Imbedding AIED in ie-TV through Broadband User Modelling (BbUM)

ROSEMARY LUCKIN AND BENEDICT DU BOULAY,
School of Cognitive & Computing Sciences University of Sussex Brighton BN1 9QH UK.
email: rosel@cogs.susx.ac.uk and bend@cogs.susx.ac.uk.

Abstract. Earlier this year we were asked to offer an AIED perspective to the development of interactive educational television (ie-TV). This *theme* paper discusses our response to the question: what can the field of AIED offer to developers of education for the wired and wireless future with particular respect to TV? We note the changes that have taken place over the past 50 years in the nature and proliferation of computing technology. We also note that this growth has not been entirely without its problems and stress the need to learn from this before moving into further new territory. To this end we consider the work done within both the field of AIED and broadcasting to highlight the areas of potential synergy. It is this expertise within broadcasting in narrative, suspense and animation combined with AIED learner modelling and grounded approaches to teaching and learning that offer a possible answer to those who may ask: interactive educational TV – so what? Interactive educational television is a fast-evolving arena, which therefore requires a flexible conceptual framework based upon sound pedagogy that is social, constructivist and enables bespoke learning experiences to huge numbers of learners at disparate as well as contained locations. It offers a great opportunity for AIED experts to bring individualised learning to all through the airwaves. In this paper we outline the current state of play for Interactive Broadcasting, and survey what both AIED and traditional broadcasting have to offer ie-TV. We propose a translation of Vygotsky's sociocultural approach into a framework for the design of ie-TV. In particular we discuss the importance of a Broadband User Model and flesh out our design approach. It is our aim to highlight questions and issues for discussion rather than to offer a clear solution.

Keywords User and Student Modelling, Intelligent multimedia and hypermedia systems, Interactive Television, Broadband, Narrative intelligence in learning environments, Vygotsky.

1. Introduction

There is significant political pressure for increased use of wired and wireless Information and Communication Technologies (ICT) within education. Within the UK, this had focussed on computers and the Internet but a recent Educational Broadcasting Services Competition [22] illustrates the attention now being given to the possibilities offered to education by broadband digital television services. At the same time, in the USA there has been a call to decrease the use of computers within education [5]. One can speculate about the reasons for this apparent lack of belief in the worth of the technology: a lack of appropriation of tools by teachers because they could not see how to use them within their current practice, perhaps, or too much focus on the technology, both software and hardware, rather than on what it can do within an educational context. The technology of the printed word has not presented educators with problems of integration, but computer technology clearly has. However, there is a substantial theoretically grounded literature about the role that computers can play to engender collaboration and likewise the role of peer collaboration in learning [6,7,25 for example]. Such a body of work offers considerable encouragement as does more recent work which indicates that the Internet offers learners and teachers an enormous array of potential collaborators: a personal electronic village [19]: localised conceptually, even if geographically widespread.

This paper examines the work done by the AIED community in order to see how it can inform the design of distributed education via new educational broadcasting services. We use the term *interactive educational television* (*ie-TV*) to refer to this technology. It represents a small step towards a blueprint for educational provision in the wired and wireless future and pays particular attention to the need for advanced models of learning and of learners. We suggest that taking care in the initial stages of development to design a framework that is flexible enough to integrate with current practice and also with the future may prevent further new technologies from falling into the demise associated with computers by some [5]. To achieve this, the framework needs to be motivated by sound pedagogy and not driven by technology. We explore what the existing domains of AIED and broadcasting, through Film and Television, have to offer the designers of ie-TV. We outline and discuss a pedagogically informed framework for design that tries to learn from past successes in both disciplines.

2. Background

2.1 What is ie-TV and where does it fit into education?

Analogue television services that transmit program information via a single channel have been until now the norm for all TV broadcasting, including those that provide educational material. However, advances in digital technology now enable broadcasters to transmit program information in a digital data stream that provides both better quality images and sound, and a wider bandwidth. This wider bandwidth means that multiple channels of information of types other than TV program images and sounds can be transmitted to viewers. Hence the advent of the term *Broadband* which is used to describe systems that transmit many channels of information simultaneously. The use of both TV and multimedia is not new to education, what is of particular interest for those of us within the AIED community is the fact that these broadband systems can carry information that travels both to and from the learner, using a combination of telephone, cable or satellite systems. This opens up the potential for the two-way communication that is a prerequisite of the adaptive interactive learning systems that many AIED researchers have been developing to great effect over the last two decades. It opens up this potential for large numbers of learners scattered across the globe. Systems such as TiVo™ (http://www.tivo.com) already provide TV viewers with computing power in a set top box. This enables them to create their own TV channels and free themselves from Broadcaster scheduling constraints. It allows their TV system to model their viewing preferences and draw their attention to programmes that may be of interest. Such systems could equally well model a viewer's progress through a curriculum of knowledge elements or their learning preferences.

2.2 What can TV and Film Offer ie-TV?

The convergence of communications and information technology within education, as well as more widely, means that concepts developed within AIED are now applicable to a wider range of wired, and more interestingly 'wireless', technologies. Interactive TV, supported by broadband broadcasting, offers interesting possibilities for education. The use of TV (and radio) in education has a long history — longer than the use of computers in education. But the traditions within which TV operates are rather different from those within which computers in education, and more particularly AIED systems operate. We can characterise AIED systems as being fundamentally concerned with individualising the experience of learners and supporting a range of representations and reifications of either the domain being explored or the learning process. The traditional division of the subject into student modelling, domain modelling, modelling teaching and interface issues reflects this concern with producing systems that react intelligently to the learner or group of learners using the system. Even where the system is simply a tool or a vehicle to promote collaboration (say), there will be a concern to monitor and perhaps adjust the parameters within which that collaboration takes place, if the system is to be regarded as of interest to the AIED community. The main focus of interest in the AIED community has shifted backwards and forwards between supporting teaching and supporting learning. The recent rise of animated pedagogical agents has placed the spotlight back on the issue of teaching, as there is now the possibility to embody many of the subtle feedback cues observed in studies of expert teachers, such as shifts of gaze, use of gesture and use of emphasis [see e.g., 11]. The use of pedagogical agents within a simulated environment (such as Steve, *ibid*), opens up the further possibility of learning situations having both an extended time frame and an extended spatial context. In other words the scope for some kind of "narrative" structure is much extended.

The tradition of broadcast TV is strongly rooted in narrative. Up until recently it has had no possibility to individualise what is broadcast or to offer anything in the way of interactive engagement with its viewers. Indeed the word "viewers" embodies rather a passive, "sit-back", notion of the learner's role. Of course, being passive does not mean that significant, constructive learning is out of the question: but it does mean that the learner's "what if" questions (at least) are harder to deal with. Despite these limitations, the best educational TV offers something that is hard to achieve within many computer-based learning and teaching environments. It can be motivating, gripping and offer a variety of stimulating images and sequences of images that both elucidate and captivate. Those skilled in this medium know how to tell a story, how to intrigue, and how to convey ideas effectively. What the medium lacks in the way of individualisability it makes up for in being able to "hit the mark" for the majority of its target audience. There are already examples of AI techniques being used by broadcasters to offer learners adaptive TV. Linear television programmes are broken into sections, each of which deal with various types of activity and offer viewers the opportunity to engage in interactive activities throughout the transmission of the linear programme, in real time. At the end of each sections, viewers who have decided to participate in the interactive version, are offered the choice of continuing to view the TV programme, or exploring the theme further through interactive enhancements (Exuberant Digital Ltd.).

2.3 What can AIED offer ie-TV?

The increasing interest in broadband broadcasting involving several channels of information out to the user and at least one channel of information back from the user opens up the possibility of bringing a number of AIED techniques to bear so as to gain some of the benefits of both the TV tradition and the computers in education tradition. Both macro and micro adaptation [25] can be incorporated into an ie-TV context. Within AIED there has been an increasing acceptance of social learning approaches and collaboration [3,7,16 for example], student modelling that can be inspect able by multiple parties and collaboratively constructed [2,12], authoring systems, software scaffolding [10], distributed peer help and embodied agents [11]. All of this work has a great deal to offer to inform the development of effective ie-TV. The affordances and constraints that different media bring to education are explored by Collins, Neville and Bielaczyc [4]. They offer a useful comparison of face to face, text, video and film, software and networks in terms of their transmission, recording, production and social characteristics. Ie-TV extends their view of video and film precisely because it introduces a greater degree of interactivity. In the same way that there has already been a crossover between work done by TV producers and that done within AIED, the same is true in the opposite direction. Those working within AIED are looking to the film and TV industry to inform their work with narrative in Interactive Learning Environments [21].

2.4 What can ie-TV offer AIED?

There is a considerable stock of existing educational video and printed matter, which could be considered as raw material for an ie-TV archive. This material has been produced to a high standard to include visually interesting examples, famous people speaking about their own work and motivating elements of various kinds. By providing both an archive of this material and a pedagogically orientated and detailed description of it, the possibility opens up for a system to dynamically recombine useful subparts of items in the archive to suit particular users or groups of users.

3. An Underpinning Pedagogy for the Wired and Wireless Future.

We propose that one way to ensure that education prospers, adapts and uses this changing environment effectively is through the construction of a theoretical framework that is not tied to any form of technology, but to the nature of the educational interactions that learners need to embrace both with and through technology. Education is interactive: interactive in the large with a multiplicity of potential participants both human and artefact. This underpinning theory therefore needs to be grounded in a pedagogy that is based upon education as interaction, both in terms of the process of interacting and the needs and abilities of the interacters. It also needs to be flexible enough to apply to current educational context and policy, which is itself widely varied, and to the evolving future. We can only speculate about what the real classrooms of tomorrow will be like and that speculation should be about the learning process we wish to engender and not the specifics of the technology that will act as the tools for learning.

Constructivism has been influential within mainstream education and the design of educational technology alike. One brand of constructivism that is particularly appropriate to our current pursuit is that of Social Constructivism, in particular that attributable to the Soviet socio-cultural school founded by Vygotsky, Leonti'ev and Luria [28]. Whilst Vygotsky and his colleagues lived in a computerless world, their socio-cultural theory of human development has been used to good effect by many designing computer systems and has acted as the lynchpin for Learner Centred Design and Software Scaffolding. It is likewise apposite for our current endeavour. For a slightly fuller version of this theoretical background see [17].

3.1 Why does Vygotsky offer a suitable theory?

Here we identify four potential points of contact between socio-cultural philosophy and broadband learning:

The role and nature of Language. For Vygotsky, individual cognition originates as interaction between human individuals not in "the internal world of the intellect, but in the social history of man-kind." [27]. Language is the sign system that allows individuals to communicate with each other and within themselves. We now face a situation in which learners throughout the world can be connected both within institutions and at home and the classroom of the future may be spread from London to Sydney and from San Francisco to Beijing. The language appropriate to educational interactions within this environment may make a paradigm shift as it becomes less appropriate to refer to physical artefacts co-located with a particular group of learners and as both synchronous and asynchronous communication occurs within the same group of learners.

The role and nature of Artefacts. The basic ideas of Vygotsky's approach are expounded in the "general law of cultural development" which states that individual intellectual (intrapsychological) processes originate in social interaction between people (interpsychological) [27]. This is a strong statement, which is particularly significant in the context of collaborative work. Human development therefore requires that society provide opportunities for shared consciousness or understanding and the symbolic tools to mediate the communication of ideas [1]. The use of computers in this mediational role is a "further development of external mediation or interpsychological functioning" [26]. Like language artefacts also carry with them a history about their use that evokes certain expectations about what and how they can and should be utilised. Contravening these expectations can cause problems that may hamper the efficacy of the learning we seek to promote [9].

The role and nature of a Distributed Culture. If we accept the social origins of cognition then we must account for how the interpsychological becomes the intrapsychological. This link occurs within the process of internalisation which is not a simple 'transfer' or 'copying' process, it is the process by which an individual gains control over, or masters, the external sign forms of her social activity [30]. The result of this process means that the psychological functioning of the individual that emerges reflects the nature of the culture from which it was derived [23]. But what does this mean within a distributed culture? We cannot make assumptions about the suitability of material developed to meet the needs of say a rural school in Middle England for an inner city school in East London let alone the suitability of material developed in Western Europe or the U.S.A. for use in Eastern Europe or Asia, for example.

The role and nature of learners and teachers. As we have already noted the teaching:learning process is inseparable within a socio-cultural approach. Both the teaching and learning processes are encompassed within the Russian term "obuchenie" used by Vygotsky. The concept of the Zone of Proximal Development (ZPD) was introduced by Vygotsky to represent the crystallisation of the internalisation process and the need for interaction between more and less able learning partners. This interaction needed to focus upon the concepts that were just beyond the less able learner's independent ability. Whilst this theory was developed with particular respect to children this does not preclude the benefits of an approach so grounded from being appropriate for older learners too. The socio-cultural approach, as we have already stressed, relies upon social interaction, internalisation, the inseparability of teaching and learning and targeting the to-be-learnt to each individual learners' point of learning readiness (the ZPD). Within our framework we must therefore provide opportunities and support for individuals and groups of all ages to act as both learners and teachers.

3.2 So how can we translate socio-culturalism into Broadband culture?

In order to explore this question we discuss three processes that engender learning and that can be extracted from the preceding discussion: Internalisation through Interaction; Abstraction through knowledge mediation; Scaffolding learning through and in the ZPD. We also introduce a fourth implicit process: Motivating the desire to learn. Consideration of these processes provides a starting point for our design framework:

Internalisation through Interaction. Here we define the term "interactivity" as: the cycle of operational or conceptual exchange between two or more parties, one of which may be a digital system. *Operational* exchange refers to functional activity: the entering of information at or through the user's system interface and the resultant response from the system. This might mean typing at a keyboard, touching a touchscreen or activating a sensor. *Conceptual* exchange refers to activity involving the concepts of the particular subject being studied. This might involve the solution of a screen based problem activity by a single user, or discussion about where chemical elements belong in the periodic table involving a teacher and learners completing a computer based task collaboratively.

We emphasise that within this definition of *interactivity* it has both *locus* and *range*. The *locus* of interactivity is the place where it occurs either *at* or *through* the interface. Interactivity at the interface, such as pointing and clicking with a mouse is deemed operational and as such it should be straightforward and intuitive. Interactivity through the interface requires interactions between users and the subject matter concepts, which make up the discipline of study. The *range* of interactivity is used to refer to the number of participants or groups of participants in the interactions: the system may involve interactivity with and between individuals, small groups or a whole class. This is important and leads to many possibilities with respect to communities of learners who may be at near and far geographical locations and yet linked conceptually. The concept of interactivity is not technology specific and can be applied to any interactive system. We therefore focus on interactivity rather than technology in order to help in constructing a design framework that is both applicable now and for the future.

*Abstraction through knowledge mediation***.** In addition to recognising the social origin of intellectual growth in the relations between people, the process of internalisation requires *intra***-**activity within the mind of the individual. This intra-activity uses language as its tools. This internal language shapes and is shaped by the language used for *inter*-action between people and represents the concepts already understood by the learner. In order for an individual to increase her learning she needs to be able to build new understanding from these existing intellectual components. In this way she can construct an increasingly abstract conceptual mind map. In addition to promoting *conceptual* interactivity we therefore also need to ensure that within this conceptual interactivity there are points of contact between a learners existing knowledge and the concepts to be learnt.

*Scaffolding learning through and in the ZPD***.** So far we have identified the need to focus on conceptual interactivity and reduce operational distraction, and to ground the material we want learners to understand in concepts that they already do understand. Now we need to turn our attention to how we can help learners identify the new knowledge they need to construct and then bridge that recognition: production gap [31]. Software scaffolding has been successfully employed within educational technology to help bridge the recognition-production gap between what learners want to be able to achieve and what they are able to effect themselves without assistance [10, for example]. Whether software scaffolding systems employ task focused and/or learner focused scaffolding [15], and whether they are adaptable or adaptive, they need to provide scaffolding which is flexible as well as context sensitive, in particular they must be capable of fading and ensure learners are challenged. In addition, if systems are to sidestep some of the more intractable problems and labour intensive computation of modelling learners, they need to address the problem of how to make learners more effective at reflecting on their own needs, at seeking appropriate challenges and appropriate support. In other words, they need to scaffold at the metacognitive as well as the domain level. Increasingly learners need to be able to set goals or sub-goals, plan, manage and reflect upon their own learning experiences.

*Motivating the desire to learn***.** While we acknowledge that a constructivist view of learning means that learners will always be learning *something,* an important role for the teacher is to motivate learners to exert themselves in roughly the direction desired by the teacher. Human teachers employ a wide range of subtle techniques to both gauge and affect the learner's motivational state [13], and some of these techniques are now finding their way into AIED systems [see e.g., 8,14]. This is an area where existing TV practice has a strong track record. In summary, we need to:

- *Create networks* of learners in existing, self-selecting and emergent communities that are conceptually grounded and local in terms of their shared knowledge or common ground [20] even if they are geographically distant.

- *Provide technology* to support conceptual interactivity between people and between technology and people.
- *Offer conceptual bridging* between the already known and the to be learnt and Task focussed and Learner Focussed Scaffolding at both the domain and Meta level.

We do not claim that these processes are complete, merely that they provide a useful basis for translating from theory to practice in a contemporary world of anytime, anywhere digital connectivity.

4. Broadband User Modelling: a design framework

If we now redefine these processes into some design principles we move closer to an initial specification. Central to this redefinition is the creation of a *Broadband User Model* .

4.1 Broadband User Model (BbUM)

Within this term we expand the definition of Broadband and intend to describe a concept that accommodates a wide bandwidth of participants, senses, devices and contexts. In fact there are elements of a BbUM for every learner at the moment. For example, within different contexts such as school and home there are models of particular learners in the heads of teachers, parents, peers and the learners themselves. These are not linked, but in sum they tell an evolving story of a learner's intellectual development. Through the creation and maintenance of the BbUM these different perspectives are brought together as different participants are able to access and update their view of the learner. Whilst the BbUM has a unique identity it is updateable and can be portable or distributed. This means that eventually learners will be able to carry a representation of their BbUM from learning artefact to learning artefact in a similar manner to the SIM card in a mobile phone or down load it to a new learning device and then upload an update at the end of the session. In order to cater for devices with different levels of sophistication the BbUM has a core and layers of embellishment. The simplest devices merely access and update the core, more sophisticated resources and people can access the fully embellished model. The different elements of the BbUM, both core and embellishments are selectively accessible: the owner can set the privileges of other contributors and viewers. The use of a core and embellishments also enables us to take advantage of a certain amount of graceful degradation: as long as the core is accessible then the model can perform a useful job. At the current time we are specifying the minimum core components of a BbUM that can be stored in a TV set top box or downloadable (and updateable) from the internet to a set top box. Whilst we are looking to the future we are also aware of the value of current technologies and the pilot BbUM needs to be able to be updated by learners, teachers and peers to reflect learning that has taken place via traditional non-networked media such as books and lectures. In addition to the BbUM itself, three further components exist to underpin the roles and processes we have specified and are trying to engender:

4.2 A Broadband Domain Model

This is a BbUM compatible storage system within which to place descriptions of the knowledge elements available. This system contains standard information about the nature and size of each particular knowledge element : media, size, subject, delivery requirements, target audience. It also contains meta-data that indicates its potential analogues for scaffolding purposes and information about its suitability for learners with particular style preferences. Clearly this is only a subset of the information one might ideally like to represent: it is a starting point and is designed to allow the addition of further categories in the future. In this way each knowledge element is tagged with information about itself and information about learners. Knowledge elements that are designed to engender task focussed scaffolding. Our current model envisages the use of much existing material, including print as well as video and audio. However, we are also aiming to create new knowledge elements and it is here that we are designing with task focussed scaffolding in mind. Currently we are focussing on two forms of task focussed scaffolding: Conceptual Grounding or Bridging and translation between Multiple External Representations.

The combination of the BbUM itself and the BbUM domain model mean that for any particular set of programmes learners could specify a number of general parameters, e.g. the *amount of time* they had available for that activity, their *general preferences as learners* (e.g. top down *vs* bottom up or activity based *vs* information based), their *general motivation* (i.e. whether they are learning for fun *vs* serious studying) and their *level of education*. These parameters would then be used to structure their interaction with the system according to these criteria and keep a record for use as a default for future interactions.

For a system to make substantial use of such preferences and provide a more tailored service than some variant of "video on demand" the resources to be made available require two kinds of prior (and probably labour-intensive) organization. First there needs to be some kind of domain specific conceptual structure within which the resources can be indexed. So, for example, somewhere in the system there needs to be a representation that computing an ANOVA (say) is a particular kind of statistical technique, and that this technique has a number of pre-requisites and possibly co-requisites. This kind of declarative domain representation is completely standard in AIED systems. The second kind of organization focuses on the resources to be made available. Let us assume, for the sake of the example, that a large amount of video material on statistics is to be reused as part of broadband education system. Let us further assume that the original materials were constructed as complete and coherent programmes/videos in their own right, with all the high production values and attention to motivational and narrative issues mentioned earlier. If these materials are to be delivered in "chunks" smaller than the original programs then each would need to be analysed at some level of granularity in terms of such factors as: this chunk is an example, this chunk is a motivating introduction, this chunk offers an alternative view of that chunk, this chunk is an abstraction of that chunk and so on. In other words some aspects of the pedagogic and narrative structure that went into the design of the original materials needs to be made explicit and re-represented within the system. This would allow the system to attempt such tasks as *conceptual bridging* (mentioned earlier) in that the fact that one part of this programme is closely related to some other part of another programme would be explicitly known to the system. Again this kind of conceptual mapping is common practice in AIED systems, where in order to allow dynamic decision making, e.g. what is the best next activity for this (kind of) individual, modelling the domain and the student (or at least the nearest student stereotype) needs to be explicit.

4.3 Help resources

As a complement to material designed to foster task focussed scaffolding, all learners also need to have access to help resources that are designed to engender learner focussed scaffolding. Help here is in the shape of other humans as well as hints and tips provided through knowledge elements. The human help resource management system has been inspired by the I-Help system of McCalla et al. [19]. It involves the matchmaking of peer help as well as the use of tutor assistance and is managed by a social mediator described below in Section 4.4. An important factor in our BbUM conception is that the system would support collaborative activities with, through and outside the system. Collaborative activities *with* the system would be of the traditional kind, as already well established [e.g.,15]. Collaborative activities *through* the system would involve setting up fluid virtual communities and peer help brokering as already described [e.g., 18]. Collaborative activities *outside* the system would involve suggestions about what the learner might do jointly with other learners when not logged into the system.

4.4. A coherence compiler

Finally, in order to ensure bespoke learning, each learner needs a coherence compiler; essentially a storybuilder. This can be thought of as a personal assistant for each learner whose role is to construct a narrative for each learning session that is coherent in itself and also maintains coherence with what has gone before. The coherence compiler uses the information contained in the BbUM and calls upon a range of agents:

- A social mediator, who will answer the question: who is available to interact with?
- A knowledge mediator, who will answer the questions: what has this learner already learnt and what should she learn next?
- A scaffolder to answer questions such as: what knowledge elements are available and which have the appropriate qualities? How much help has this learner needed so far and how much should we be looking to provide next?

It may seem that nothing has been gained over and above a standard AIED learning environment. But that is not the case. What would now be possible is the delivery of small chunks of high quality material re-organised into new structures and supporting some of the more traditional capabilities of an AIED system such as monitoring student problem-solving, assisting with reflection and so on. These chunks could provide that motivating example or those links to real life that might be rather harder to produce within the tradition of *computer*-based education. Rather than seeing this as TV imbedded inside an AIED system, one could just as easily regard this as AIED system imbedded inside a TV program.

6. Example Scenario

The following example scenario fleshes out the sort of learning interactions envisaged within the BbUM design framework. Helen and Peter are both university students studying psychology. They are preparing for a statistics exam and Peter wishes to revise. He is sitting in the lounge area of their garden flat and turns on the TV; he switches to the learning channel and logs on. He has used the system before and so the system recalls his BbUM and clarifies with Peter the sub-topics within statistics that he needs to tackle and the amount of time he has available for study today. Peter's BbUM reflects the fact that he prefers a top down, activity based approach to his learning. He struggled to complete the last activity he tackled with the system and so the first activity selected for today's session covers the same material but uses a different example and activity. It replays a clip from the video that Peter saw last time and then presents today's activity. Once the system has constructed an initial study plan for today's session it monitors Peter's interaction over time. For example, it keeps records of which materials he has accessed, whether they have been completed, and if not, at what point they were abandoned. This monitoring is intended to adjust future interactions with Peter and to add information to the BbUM domain model (meta-tags) about resources that do not seem to be used effectively so that they can be omitted from future study plans. Peter starts working using an infrared keyboard to complete the stats exercise, which involves analysing information about the relationship between certain sorts of plant growth and soil type around the British Isles. The system has information about Peter's location and initially introduces the data about the plants and soil in his locality. Helen wanders in from trying to tame the overgrown garden they have inherited and notices Peter using the TV to complete some stats revision. She joins him on the sofa and they start working on the activity together. After they finish the activity the system advises them that there are four other students living quite close to them who are also studying stats and who have indicated their willingness to help others. Peter feels satisfied with his success for now and decides to save the study plan he is working on so that he can return to it later. He goes into the kitchen to make tea, but before he logs off he emails the other students the system identified to ask them how they had managed to complete the exercise that had stumped Peter last time.

While Peter was using the system on his own he saw one particular video clip that he thought might interest Helen and he bookmarked it for her. Before logging-off he shows Helen the clip about soil types in their area and plants that do well. Helen has never used the learning TV channel before and she decides to log-on in her own right. The system initiates a dialogue with Helen to gather some initial information about her: her name, age, address, what she would like to learn about, why she wishes to learn about this and how long she has to learn today. The system will initially call up a stereotypical model for a university student such as Helen and tailor it as Helen interacts with the system. Helen does not want to learn about stats now, she saw the information about plants and wonders what other gardening information might be available. She feels a bit guilty about not doing the stats so decides to opt for a short session on gardening today and has stated that she has only 20 minutes to spend this time. Through supplying her address she has given the system enough information to tap into geographical data about where she lives, soil type and conditions in her area and it uses to choose between alternative versions of gardening video material it has access to. Within the current database of knowledge elements about gardening there is some high quality broadcast video in various programme formats: the garden ‘makeover’ programme, tours of famous gardens, how to deal with specific problems. In order to find out what interests Helen a video montage of these different approaches is played – it lasts about 6 minutes and at the end leaves thumbnails representing the various different types of gardening material available on the screen so that Helen can select the area that interests her. She clicks on the Garden Makeover option and the system selects a video that is introductory and lasts 7 minutes. Helen watches this through and on its completion the system asks Helen to map out her garden dimensions on a screen grid using the keyboard or drawing tablet. Once the time she had specified as available for study has been reached the system reminds Helen of this fact. She saves the garden map she has started to draw as an HTML document and down loads it onto her laptop. She can then work on it offline and upload it next time she uses the system. She also prints off some plant details she had book marked as the Garden Makeover video had been playing. As with the stats revision example, in later sessions the system would assist Helen to contact other people interested in gardening and willing to collaborate on gardening issues.

7. Conclusion

This theme paper has explored the potential for bringing AIED techniques to ie-TV. The idea behind this is to explore how the enhanced interactivity of this medium compared to film and video can be harnessed so as to achieve some of the individualisation that AIED systems can produce while tapping into its motivational strengths and narrative structure. Interactive educational television is a fast-evolving arena which requires a flexible conceptual framework based upon sound pedagogy that is social, constructivist and enables bespoke learning experiences to huge numbers of learners at disparate as well as contained locations. It offers a great opportunity for AIED experts to bring individualised learning to all through the airwaves. By adopting a Vygotskian paradigm we have attempted to provide a technology-independent notion of user modelling that can be adapted according to the resources available.

8. References

[1] Bruner, J. S. (1984). Vygotsky's zone of proximal development: The hidden agenda. In B. Rogoff and J. V. Wertsch (Ed.), *Children's Learning in the "Zone of Proximal Development"* (Vol. 23, pp. 93-97). San Francisco: Jossey-Bass.

[2] Bull, S. (2000). *Individualised Recommendations for Learning Strategy Use*. Paper presented at the Intelligent Tutoring Systems: 5th International Conference, ITS2000, Montreal.

[3] Burton, M., & Brna, P. (1996). Clarissa: An exploration of collaboration through agent based dialogue games. In Brna. P, Paiva, A. & Self, J. (Ed.), *European Conference on Artificial Intelligence in Education* (pp. 393-400). Lisbon, Portugal: Colibri - Artes Graficas, Lda.

[4] Collins, A., Neville, P. & Bielaczyc, K. (2000) The Role of Different Media in Designing Environments,*International Journal of Artificial Intelligence in Education*, **11**(2), 144–162.

[5] Cordes, C. & Miller, E. (Eds.). (2000). *Fool's Gold: A Critical Look at Computers in Childhood.*: U.S. Alliance for childhood http://www.allianceforchildhood.net/projects/computers/computers_reports.html.

[6] Crook, C. (1994). *Computers and the collaborative experience of learning*. London: Routledge.

[7] Dillenbourg, P., Baker, M., Blaye, A. & O'Malley, C. (1995). The Evolution of research on Collaborative Learning. In P. Reimann & H. Spada (Eds.), *Learning in Humans and Machines*. Pergamon.

[8] del Soldato, T. & du Boulay, B. (1996) Implementation of Motivational Tactics in Tutoring Systems, *Journal of Artificial Intelligence in Education*, **6**(4), 337–378.

[9] du Boulay, B., Luckin, R. & del Soldato, T. (1999) The Plausibility Problem: Human Teaching Tactics in the 'Hands' of a Machine, in Lajoie, S.P & Vivet, M. (Eds) *Proceedings of the International Conference of AIED'99*, Le Mans, France, IOS Press. 225–232.

[10] Jackson, S. L., Krajcik, J., & Soloway, E. (1998). The Design of Guided Learner-Adaptable Scaffolding in Interactive Learning Environments. *CHI 98 Human Factors in Computing Systems*, 187-194.

[11] Johnson, W.L., Rickel, J.W. & Lester, J.C. (2000) Animated Pedagogical Agents: Face-to-Face Interaction in Interactive Learning Environments, *International Journal of Artificial Intelligence in Education*, **11**(1), 47–78.

[12] Kay, J. (2000). Stereotypes, Student Models and Scrutability. In G. Gauthier & C. Frasson & K. VanLehn (Eds.), *Intelligent Tutoring Systems ITS2000* (Vol. No 1839, pp. 19-30). Montreal: Springer: Berlin.

[13] Lepper , M.R., Woolverton, M., Mumme , D.L. & Gurtner, J-L. (1993) Motivational Techniques of Expert Human Tutors: Lessons for the design of Computer-Based Tutors, in Lajoie, S.P & Derry, S.J. (Eds) Computers as Cognitive Tools, Lawrence Erlbaum : Hillsdale, New Jersey, 75–105.

[14] Lester, J.C.,Towns, S.G. & Fitzgerald, P.J. (1999) Achieving Affective Impact: Visual Emotive Communication in Lifelike Pedagogical Agents, *International Journal of Artificial Intelligence in Education*, **10**(3–4), 278–291.

[15] Luckin, R. (1998). Knowledge construction in the zone of collaboration: scaffolding the learner to productive interactivity. In A. Bruckman & M. Guzdial & J. Kolodner & A. Ram (Eds.), *International Conference of the Learning Sciences* (pp. 188-194). Atlanta, Georgia: AACE.

[16] Luckin, R., & du Boulay, B. (1999). Designing a Zone of Proximal Adjustment. *International Journal of Artificial Intelligence and Education*, **10***(2)*, 198-220.

[17] Luckin, R., & du Boulay, B. (2001). Broadband User Modelling: where AIED meets ie-TV. CSRP 531, School of Cognitive and Computing Sciences, University of Sussex.
[18] McCalla, G. (2000). Life and learning in the Electronic Village: the Importance of Localization for the Design of Environments to Support Learning *Intelligent Tutoring Systems*. ITS2000 Montreal.
[19] McCalla, G., Vassileva, J., Greer , J. & Bull, S. (2000). *Active Learner Modelling.* Paper presented at the Intelligent Tutoring Systems ITS2000, Montreal.
[20] Mercer, N. (1995). *The guided construction of knowledge: talk amongst teachers and learners.* Clevedon: Multilingual Matters.
[21] Plowman, L., Luckin, R., Laurillard, D., Stratfold, M., & Taylor, J. (1999). Designing Multimedia for Learning: Narrative Guidance and Narrative Construction, *In the proceedings of CHI 99* (pp. 310-317). May 15-20, 1999, Pittsburgh, PA USA.: ACM.
[22] Plowman, L., Mateer, J., Luckin, R., Back, J., Barnard, J., Hewitt, D., Jones, C., Lace, J., Musselbrook, K., & Stewart, J. (2000). *An Evaluation of the Educational Broadcasting Services Competition.* Unpublished report for the DfEE. Edingurgh: SCRE.
[23] Rogoff, B. W., J. V. (Ed.). (1984). *Children's learning in the zone of proximal development* (Vol. 23). San Francisco: Jossey-Bass.
[24] Scardamelia, M., & Bereiter, C. (1996). Student communities for the advancement of knowledge. *Communications of the ACM*, **3***9*(4), 36-37.
[25] Shute, V. J. (1995) SMART: Student Modelling Approach for Responsive Tutoring, *User Modelling and User-Adapted Interaction*, **5** (1),1–44.
[26] Tikhomirov, O. K. (1979). The psychological consequences of computerization. In J. V. Wertsch (Ed.), *The Concept of activity in Soviet Psychology*. New York.: M. E. Sharpe.
[27] Vygotsky, L. S. (1978). *Mind in society: the development of higher psychological processes* (V. J.-S. M. Cole, S. Scribner, E. Souberman, Trans.). Cambridge, MA: Harvard University Press.
[28] Vygotsky, L. S. (1986). *Thought and Language*. Cambridge, Mass: The MIT Press.
[29] Wertsch, J. V. (Ed.). (1979). *The concept of activity in Soviet psychology*. New York: Sharpe.
[30] Wertsch, J. V. S., C. A. (1985). The concept of internalization in Vygotsky's account of the genesis of higher mental functions. In J. V. Wertsch (Ed.), *Culture, communication and cognition* (pp. 162-181). Cambridge, MA: Cambridge University Press.
[31] Wood, D. J., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, **17**(2), 89-100.