cost and schedule estimation models such as those developed for the Software Industry, as well as Project Management approaches similarly created.

3.6 Graphical Representation of the Courseware Development Model

This four dimensioned space is to be seen inside an envelope which focuses upon the assessment of the effectiveness and efficiency of the courseware by students and teachers**.**

"Development" here is intended to mean processes which Plan, Organise, Staff/Motivate, Monitor & Control the designated activity.

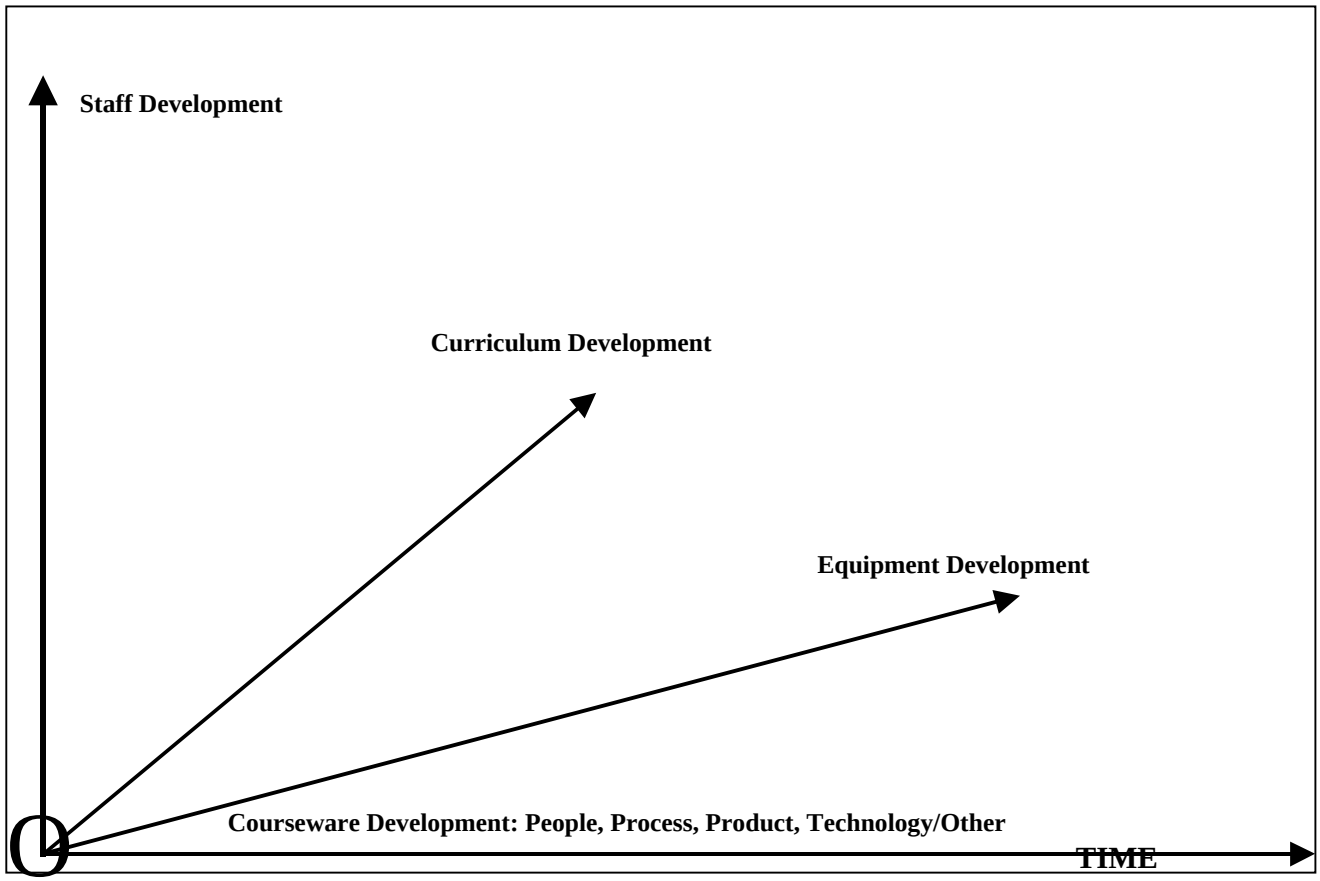

Figure 1: A General Model for Courseware Development

4. Key Factors Affecting the Use of Multi-Media Technology for Effective Teaching and Learning

•KF1: The General Model presented in the foregoing section co-relates many of the prime, success-determining, or Key Factors. In addition to those factors, several other sets of important issues were identified in the review of recent work: these are numbered KF2 to KF11 and are perceived to be generally agreed at this time

•KF2: Most projects have been pilots and have not been scaled up to address large local, National or International groups. Some attempts [11] to scale up have revealed problems arising from the "Responsiveness" of the T&L system overall. Without a hardware/.../courseware and personal support infrastructure which is "responsive", student motivation diminishes and learning effectiveness drops

•KF3: Many assumptions concerning the use of technology for effective T&L are now being questioned. Included in these are (Sims [12]): "A1:Technology makes learning more effective, A2: Traditional teacher-student interactions can be mapped directly to interactive learning, A3: Interactive learning will cater for individual differences and learning styles, A4: Design and development methodologies will improve courseware quality"

•KF4: Production of material which is acceptable to student groups with heterogeneous preferred learning styles and learning performance requires the employment of a team of professionals with the following knowledge and skill sets: Project Controller, Content Specialist(s), Teaching/Learning Specialist, Human-Computer Interactive Architect, Graphics/Audio/Video Specialist(s), Communications Technician and Software/Courseware Developer. The result of the size and capabilities of such teams is that each course of around 10 subjects costs in the order of AUD $3 Million to produce and requires around 18 months for its completion. (This is based upon the RMIT experience and is supported by that at the UK Open University which cites the figure in excess of 1 Million pounds sterling to produce a "half credit course requiring 240 hours of student study" [3]).

•KF5: Production (software) tools to support the creation of courseware have incompatibilities between versions of the one tool, and between tools from different vendors which render effective conversion from one base to another a difficult and demanding undertaking

•KF6: Not all students and not all staff have the knowledge & training to make effective use of text-based computer technology. Competence with audio- and video- based materials lags far behind that relating to simple text

•KF7: Expecting the content specialists to master all the skills necessary for the preparation of high quality courseware deflects them from their areas of comparative expertise and therefore, advantage

•KF8: Great care needs to be taken to ensure that cultural aspects of the courseware do not render it not appropriate in contexts other than its initial use

•KF9: In times of rapid technological change, long-term/ strategic planning for the effective use of technology become *more* important. Such planning must be based upon an understanding of the technology and where it is going and commitment to plans that ensure arrival at the desired target

•KF10: Delay in the use of technology because its cost is reducing is a false economy. Best performance is achieved by those who are early adopters of knowledge-augmenting technology, and

•KF11: Most projects have not been subjected to rigorous and meaningful evaluations by the several stakeholders which correlate the costs and the benefits in a manner which supports decision-making by those wishing to apply the findings of those studies.

In addition to these factors for which there appears strong supporting evidence at this time, there are several open questions which relate to issues as yet un-resolved.

5. Open Questions

•Q1: With co-operation in mind, what set of curriculum modules is best to use which can be applicable to a range of target outcomes and in a wide range of cultural contexts?

•Q2: What mixture of modes of presentation is the best for a given subject domain and student type? What cost/benefit data are available to support choice of a particular mixture?
•Q3: What courseware tools are best for creating material, exchanging it with others, and ensuring easy & effective student use and easy maintenance? Will this set of tools remain stable into the future?
•Q4: For each of the modes of T& L selected for a subject domain, what is the required level of staff involvement in student support, discussion group convening, individual query answering, and so on, which are required, and do these match student expectations? For example, in discussion with delegates at RUFIS'97, Koller AM [7] felt that the time spent providing individual assistance for students taking a course through the Web was around 3 times that provided when students can attend tutorials. And followed up with the observation that: "A class of 30 students can generate 1000 e-mail messages in one day". Hall [3] echoes this view giving an estimate of 4-8 times (see page 79)
•Q5: What staff and student development programs are necessary before Informatics-based T&L programs will be acceptable?
•Q6: What is the best (least costly and most responsive) way to provide students and academic staff with a technology infrastructure and human assistance to support the T&L activities desired?

These Conclusions and Questions, and many more, were addressed in the pre-amble and proceedings of conferences such as UNESCO EI'96 [15] and ASCILITE'96 [1].

With so many un-answered questions, how can International Co-operation possibly proceed?

6. The Role of IFIP & UNESCO

The foregoing discussion indicates that there is a large number of issues upon which no immediate agreement seems feasible. Can any useful International initiatives be taken which will aid co-operation which will support, particularly, *Less Developed Countries* ? In my opinion there are two important areas which can be tackled immediately: 1. Definition of Core Curricula for agreed knowledge domains and 2. Definition of Quality Criteria for selecting both courseware and course authorship tools.

6.1. Curriculum Design and Promulgation

In the past, IFIP and UNESCO have performed important service by defining curricula at both the Secondary School (IFIP-UNESCO [5]) and Tertiary [6] levels. Both curricula are comprised of a number of modules which can be used as building blocks for either deep or broad programs.

UNESCO has also conducted many workshops and conferences on the subject of Strategic Planning for Information Technology Resources (eg [13], [17]), Computer-based Electronic Communication (eg [14]) and the like. Those activities have emphasised the importance of approaching any Informatics project with a long-term, strategic, perspective. Such an approach leads to definition of objectives which are desirable and step-by-step achievable. It also ensures that all the elements of the infrastructure essential to the support of the technology are put in place as an integral part of the Informatics initiative. In my opinion, if we do not - at least - have agreed curricula as a starting point, and use those as the basis of International co-operation in the creation, promulgation and exchange of courseware, much of our enthusiastic mutual support effort will be mis-spent.

6.2. Evaluation Criteria for Courseware and Authoring Tools

A further area of International co-operation where IFIP & UNESCO could play important roles lies in the area of definition of evaluation criteria for courseware and for tools which facilitate courseware development.

7. Short-lived Co-operation

At the recent UNESCO RUFIS'97 [16] conference in Prague, a decision was made to support co-operation between UNESCO member countries by providing a clearing house for Web-based University-level Courseware. This important initiative, which relates to *all* disciplines could greatly benefit international courseware sharing and be particularly beneficial for Less Developed Countries.

However, such initiatives will be short-lived if there is no coherent framework within which such materials will be contributed, evaluated, placed on the repository and used. Without agreement on

the broad curricula elements, courseware modules created will inter-link poorly. The starting point for strategic planning in this context is an agreed curriculum framework. Without agreement on acceptable quality parameters, courseware will be contributed which is basically unusable.

8. Conclusion

Following a review of recent Australian & International work on the production of Informatics-based courseware and recognising the wish of the International community to have a freeware repository, recommendations are offered on the roles that IFIP and UNESCO can play in progressing that desire.

The roles include co-ordinating the definition of curricula in areas of common interest, and in defining quality criteria relating to courseware itself and to the tools which support courseware authorship.

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