British Journal of Educational Technology *Vol 30 No 2 1999* 101–113

Making values and beliefs explicit as a tool for the effective development of educational multimedia software—a prototype

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Abstract

This paper puts forward a prototype process for the development of educational multimedia materials, which can help educational multimedia software developers produce more coherent and effective learning resources by making explicit the value/belief system on which the project is founded. The prototype is presented as an object and stimulus for debate and discussion, around the many issues it raises.

The paper critically reviews some current models of educational multimedia software development with regard to the role of "values/beliefs" and discusses why there is a need for these factors to be taken into account. It particularly focuses on environmental issues and is more widely applicable to those subject areas which involve the teaching of "controversial issues".

The basic process put forward involves three steps: 1) identifying and agreeing a prioritized list of the core values and beliefs on which the project is based 2) using these to inform the specification/design process 3) using them as part of the evaluation/quality control process. The process is illustrated using a small number of examples and the paper ends by looking forward to a full trial of the prototype and suggestions for further work.

Introduction/background

The ARKive project is part of a new "museum-cinema-electronic zoo" development in Bristol (UK) called Wildscreen World, which is one of the large-scale projects funded by the UK lottery millennium fund. It is supported by Wildscreen Trust, University of the West of England, British Broadcasting Corporation, Partridge Films, Hewlett Packard, WWF-UK, Wildlife Trusts and others. ARKive will be a multimedia database, which will initially contain film, photographs, sound and text-based information on all recognized endangered species worldwide and all UK species for which film and photographs will

Published by Blackwell Publishers, 108 Cowley Road, Oxford, OX4 1JF, UK and 350 Main Street, Malden, MA 02148, USA.

be available. We estimate this will include in excess of 10,000 species. The database will be available free via the Internet as a World Wide Web (WWW) site to schools and the general public.

My role in the project is to help identify how we can make ARKive as useful and usable in school classrooms as possible. As part of this research, I am investigating the most effective way(s) to design, develop, create and manage this very large educational multimedia database and its supporting learning materials. Quite early in this process a fundamental problem was identified with the existing models of the developmental life cycle of multimedia learning materials.

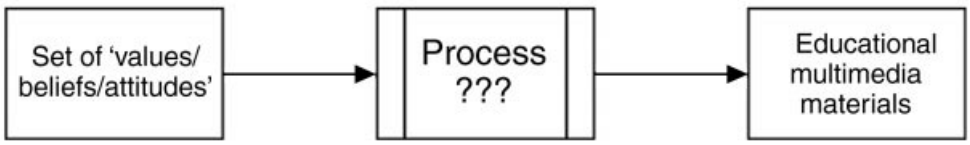

Figure 1: A simplistic representation of the problem

It is clear that within the subject domains relevant to bio-diversity such as "species conservation", "sustainable development", "zoology" and "botany" to name but a few, people hold specific sets of sometimes conflicting "values and beliefs" (the definitions of these terms will be discussed later in this paper). It seemed vital to me, for a range of reasons (see below) that those involved in the development of ARKive, needed to be aware of these and decide where, how and which to build in to the design of the ARKive WWW site. In particular the educational materials, which support use of ARKive by school pupils and their teachers. However, as yet I have been unable to find a published model of multimedia design, requirements engineering or software engineering life cycle, which provides a detailed process to enable this to be done and thus no model of what makes up the "process" in the central box of Figure 1.

One early indication that "values and beliefs" were not part of current models was the lack of any index references to "values" or "beliefs" or variations thereof, in over 30 textbooks consulted on software development, requirements engineering, multimedia development, or educational software development.

Figure 1 is a simplistic representation of the problem, as there are multiple sets of values. Different subject domain experts and members of the production team, (graphic artists, computer programmers, educationalists, project managers amongst others) each have different professional (and of course personal) sets of values and beliefs. In addition to that there are overarching corporate, local community and national cultural values and beliefs in the countries where the development is taking place and will be used. A further significant issue will be the values and beliefs of the clients who have

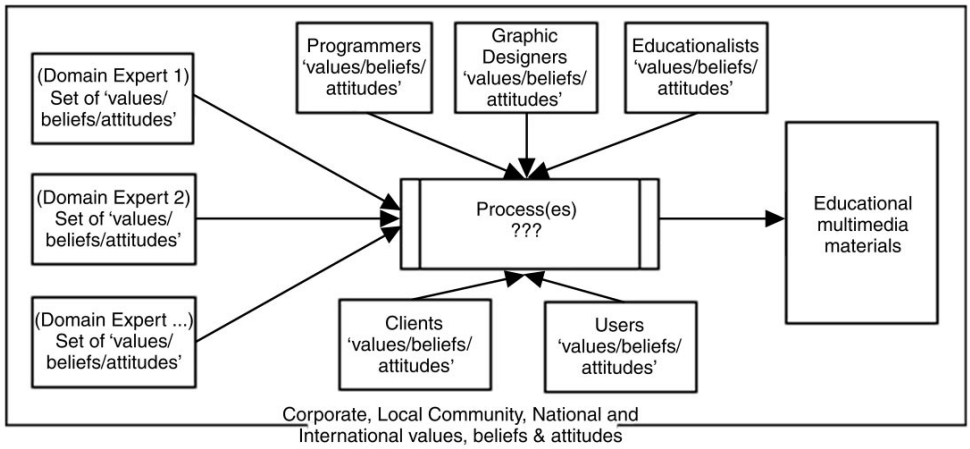

Figure 2: A more realistic, although still somewhat simplistic model

commissioned the product, and of its final users. Figure 2 sets out to show a more realistic, although still somewhat simplistic model.

The central "Process(es)" box needs to specify the possible ways these sets of values can be identified, clarified, prioritized and integrated into the design of the end product of "educational multimedia materials": for example ARKive. It also needs to specify how contradictory values will be handled. While this paper concentrates on identifying and clarifying the values and beliefs of stakeholders, it is important to be aware that each stakeholder also brings knowledge, skills and goals to the process, which a yet more inclusive "process" must also handle.

What are values and beliefs?

The terms "value" and "belief" are themselves difficult to define and a large literature has been published in this regard, for example, Fishbein and Ajzen (1975) and Caduto (1985). The New Shorter Oxford Dictionary defines the key terms as follows:

Belief: "Mental acceptance of a statement, fact, doctrine, thing etc., as true or existing"

Value: "The principles or moral standards of a person or social group; the generally accepted or personally held judgement of what is valuable and important in life"

Although these lack some of the specificity of more highly defined academic terms they have the advantage of being relatively simple and usable in a wide range of contexts and by a range of people. My own experience in practical settings, with people from a range of disciplines and backgrounds, indicates that it is difficult, and not particularly useful,

to differentiate between "beliefs" and "values". The question "is this a value or a belief or a belief about a value or ...?" takes up significant and generally fruitless time and mental energy. This is not to say formal definitions are not valuable or important in the context of theoretical underpinning of this prototype. In subsequent work it is planned to explore the processes from the perspectives of the more formal models of value, belief, attitude and behaviour.

Why does it matter ?

ARKive's subject matter is largely that of endangered species and the related issues of "sustainable development", "wildlife conservation" and "animal rights" amongst others. It is clear that many of these issues are controversial in both public and academic circles. See, for example, The Observer (UK) newspaper's (McKie, 1998) coverage of research being conducted at the CERN laboratories near Geneva into the possibility that sun spot activity and not humans are causing "global warming". It is well documented that books, photographs, films, TV and radio programmes contain and communicate explicit and implicit beliefs, values and attitudes and a growing literature discusses the same issues for multimedia (Barrett, 1992; Barrett and Redmond, 1995).

Indeed it is often these very beliefs, values and attitudes, which we wish children to learn and assimilate as evidenced by the fact that the UK School Curriculum and Assessment Authority (SCAA, 1996) have recently consulted on what "values, attitudes and behaviour ... schools should promote on society's behalf". If we are creating multimedia educational resources with little explicit discussion about the values, beliefs and attitudes, which underpin them, it is at best a serious gap in the process of developing learning materials and at worst an abdication of responsibility.

Why is it useful to make values and beliefs explicit ?

There are a range of reasons why making values and beliefs explicit is useful in the design and development of educational multimedia materials. Below is a list of nine that I have identified from experience.

- It could help clarify the overall aim/mission of the project
- It would enable the values and beliefs to be discussed by the development team explicitly
- If cultural values are made explicit it will help effective "internationalization"
- It enables consistent use of both "embedded and 'meta-messages' or pervasive" design elements
- It would give the whole team a common understanding and set of values to work to
- It could help make a more informed choice when compromises have to be made during the design and development process
- It could give a new set of measurable objectives (metrics) by which to measure the quality of the product
- It may even be possible to devise a way to give a summary of the beliefs and values on which the material is based on product documentation
- Some categories of "value/belief" are likely to be reusable in future projects.

The current situation

The classic "waterfall" development cycle for multimedia is based on the premise that the various stages of development are sequential with no feedback or re-evaluation of the "output" of a given stage once complete. The model shown in Figure 3 is more realistic, in that it does allow for such feedback (Shearer *et al.*, 1997). Taking this model as a starting point, the responsibility for the "specification stage" in general falls to a "domain expert" and/or "pedagogic expert" who defines the learning outcomes, and pedagogic elements of the product (Good *et al.*, 1994) and so it is they who have implicit responsibility for dealing with the relevant values and beliefs.

There is a wide range of more developed models for the development cycles of computer software (Sallis *et al.*, 1995) and a variety designed for the development of educational multimedia materials, for example Koper (1995), Potgieter (1994) and Donnelly (1994). These generally combine some form of "instructional design" system with a software development cycle (Koper, 1995).

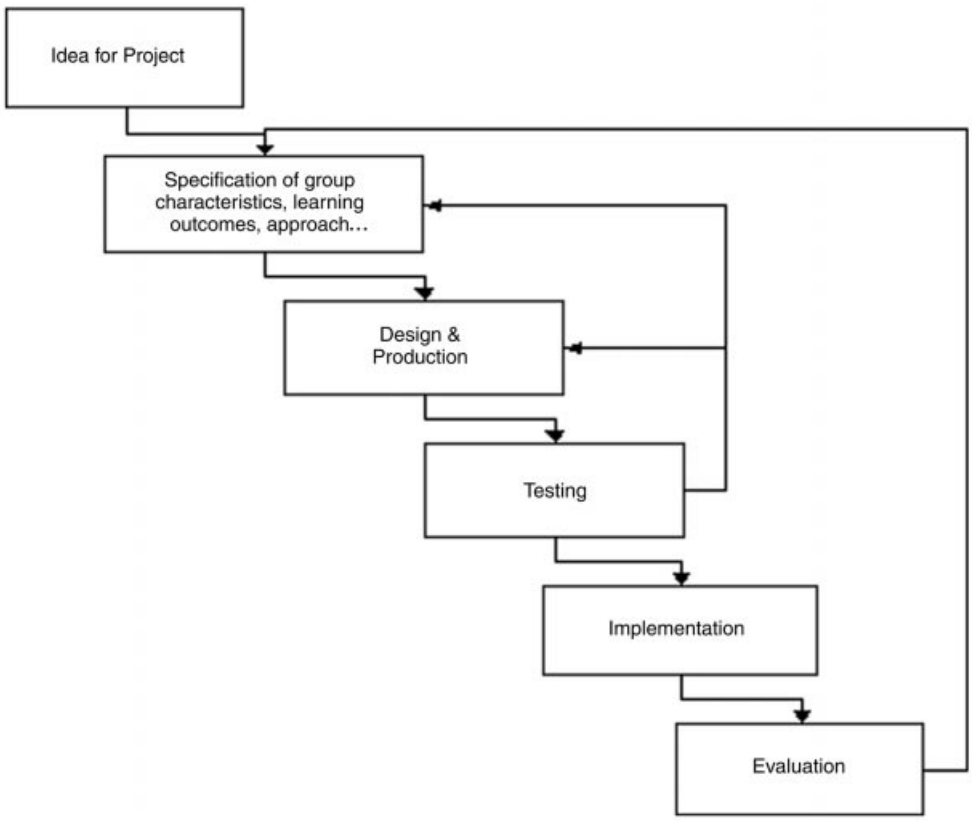

Figure 3: A multimedia development cycle with feedback

The most commonly utilized Instructional Design principles (Romiszowski, 1981; Gagne *et al.*, 1992) do not include a values analysis of the subject domain as part of their processes. Gagne *et al.* (1992) pay considerable attention to attitudes as learning objectives and point out that Martin and Briggs (1986) note that many cognitive behaviours have affective components which impact significantly on learning.

Romiszowski (1981) points to gaps in approaches to instructional design including the common omission of aspects of the social, interpersonal and interactive domain; the affective domain, and the physical domain. Within the affective domain the focus is on ways in which instructional techniques may be chosen to bring about learning, values and behaviour change, and it seems to be assumed that the designer is fully aware of the necessary values and attitudes the student "requires".

Values do have a major impact on the design of some learning materials supporting relevant subjects, and Scott and Oulton (1998) explore this with regard to environmental education in some detail. There are also instances where "values" are made explicit in the specification phase of educational software development. For example, Jones and Britton (1996) where they describe the development of the MARS project, a health education project about smoking, in which, as part of the requirements statements with regard to the users they include; "children of any ethnic origin should feel comfortable using the system". This example also highlights the difference between "values" which underpin the design of a resource and the values which the resource aims to teach.

As yet I have been unable to locate any published examples in which such issues are explored explicitly prior to the specification of computer-based learning materials. In most cases, as in this last example, they are specified along with learning outcomes and program functions; I would argue they precede both. It seems that such issues are "taken into account" by the authors in the case of written learning materials and domain experts in the case of computer-based multimedia materials.

In a recent paper Shearer *et al.* (1997) point to the influence of assumptions about *learning style/nature of the educational process* on the design of educational software. Shearer *et al.* (1997) discuss the role of "epistemology", "pedagogy" and "psychological" assumptions on the usability of educational multimedia resources. They argue that these can be made explicit and evaluated in the design process. My argument takes this a step further and proposes that "axiology" as defined in Poole (1995, 18) (that is, "concepts about values and their relation to ultimate reality") should be explicitly taken into account. In the process shown in Figure 3 above, issues related to values and beliefs seem to be an unstated role of the "domain experts", who may be educationalists and/or subject specialists.

Goguen (1994) offers a technique which yields the value system for an organization in the form of "value system trees" which are hierarchical structures of values. He points

out that the value system tree can "help requirements engineers to make appropriate tradeoffs between conflicting requirements of the client and/or end user". However, as the author points out, these are constructions of the (external) analyst and not necessarily meaningful to the members of the organization themselves.

There is a growing literature on how "new media" inherently contains *value biases* (for example Barrett, 1992), as well as general discussions about the inherent biases in using computers at all (Chandler, 1990; Roszak, 1996). Of course there are whole disciplines studying similar issues in literature, film and photography. Terms are being adopted which can help us raise awareness of these issues eg, "social acceptability" (Nielsen, 1993) which refers to the overall social acceptability of a piece of software and "Sociomedia" (Barrett, 1992) which implies explicitly the role multimedia plays in the social construction of knowledge. However I am unaware of any formal models which help developers bring these and other value-based issues into their consciousness let alone make them explicit.

Why are values currently not made explicit in educational multimedia design?

One fundamental question arising from the above is that, "If I am indeed correct that values are not currently made explicit in the design of educational multimedia, why not?" At this early stage I can suggest some tentative answers.

- *Some very "impactful" values are implicit* for example, in the commercial sector "we must make a profit" and "we must keep to time" and more and more in the educational sector "we must be cost effective".
- *Some values are potentially embarrassing or damaging if made public* for example, "the priority is that it must look good rather than be effective for learning" or "we know this project would be better as a book/CD ROM but we have committed to a CD ROM only product".
- *It has never been the explicit role of any member of a team to take responsibility for taking values into account*—it is generally fallen to the "subject specialist" to determine this with respect to the subject matter.
- *Those from a formal programming or project management background may never have come across the idea that software can contain implicit "belief/values".*
- *Many personal values and beliefs are taken into account but at a subconscious/non explicit level.*
- *The majority of historical "Computer-Based Training" or "Computer-Assisted Learning" has been developed under a rote learning model*, which aims to teach "facts", skills and information rather than understanding at the level of values.
- *Historically it has not been part of the development process of the vast majority of learning materials.*

This list is by no means exhaustive but it shows that there may be many possible reasons why values and beliefs have not generally been made explicit.

The beginnings of a prototype and process

In this and subsequent sections I begin to develop an initial set of ideas and a trial process which will then be open for critical analysis and review.

One of my preferred ways of working is to have a prototype process for investigation rather than attempt to create a complete theoretical model from which to create an "ideal process". The reasons for this are that firstly, it is my view that it is often the case that once a "well developed" theoretical model is created it is difficult to change, as people are reluctant to amend or dismantle it, when it proves inadequate or a more appropriate or effective one is found. Secondly, I believe that evolution is a very effective method of development for theoretical models, that is, starting with a *very basic* prototype which is then tested and amended (ideally in a variety of forms) and improved in a cyclic manner.

Figure 4 represents the first draft of the prototype development model. There are three additional elements when compared to the model depicted in Figure 3. Firstly (1) values are made explicit prior to the generation of aims and objectives or specification. Secondly (2) "aims and objectives" have been separated out from the "specification" stage and lastly (3) the specification of "meta-messages" and embedded messages are also made prior to the formal specification stage. In addition to the elements themselves the arrows show the interrelationships between these elements.

The results of the first phase of "identifying and prioritizing of beliefs and values" (1) feeds directly into all of the other three (2, 3 and 4). Both the specification of "aims and objectives" (2) and the "meta- and embedded messages" (3) which will impact on each other. These then feed into the formal specification (4) which is similar to the "specification" element of the model in Figure 3.

The new elements 2 and 3 make it explicit and clear that they both follow stage 1 and need to be fully explored, analysed and specified prior to the "formal specification" of

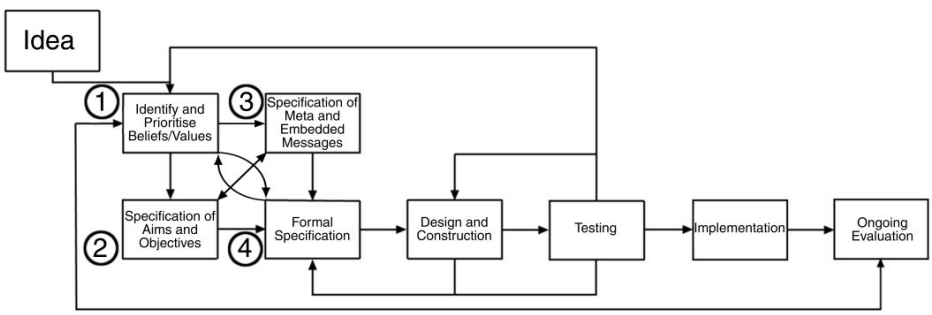

Figure 4: Prototype model for the development of educational multimedia resources

the product. The interrelationship between these four elements is seen as a dynamic one, taking perhaps three or four cycles around the initial loop from "identify and prioritize beliefs and values" (1) to "formal specification" (4) to stabilize. After these cycles the "formal specification" documentation should have explicitly integrated the "belief and value base" into the specification and so the design of the product. It is envisaged that the feedback loop from "testing" to "identify and prioritize beliefs and values" will be necessary as during testing it is likely shortcomings and gaps in the initial identified "beliefs and values" will arise.

At present the latter stages of the suggested process are similar to those in Figure 3 which is already well documented by Sallis *et al.* (1995) and Shearer *et al.* (1997). One additional aspect will be the use of "belief and value" based specifications as evaluation criteria. However it is likely that once this prototype has been evaluated a model will evolve dealing in more detail with the latter stages of development.

Wider categories of value and belief

The original problem which I identified was focused on the subject domain "beliefs and values" such as "bio-diversity is valuable because ..." nonetheless, there are other "categories" or "domains" of beliefs and values including:

- Corporate—"our mission is to ..."
- Epistemological—"knowledge is ..."
- Pedagogical—"the best way to teach this point is ..."
- About the users—"children are ..."
- About multimedia design—"that should look like that because ..."
- About the use of the product—"it will be used ..."
- Project management: "it must make a profit and be finished on time, so ..."
- Personal beliefs: "I believe ..."

Any advanced and inclusive model of the development process of a multimedia learning resource must include *all* of these. However in line with my desire to keep this initial prototype simple and focused on a practical task, I will continue to focus on the subject domain(s) around bio-diversity. Below I illustrate how the prototype process described may work.

Identifying and prioritizing beliefs and values—starting to implement the prototype

Below I give some illustrative examples of how the proposed prototype can work in practice. I and my colleagues are currently in the process of carrying out a small scale trial of the prototype, which along with debate and discussions from others will lead to the refinement and evolution of the next prototype.

In order to illustrate the process I have found that it is useful to start with demonstrating how value and belief statements can be used as described above and then to explore how to identify a prioritized list of values and beliefs. I will therefore start with a pre-defined set of beliefs and values and follow the prototype through with

some examples. Stephen Kellert (1996) has devised typology of environmental values namely:

- Utilitarian—practical and material exploitation of nature
- Naturalistic—direct experience and exploration of nature
- Ecological-Scientific—systematic study of structure, function, and relationship in nature
- Aesthetic—physical appeal and beauty in nature
- Symbolic—use of nature for language and thought
- Humanistic—strong emotional attachments and "love" for aspects of nature
- Moralistic—spiritual reverence and ethical concern for nature
- Dominionistic—mastery, physical control, dominance of nature
- Negativistic—fear, aversion, alienation from nature.

Taking this as a starting point it is possible to select one, for instance the "Ecological-Scientific" value, and list some likely associated beliefs and values. For example, "small animal species are as valuable as large mega-fauna such as tigers and pandas" and "we believe that the actions of human beings are the primary cause of the current, high, rate of species extinction" and so on. The first statement concerns relative value and the latter is a statement of belief about the causes of extinction. It would be a simple matter to re-phrase each of these so that the first was stated as a belief and the latter a value. It is this type of situation that persuades me that, at least for this first prototype, it is not useful to ask that all statements should be either values or beliefs.

These statements can then be prioritized (see below) to; help identify aims/objectives, for instance the learning outcome, "after using this resource users will be able to state four ways humans have acted so as to increase the rate of species extinction over the last 100 years"; help specify embedded messages for example in this case, "the impact of human beings on their environment will part of at least one design element on every screen", and finally the statements can lead directly to formal specification for example, "impact of human beings on animal species should be in the top three of any causal elements of any list, graphic, video or sound clip regarding causes of current global rates of extinction of animal species".

Identifying and prioritizing the list of beliefs and values can be done as follows.

i Identify project idea and devise a maximum of two-paragraph statement.
ii Draft beliefs/values with regard to the subject domain.

I have found that it is helpful to brainstorm statements of belief/value about the domain, either individually or in groups. It may be helpful to have a facilitator conduct interviews. Multiple rounds of such activities should provide a significant list, possibly thousands of items. This may sound an arduous and daunting process, however it can be both quick (a day) and easy if carried out by an experienced facilitator.

Create headings under which the beliefs can be placed and rationalize if possible.

iii Prioritize them

I suggest two ways of doing this. The first is for each person to do it alone and collate the results (confidentially or not) and/or a group session. The arbiter in case of disagreement is a question for the company/institution—it is not a matter to be taken lightly.

It may be interesting and illustrative to note that this process of identifying and prioritizing was adapted from one devised while I was working as a project coordinator for a youth work organization. There seemed to be some disagreements about the types of projects on which the organization should work. It was not clear from where the disagreement stemmed as there was general agreement on the aim of the organization. I decided to look at the level of "values" of the organization. After meeting privately with all members of the management committee of the organization a set of "value" statements was created. I sent out a postal form asking each member to prioritize the statements. They returned the forms (all confidential) and I collated the results and presented the results to the whole committee. The results showed two clear groups with differing views about how "personal development of young people" was best facilitated. The difference made clear, more fruitful discussions followed and a new constitution was produced which led to a more coherent programme of projects. This approach seems appropriate here, since the fundamental issues of need to identify and prioritize values and beliefs are similar.

Conclusion and further work

The prototype process put forward for the development of educational multimedia learning materials takes explicit account of the beliefs and values that underpin a product. The illustrative examples were taken from the subject domain but it would be equally possible with any other category of values (see above). It is hoped that from this initial work a more comprehensive and theorized model can evolve. It is my view that a more evolved model will enable the designers and developers of multimedia learning resources to create higher quality, effective and responsible learning resources and enable educators and students make more informed choices when choosing educational multimedia resources. It may be possible, although controversial, that this or a similar process of making beliefs and values explicit could be part of a quality indicator for education multimedia.

As noted above this prototype is proposed as an object to promote discussion as well as a working prototype. As part of the work at ARKive, we will be using this process to develop a subsection of the ARKive, World Wide Web site. The process will be continually evaluated and it is intended that the report and evaluation of this process be published. It is already evident that there are major areas of further research which would enable a more effective development process based on these arguments to be developed. Below is a list of some of these main research questions.

- What are the discernible categories of values, beliefs and attitudes that impact on an educational multimedia project?

- What are the relative impacts of these categories/domains of values?
- How can formal models of the nature and interrelationships of beliefs, values, attitudes and behaviour inform and underpin the development of these development processes?
- What are effective working definitions of value, belief and attitude?
- To what extent are values, beliefs and attitudes regarding a project shared amongst members of development teams?
- How could end users be integrated into the process?
- What are the most effective processes for determining the values, beliefs and attitudes of project team members? The process above is similar to the Delphi technique of which there are a range of variations.
- How will making beliefs and values explicit affect team dynamics and management practices especially with regard to corporate and project management categories of values.
- How can these values, beliefs and attitudes be usefully represented in order to be used as a basis for specifying requirements of educational multimedia resources?
- What are the most effective ways to prioritize the values, beliefs and attitudes?
- What impacts do differing degrees of "shared" values, beliefs and attitudes have on the nature of the development and end product?

Acknowledgements

I wish to thank my colleagues Gay Attwood, Kate Ashcroft, Keith Postlethwaite and Bill Scott for their support and help in preparing this paper and Sarah Raynes, Sara Jones and Anne Sparrowhawk for helping me explore and develop the foregoing ideas. The ARKive Education Research Project is funded by a "single regeneration budget" grant administered though Government Office South West (UK).

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