PRINCIPLES AND REALIZATION OF INTERACTIVE TV-BASED LEARNING PROCESS

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Abstract

The arrival of digital television (digital TV) has the potential to expand the power of the TV medium by providing viewers with new services not only for information delivery and entertainment, but also for modern learning at home and on the workplace. The extension of digital television with different forms of interactivity leads to so-called interactive digital TV (iTV). Interactive TV-based learning or t-learning is a new e-learning approach which assures interactive access to video-rich learning materials through iTV. This paper explores the current development state of the interactive TV-based learning. It describes some principles for realization of e-learning process by means of iTV technology as well as the realization of this process. There are several case studies included, which adhere to the realization without meaning to. Special attention has been drawn on the individualized language learning through interactive digital television. Finally, the paper includes a strategy for language learning, which is based upon the communication spaces' convergence of interactive digital television and the mobile communication technology.

Keywords

Interactive Digital Television (iTV), Interactive TV-based learning (t-learning), Principles of t-learning, Realization of t-learning process.

1. BACKGROUND

With the advent of digital networks, the world of TV as we know it -- *mass-media broadcast* -- is undergoing tremendous changes. The increase of the number of available channels, the convergence of TV and Internet and the proliferation of new interactive services transform the TV box function from a program watching device to a portal towards all kinds of content and services.

The next/current TV era revolves around the set-top-boxes integrating viewing, listening and recording functionalities, connections to several sources (Internet, cable, and satellite), games, as well as communications features. In order to cope with the complexity of such an environment and efficiently choose among the huge amount of available alternatives, the users are in need of an advanced user interface and services to provide them with an intelligent assistance.

Television plays a major role in society. It has an impact on nearly everyone – informing, entertaining and educating. However, most aspects of learning through a TV tend to be informal, or what is sometimes described as 'edutainment' (a mix of education and entertainment). With the exception of a few schools' and Open University-focused educational programmes there is very little specifically structured and engaged learning. [3][4]

Until recently, television was generally a passive medium, but digital TV is starting to enable new forms of interactivity with viewers. New technologies are starting to offer opportunities, within some learning contexts, for appropriate and sustainable enhanced learning opportunities in the home – moving from edutainment to more engaged learning. Digital TV also has the advantage of being easy to use and, unlike the Internet; it does not tie up the phone line for hours.

However, the early developments of interactive digital TV failed to live up to expectations in creating new learning opportunities. The UK leads the world in the uptake of digital TV but has also experienced the

problems associated with being a 'first mover' – mistakes over certain aspects of the business that have not been sustainable; incompatible systems, fragmentation of services, etc. [5]
This has made it difficult for those in education and training areas to identify the best way forward. However, now is a good time to reconsider interactive TV for learning. Strategies, schemes and scenarios have been developed for implementation of personalised, adaptive learning experience for individuals and groups of learners; case studies have been introduced and that have resulted in a higher interest in the potential of television for education. Different standards have been developed and we expect that they would serve as a regulatory framework for current and near-future iTV applications. There are also some proposed models for interactive TV-based learning, which are consistent with the modern e-learning strategies. Furthermore, different strategies have been explored for integration of iTV with other communication spaces like Internet and mobile communication technology for delivering different services including learning solutions. [1]

2. PRINCIPLES FOR REALIZATION OF AN E-LEARNING PROCESS BY MEANS OF ITV TECHNOLOGY

Interactive digital TV should serve all aspects of lifelong learning, meeting the educational needs of young and old people through pre-school programming, supplementary classroom materials, distance learning, vocational training, and other educational possibilities.
Defining common e-learning principles and observing them according to the current interactive TV-based learning strategies and decisions determine structural frameworks of that contemporary approach and make it more advanced and applicable in the real world.
The following main principles can be summarized:

- **Flexibility and efficiency of use**
- **Accessibility**
- **Interactivity /**"Turning passive viewers into active learners"**/**
- **Principles for development and presentation of the learning content**
- **Learner control and access**
- **Facilities for learner communication**
- **Adaptation and adherence to the standards**
- **Help and documentation**

Flexibility and efficiency of use

Flexibility of the interactive TV-based learning is based on service flexibility of digital interactive television and datacasting. Educational production can be offered in different program types: for example, only a picture, a picture with a prompt that provides the viewer with additional information, a picture with overlaid information, information with an inserted picture (still image or video), and lastly, information only. Once the relevant data is inserted into the transmission stream of the service provider (TV broadcaster, datacaster), it is subsequently extracted by a set-top-box (STB) or tuner/decoder within a personal computer and displayed on either a television screen or PC monitor.
That variety of visualization allows educational content to be conforming to different levels of learners (learners with basic knowledge, average learners, advanced learners, etc.) and their learning styles, preferences, background, aims, etc.

Accessibility

This principle can be considered in several aspects. On the one hand, there are a number of factors that are important for accessibility and ability for using iTV for e-learning strategy:

- Most people have access to a television in their homes. Some people even have TV access at their offices.
- The TV set is an easy-to-use device.
- People tend to trust the content that is on the TV.

- Television has the potential of reaching more people and offering more learning opportunities than traditional learning institutions can do.

On the other hand, interactive television could be of particular use to the physically disabled people (94% of visually impaired people watch television regularly), as it would allow them to access services from home. However, usability and accessibility currently cause serious problems for many potential viewers. Difficulties include the use of the remote control handset by people with impaired motor control, perception of text and icons on screen by visually impaired or dyslexic people and the limitations of subtitles designed to include people with hearing difficulties.

Interactivity /*"Turning passive viewers into active learners"/*

Interactivity in e-learning is considered "a necessary and fundamental mechanism for knowledge acquisition and the development of both cognitive and physical skills" and that interaction is intrinsic to successful, effective instructional practice as well as individual discovery. It is also argued that "making automated learning environments highly interactive is a multi-disciplinary art ...however, the level of interactivity as measured on anyone's scale does not approach the level of interactivity in a human tutoring situation". [10] Therefore, the challenge is to make best use of the iTV technology, not to replicate human behaviour and communication, but to enhance human-TV (or computer) communications through a better understanding of the use and implementation of interactive events.
The system also should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. It has to follow real-world conventions, making information appear in a natural and logical order.

Principles for development and presentation of the learning content

There is a wide belief in the Interactive TV industry that "content is the king" and that filling the bandwidth with "rich media" content is the way to produce a good service. The fact that the content is necessary is obvious and there are a number of principles that should be the focus of attention:

- *Principles for including media elements*
- *Principles for including proven practice examples*
- *Principles for creating online practice exercises*
- *Delivery of learning content in bit-size units*
- *Principles for building problem solving skills and curiosity-led learning*
- *Quality and diversity of learning content*
- *Search and provide information about sources of t-learning*
- *Learning content on demand*

Principles for including media elements

- Multimedia: use words and graphics rather than words alone.
- Contiguity: place corresponding words and graphics near each other.
- Modality: present words as audio narration rather than onscreen text.
- Redundancy: present words in both text and audio narration can hurt learning.
- Coherence: adding interesting material can hurt learning. (Avoid extraneous material and verbosity.)
- Personalization: use conversational style and virtual coaches.

Principles for including proven practice examples

- Replace some practice problems with worked examples.
- Use job-realistic or varied worked examples.
- Teach learners to self-explain examples.

Principles for creating online practice exercises

- Interactions should mirror the job.
- Critical tasks require more practice.
- Train learners to self-question during receptive t-lessons.

Delivery of learning content in bit-size units

It should be suitable to divide the learning content into very small didactic units relating to particular definitions, processes, activities, etc., and automatically generate the appropriate teaching materials according to the present situations of each particular user.

Principles for building problem-solving skills and curiosity-led learning

Principles for building problem-solving skills learning are important for the continuous professional development. They determine:

- Use job contexts to teach problem solving processes.
- Make learners aware of their problem-solving processes.
- Incorporate job-specific problem-solving processes.

The fundament of curiosity-led learning is the natural desire of humans to note everything that is interesting. It is proven that people learn many useful things without meaning to, without the intention to learn, just because of the inborn willingness to discover new phenomena and events.

Quality and diversity of learning content

Television viewers expect qualitative, compelling, visually rich content – using experts from all over the world, providing simulations and graphics far superior to those generally available in the traditional learning environments. Content packaging and the development of personalized TV services is starting to create new opportunities for bringing "visually rich, on-demand content" to the viewer. Valuable content should be handled with care and rendered in the highest quality possible. Diversity should be considered in the design and implementation of educational content. Elements to encourage diversity may address, among other aspects, gender, culture, nationality, ethnicity, learning capacity, learners with special education needs, and multi-level and multi-age instruction.

Search and provide information about sources of t-learning

An overlooked educational use of interactive TV is its potential to provide information about sources of learning and guidance on how to use them. An educational electronic program guide (educational EPG), to guide new learners to learning opportunities, is needed. It will be very powerful tool if we use efficiently its search function that is similar to the Internet search engine.

Learning content on demand

New developments around "personalized TV" could potentially offer new ways of enabling high-quality, interactive learning modules for engaging learning. At this stage, the services have key importance:

- video- or content-on-demand services from remote servers;
- home storage using personal video recorders (PVRs).

Both methods have similar functionality to a VCR. They allow users to browse, query linked text and video databases, author video modules and play back the selected video over the network or using PVRs. These technologies are likely to greatly enhance the availability of multimedia information to teachers and add substantial value to the educational process. The benefits include:

- Teaching material can be encoded and stored on media server (or downloaded on local PVR), allowing simultaneous real-time access to the same piece of information for teaching in various locations.
- Information can be retrieved instantly from the media server (or local PVR) at any time. No initial preparation such as moving the huge TV and VCR, pre-loading of the tape and connecting the audio/visual equipment is required.

- Seminars from other institutions, laboratory demonstration, training sessions and lectures etc. can be pre-recorded by the speaker or lecturer. These sources can be played back at any time during a class to supplement the classroom experience and open up the exposure of the students to a more diversified wealth of information.
- Forums or conferences held abroad could be recorded. Users can review them at a later time, thus saving travelling time and expenses.
- Video-on-demand (or PVR) allows users to rewind and play back as if they are watching from a videotape. This helps to better understand the taped material.
- Material used repetitively (e.g. orientation information) can be loaded on the server (or PVR). This helps to ease manpower limitation in arranging guest speakers.

Such activities deal with materialization of personalized life-long learning on demand for all, everywhere and anytime. [6] It provides engaging for the learner learning process and individually tailored and addressed courseware.

Learner control and access

The learner control and access should depend on different factors: for example, level of acquired knowledge of the learners, their cognitive skills and abilities to work with new technologies, technical and technological equipment, available services, etc, but their implementation makes the learning process flexible and user-desired. It should be suitable to use learner control for learners with high prior knowledge or high metacognitive skills. It is recommendable to add advisement to facilitate learner work. It would be good to make important instructional events the default navigation option.

Facilities for learner communication

Implementation of different types of communications is essential. If learners can interact with experts, teachers, or peers in the form of synchronous or asynchronous communication the learning process will be more useful and successful. Hence, the experts are more reachable and the knowledge is more available.

Adaptation and adherence to the standards

There are a number of initiatives afoot to standardize iTV technology. The development of common standards and their adherence is a guarantee for quality, duration, interoperability and accessibility of that new contemporary technology.

Help and documentation

Intuitive interface and easy navigation are sometimes insufficient for the user to cope with the working environment of an interactive learning system. This is why there is a need of providing help information, documentation, interactive help assistants and advising users in their work as mandatory components. Providing search functionality is an important aspect of the help system.

3. REALIZATION OF INTERACTIVE TV-BASED LEARNING PROCESS

The principles, which were described, should not be considered separately. They are important and relate to one or more of the main components of the realization of the t-learning process, which are: communication space, used services, users and learning content.

In short, the interactive TV-based learning process is performed in the following way: the communication space is the core component, in which services and learning content are situated. Besides, services are intermediate components, connecting the user and the communication space. The user sends a request for a specific learning content, in which s/he is interested, the services search for it in the learning content repository and deliver it to the user in a suitable form. Figure 1 shows how this process could be realized.

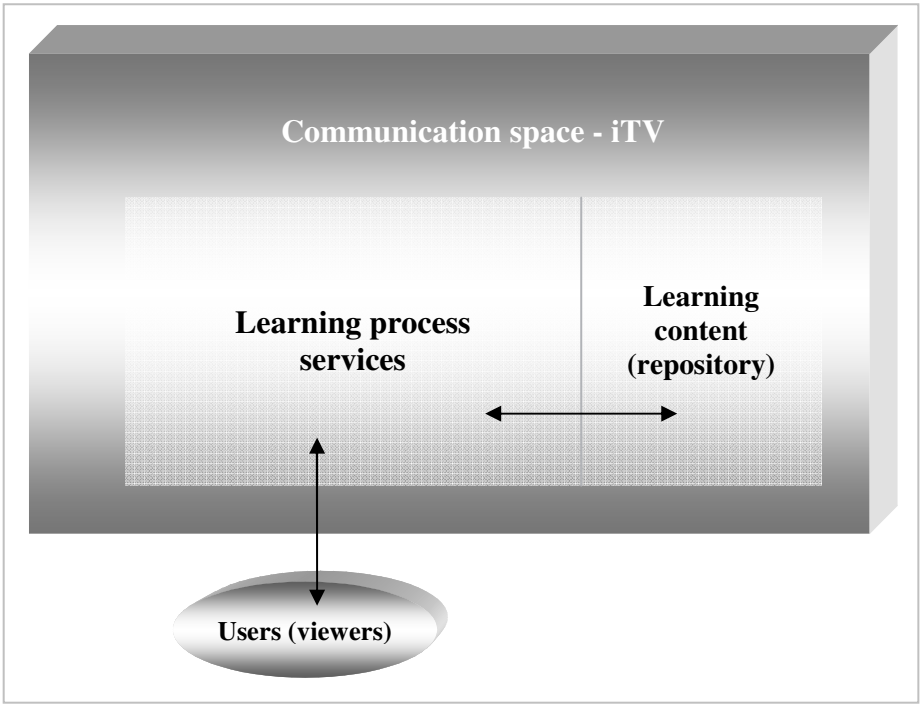

Figure 1: Realization of interactive TV-based learning

Considering the principles, described above, it is most appropriate to associate the following principles with the component communication space: Flexibility and efficiency of use, Accessibility, Facilities for learner communication, Adaptation and adherence to the standards.

Services could be fall into two types: communication space services and learning process services. Let us focus on the second type. The learning process services are software applications through which one can create, search and choose the learning content, structure the learning process according to strictly-defined criteria, evaluate the acquired knowledge and skills of the learners, establish the connection between the users (learners and instructors), etc. Services are a part of the set-top-box device software and usually the user uses remote control to manage them. Learning process services should keep up with the following principles: Interactivity, Accessibility, Adaptation and adherence to the standards, Help and Documentation, Learner control and access.

Users, in particular learners, are described with their educational background, age characteristics, motivation, requirement, professional curriculum, etc. They "dictate" the conditions, principles and the characteristics, to which the services should comply, and thus the communication space also, so that a successful t-learning process can be performed.

On the other hand, the last component (the learning content), should also be developed considering a target group, their profile and other features. The learning content should follow the principles, described above, namely: Principles for development and presentation of the learning content, Adaptation and adherence to the standards. Besides, the learning process and the learning material for it must conform to a proper methodology, for example, constructivist methodology, learning-by-doing, on-the-job training, etc. Both the content and the environment must keep a certain level of personalization.

4. CASE STUDIES

Below there are a number of examples or case studies, available on "pjb Associates" site, that describe the various ways in which interactive digital TV is currently being used for learning purposes across the world. [2][9] They "unwittingly" keep up to a higher or lower degree with the realization schema described above and with the principles for e-learning process through iTV.

Pre-school learning activities

In the UK the BBC's CBeebies digital channel is aimed at pre-school children and has been designed to develop pre-school learning skills. Whilst watching the channel, pressing the red button on the remote control takes the viewer to the interactive area. A number of different activities or stories tend to be available at different times and relate to the programmes being broadcast. At any one time there are usually three interactive activities out of about twenty that are available on a rotational basis. They tend to be based on popular children's' programmes like "Bob the Builder" – with an interactive activity aimed at colour recognition and matching colours or "Bill and Ben" - a "hide and seek" activity based around the recognition of characters and remembering under which flowerpot they are hidden. Although very simple activities, they can be very engaging for 3-5 year olds. The stories tend to have various options enabling the child to select a specific character or an event and the story then branches off using that character or event.

Early years learning materials - on demand

Subscribers of the Video-Networks video-on-demand Broadband TV service branded as HomeChoice in the London area can access a number of videos in the LearningChoice area. There are some videos on parenting and for early years children. Video clips could lead to a number of interactive 'what if' scenarios relating to a child's behaviour, for example. This same 'interactive space' could be used to inform parents of specific child-related healthcare issues and provide advice and information for encouraging a parent back into work through new learning opportunities.
In the UK, NTL's digital TV cable service has "NTL: Knowledge" as part of its interactive services. This includes a section from the BBC called BBC Learning with various question and answer activities and revision notes covering different aspects of the English, Maths and Science as required by the National Curriculum. The same type of information is also available of the BBC's web site. But on a TV it could be used as an individual activity or more likely as a group activity with parents or a group of students revising together.

SOS Teacher

In the Kingston upon Hull area of NE England on Kingston Interactive Television (KIT) broadband TV service has run a pilot project with BBCi – the BBC interactive service. During the run-up to the examination period for 16 year olds, BBCi ran an extension of their GCSE Bitesize revision service involving local teachers.
When students accessed the service on KIT they were given the option to ask a question to a real teacher via sending an e-mail through the set-top-box or a computer or telephoning in the question. Usually within thirty minutes the team of teachers was able to give the answer via TV. The answers were also saved so students could access them on-demand at a later time.

Education and Training Catalogue

Aston Media, part of the University of Aston in Birmingham, UK is currently using Telewest's digital cable interactive services to enable subscribers to access a catalogue of learning courses supplied by colleges and universities in the West Midlands area. This is an extension of Aston University's distance-learning programme that has been operating since the 1980's, where lectures have been recorded on video-tape and sent out to students by post.

Individualized language learning

In her publication "The Potential of Interactive Television for Delivering Individualised Language Learning", Lyn Pemberton from the University of Brighton describes a very simple model of language skills and maps it on the interactive TV services that are either currently possible or will be possible soon. This model contains four parts – reading, listening, writing and speaking. It is clear that some of these categories of language skills naturally lend themselves to television; while in other cases, it is hard to immediately see how the technology can be of help without the support of other technologies or facilities. [7]

	Written language	**Spoken Language**
comprehension	Reading	Listening
production	Writing	Speaking

Figure 2: Parts of Pamberton's language learning model

- **Listening**

Listening comprehension is a language skill already supported by conventional television. Sherington (1973), exploring the potential of conventional television for language teaching, notes that a number of listening skills can easily be practised via television, including recognising and understanding:

- segmental and suprasegmental features
- vocabulary items, short phrases and longer segments of speech
- syntactic structures
- varieties of speech, such as registers and dialects
- discourse patterns
- pragmatically determined features

Building on current provision of subtitling and captioning is one immediately attractive option for interactive learning, easily implementable if we assume a marked up version of the programme defining relevant segments. While watching mainstream programmes, learners could choose to view either an L1 (native language) or L2 (foreign language) accompanying text to support the speech component, and this text could be varied in completeness, complexity and so on, according to aspects of the learning situation. Some learners, particularly those with literacy problems, might benefit from abbreviated L1 spoken commentaries or explanations, supporting the original speech without obscuring it. This would need to be delivered via headphones in group viewing settings. Other scenarios for acquiring listening skills are not difficult to imagine. Specialised learner handsets might allow querying of the programme, allowing users to see/hear in their language of choice a repetition, explanation or translation of the previous speech. If programmes are viewed offline rather than live, a "back" function could skip back to a marked up point at which a meaningful chunk of speech began. Linguistic or cultural teaching points could also be included either on the screen or on an individualised handset: for instance, an actor's "Ta" could be accompanied by an audio or textual note showing "Thanks," " Cheers," "Thank You" and so on as alternatives. Advanced learners could access explanatory notes, or better, example scenes where the phrases are used in conversation.
An alternative approach, of course, would be to design programmes specifically for language learners. Here the pace could be slower, pauses for user input incorporated into the design and the language and other content tailored for language learners. The interactive functions sketched above could also be used in this context. However this is a more costly alternative, which does not have the flexibility of the enhanced mainstream approach, and which also loses the valuable aspect of sharing a mainstream cultural experience, which some language learners might value. [7]

- **Reading**

Acquiring skills in recognising and understanding written language is less straightforward. One important issue is that of writing system. Some speakers of minority languages will be used to a quite different writing system from the Latin alphabet, while still others will not even be literate in their own first language (with

obvious implications for the design of the interface to these facilities). Sherington suggests that purpose made programmes might demonstrate the various forms of graphical representation, such as upper and lower case, punctuation marks, typescript and cursive script. We could imagine an interactive form of this teaching of reading involving perhaps the matching of keys on a keyboard to the signs on the screen.
Comprehension of more extensive textual elements, perhaps using a multiple choice format, seems a good option for more advanced learners. As working with text while watching a mainstream programme is likely to be cognitively very demanding for a learner, these activities might be best tackled in offline mode, using a personal video recorder or similar technology. [7]

- **Writing**

Learners might also be supported in language production skills, whether of spoken or written language, though scope for learning writing skills does seem limited, and does not, perhaps, integrate as naturally with the technology as the learning of oral skills. For instance, supporting the learning of handwriting as the process of creating written symbols could be supported simply with a pen-based interface to a handset to create a symbol to match one shown on screen.
A more sophisticated approach would incorporate an assessment element, using character recognition technology to assess the learner's success in creating a recognisable symbol or string. However, if we extend the notion of interactivity to include sending emails from the television, the scope for writing activities becomes much wider, and issues such as the possibility of the development of a community of language learners, of the use of pen pals and the direct involvement of teachers and other facilitators are raised. [7]

- **Speaking**

Encouraging spoken language via interactive television is also quite feasible. Simple audiotaped language lessons already ask for spoken learner contributions and there seems no reason to suppose that an individual TV viewer would find speaking to a TV screen any stranger than responding to a tape (though group viewing might well be an inhibitor). In future scenarios, on-screen dialogue agents and "karaoke" style programs, where the learner speaks a character's part, could be produced. It is in assessing the quality of the learner's speech that more complex language processing technologies would be needed, and the pedagogic aspects of any feedback from this would need to be carefully designed. [7]

5. STRATEGY FOR INTEGRATION OF COMMUNICATION SPACES FOR DELIVERING INTERACTIVE TV-BASED LANGUAGE LEARNING

The work on the integration of the different communication spaces (TV, Internet, Mobile technologies, etc.), has been going on for a long time now, aiming to optimize various business processes, education, advertisement, entertainment, science, etc. In [8] Sanaz Fallahkhair explores the potential of convergent media, in this case interactive TV and mobile communication phone, for delivering interactive language learning. He proposes an innovative and workable cross media solution architecture that uses the power of Digital Video Broadcasting (DVB) stream, Java programming environment and Bluetooth technology. Furthermore, this paper discuses the advantages that this architecture might have over current methods of delivering interactive content.
According to this publication there are two ways to use the mobile phone for interacting with television programme: as synchronous or an asynchronous interaction. Synchronous interaction happens while watching a programme. For example: being able to play along with a quiz program, which allows viewer who are registered to receive questions based on the show and to reply using their mobile handsets in real-time (e.g. "Who wants to be a millionaire"). Asynchronous interaction happens during a defined time window prior to or after the television show. Current examples include getting an SMS of the latest news

headlines, receiving weather forecasts, receiving or revising for your exams[1]. Mobile phones offer a form of interactivity that is the equivalent of 'red-button' without the need for a return path to a broadcast server. Furthermore, using mobile phone guarantees the existence of the return channel two-way data services (SMS) and may ultimately provide an additional revenue stream. [8]

For language learning services, we can also imagine both synchronous and asynchronous scenarios. In the synchronous scenario, the learner would be sitting in front of the iTV set and watching news or something else. A graphical item (a "call to action") on the TV screen indicates that a language learning service is available via mobile phone or remote control device (i.e. 'press red button on your remote control', or 'press definite key combination on your mobile phone'). The user decides to use a mobile phone device as a means of interaction and keys in the required number. The client application running in the set-top-box detects a mobile interface and also checks the user authorisation. The mobile application should provide an easy to use graphical user interface enabling the user to interact with the service and request learning content. The learning content in this example is a vocabulary related to the TV programme, categorised by subjects, e.g. health, shopping, ordering food and so on. The learner uses the mobile keys to select a chosen category from the available options. The language learning service processes the request and generates the required vocabulary back to learner's mobile phone, where it is displayed on the screen and optionally integrated into the learner's own "vocabulary bag" or personal dictionary for later use. The scenario using the remote control device to interact with language learning services will be similar to the mobile phone. The only difference is that the user can use the remote control device to make their choices and the learning content will be displayed on the TV screen rather than on the mobile display. In the asynchronous scenario, a learner will be able to use the mobile phone to request learning content for a defined period around the broadcast slot. [8]

Whole description of Fallahkhair's architecture and its advantages will be included in the e-training course "Introduction to Interactive TV-based Learning and Standards" created for Leonardo da Vinci project - **KNOSOS** "New Media Knowledge Village for Innovative e-Learning Solutions".

6. CONCLUSION

The included case studies strictly adhere to a part of the previously-described principles of realization of e-learning process by means of interactive digital TV technology. Regarding the implementation of the process, the last example - Strategy for language learning through iTV in combination with a mobile communication technology - shows that the scheme must be extended to allow integration of different communication spaces in the leaning process.

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