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E-learning for assistive technology professionals—A review of the TELEMATE project

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Abstract

The Telematic Multidisciplinary Assistive Technology Education project (TELEMATE) was conducted during 1998–2001 by a consortium of seven European organisations involved in rehabilitation engineering and education. Assistive technology professionals work in a rapidly developing field but are few in number and widely dispersed, therefore, electronic delivery of their education is particularly advantageous.

TELEMATE took existing concepts and standards in education to create and test an e-learning framework. As well as providing an appropriate learning environment, the aim was to share teaching resources and encourage a sound and consistent understanding of assistive technology across the European Union. This paper explores work carried out and the subsequent outcomes of the project.

Keywords: E-learning; Distance learning; Assistive technology; Telematics; Disability

1. Introduction

The Telematic Multidisciplinary Assistive Technology Education project (TELEMATE) aimed to provide a European-wide network for tutors and students to share multidisciplinary training and education in the field of assistive technology, while ensuring that users of Assistive Technology (AT) and their service providers have the best possible provision and information. The European Commission, in relation with the Telematics Applications Programme, funded the project for three years from 1998 to 2001. In addition TELEMATE amassed recent progress in understanding of disablement in society and up-to-date knowledge of technological developments.

Assistive technology is an umbrella term for any device or system that allows an individual to perform a task they would otherwise be unable to do, or increases the ease and safety with which the task can be performed. TELEMATE focuses on the educational needs of AT professionals and not the end-user of AT. The "users" of TELEMATE are therefore the student professionals and their tutors. However, the empowerment and needs of disabled and elderly people who use AT are at the heart of the educational processes investigated.

Telematics is essentially Information and Communications Technology (ICT), such as video conferencing and the Internet. One of the principal applications of telematics is in the delivery of distance education. While the use of technology in distance learning is not a new idea as television, video, etc. have been used for some time to support students [1] the emergence of e-learning has enhanced the learning experience for both student and teacher and created opportunities to transform teaching methods [2] while at the same time enabling universities to reach increased numbers of students [3]. E-learning offers to many the solution to common obstacles associated with attending educational courses, such as classroom and lecturer availability [4], lack of adequate transportation, accommodation costs and lack of appropriate childcare, if the student is a parent [5]. A key factor behind establishing TELEMATE was that in-service professionals would consider electronic distance learning easier to fit into their pattern of work than lecture attendance. This paper explores work carried out during the TELEMATE project and discusses the subsequent outcomes.

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2. Background

Rapid technological development during recent years has resulted in many new technological services and devices with the potential to greatly improve quality of life for elderly and disabled people. However, the necessary training and education of AT professionals, especially those involved in the design, adaptation, prescription and maintenance of assistive technology, has not always followed the technological advances. Lack of awareness, knowledge and skill reduces the benefits that technological advances can bring.

This concern began to be addressed in the Horizontal European Activities in Rehabilitation Technology study (HEART) [6], launched in 1993 by the Commission of the European Communities. The objective of HEART was to survey the state of assistive technology markets in Europe and its problems caused by fragmentation in order to identify a solution.

The Line E section of HEART [7] focused on education and training, with the main objective to propose a European curriculum for assistive technology at different educational levels for diverse professionals. A comprehensive assessment of teaching and training programmes in AT in Europe and North America was conducted, which discovered that not many AT training programs existed. A common framework for AT training was developed and several recommendations for further work were made. Two of these recommendations were.

2.1. Recommendation 4: Educational material

"Action should include:

- a study about existing educational material in the area of assistive technology training, in Europe and North America, suitable for the purposes of the European curriculum;
- support of the translation and adaptation of existing educational material to the specific technical, social and cultural conditions within the European Union;
- support of the production of new educational material through the co-operation of universities or institutions providing training in the area of assistive technology" [7, p. 7].

2.2. Recommendation 5: Long distance education

"We recommend long distance education courses in assistive technology. It is probably necessary to use distance learning in order to cover all of Europe in a new, relatively small and multidisciplinary subject, such as assistive technology. This is essential for the updating of in-service training of professionals and other actors actively involved in the field" [7, p. 7].

Three projects funded by the European Union under its Framework 4 research programme addressed these recommendations. EUSTAT targeted the actual end-users of AT and their families rather than caring professionals. Its products are available from http://www.siva.it/research/eustat/index.html. IMPACT supported the training of European caring professionals concerned with AT (as opposed to specialists). Caring professionals are those people, such as family doctors, nurses, social workers, home carers and occupational therapists, who regularly act as assistive technology intermediaries. Its products are available from http://www.fontys.nl/impact. TELEMATE focused on AT specialists: those professionals working daily with assistive technology and matching the right technology to the needs of specific persons and situations. This includes specialist engineers, technologists and equipment service managers in addition to the intermediaries served by IMPACT.

The TELEMATE consortium consists of seven partners all involved with rehabilitation engineering, rehabilitation education and distance teaching. Three of them are universities:

- Centre of Rehabilitation Engineering (CoRE), King's College London, represented by Alan Turner-Smith (Co-ordinator);
- Instituto Superior Técnico/Centro Anàlise e Processamento de Sinais (IST/CAPS), Lisbon, Portugal, represented by Luis Azevedo;
- Fern Universität Hagen (FernUni), Hagen, Germany, represented by Rainer Wallbruch.

Two are non-profit research institutes:

- Forschungsintitut Technologie-Behindertenhilfe (FTB), Wetter, Germany, represented by Christian Bühler;
- Societaĭ di Ricerca per l'Organizzazione Sanitaria (SAGO), Florence, Italy, represented by Alberto Renieri.

Two are companies:

- Handitek AB, Borlänge, Sweden, represented by Jan-Erik Wänn and Elizabeth Frisk;
- Rehab-Nor AS, Tomter, Norway, represented by Øivind Lorentsen.

3. Method

Practical objectives of the project were:

- to classify a curriculum based upon course user needs;
- to record existing accreditation procedures for professionals in the EU working in the field of AT;
- to create an appropriate framework for a curriculum in assistive technology that can be maintained and extended as the field develops;
- to establish appropriate delivery methods for the widely varying topics in AT education and training;
- to set up maintenance procedures that will attract the support of as extensive a range of education, service and user institutions as possible;
- to collate existing courseware and select appropriate modules for a demonstration course;

Table 1
Educational background of AT professionals

HEART area	Basic profession	Underpinning disciplines
Human	Medical/welfare	Anatomy, physiology, biomechanics, disabilities, psychology, sociology, knowledge transfer, and ethics
Socio-economic	Administration	Management/service delivery, standards/testing, legislation/economics
Technical	Engineering	Mechanics, electronics, physics, information technology, etc., and their practical embodiments in at devices classified under communication, mobility, manipulation and orientation

The TELEMATE framework assembles the many elements of education and training needed in understanding and providing Assistive Technology. The Heart report E3.2 (Azevedo et al. [7]) identified three areas of education and training: human, socio-economic and technical.

- to build demonstration courseware to be delivered by a range of methods to both in-service and pre-service students: collegiate and distance-learning, conventional and telematic;
- to deliver the courses and to verify their performance and the performance of the maintenance system;
- to disseminate the findings and open structure of TELEMATE to encourage future continuing involvement and networking of education, service and user institutions across the EU.

The project was delivered in the following five phases:

- analysis of user requirements;
- definition of functional specification;
- building of demonstrator courses;
- validation of demonstrator courses;
- exploitation plan.

3.1. Analysis of user requirements

In order to update knowledge of existing AT courseware following the HEART study [6], a limited survey was undertaken by the TELEMATE consortium, which, in addition, researched accreditation and requirements of the course users. Each partner surveyed his/her own country and several others. A total of 25 countries were surveyed, 19 European plus 6 others. Each consortium partner set up a "National Advisory Group" composed of significant professionals within their country. The group was intended to be a multi-professional forum to stimulate discussions and ideas for input to the TELEMATE project.

3.2. Definition of functional specification

The goals of this phase were to:

- establish a course curriculum framework;
- determine the most effective method to deliver the courses;
- develop procedures to maintain the courses and to handle Intellectual Property Rights (IPR).

Reports produced for the above three objectives were made available on the TELEMATE website (http://www.telemate.org) and advertised through the National Advisory Groups and via leaflets. The aim of this was to stimulate feedback to guide the consortium in producing a final educational structure acceptable and appealing to all AT practitioners.

A TELEMATE course was determined to be one that

- has modules with an allocated classification within the TELEMATE framework, defining its relationship with other TELEMATE modules;
- is available in all EU countries;
- downloadable by telematic communication to user or;
- delivered by local educational institution with telematic links;
- includes quality control and validation;
- respects the intellectual property rights of authors.

The knowledge framework for inter-disciplinary education in AT was based on the following premises:

- professionals involved in AT generally come from three educational backgrounds described in Table 1;
- professionals in the AT team all require access to a common core of knowledge in the field (the fundamentals of the knowledge framework);
- professionals require cross-disciplinary education depending on their educational background.

The implication is that the field requires both common core (the fundamentals) and cross-disciplinary education. This requirement is represented diagrammatically in Fig. 1.

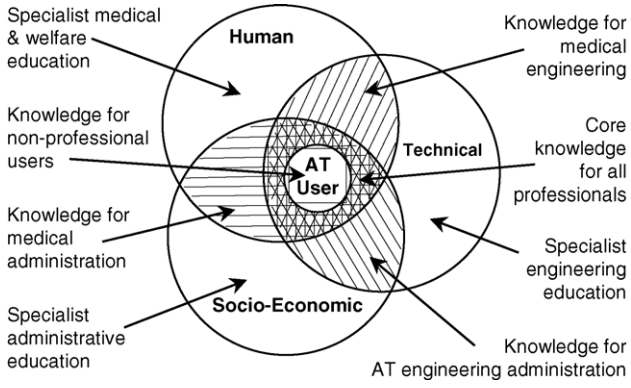

Fig. 1. TELEMATE course–user backgrounds. The three circles represent the body of professional knowledge that medically or welfare-trained people, engineers and administrators or managers would bring to AT. The important cross-disciplinary areas are represented by the shaded area.

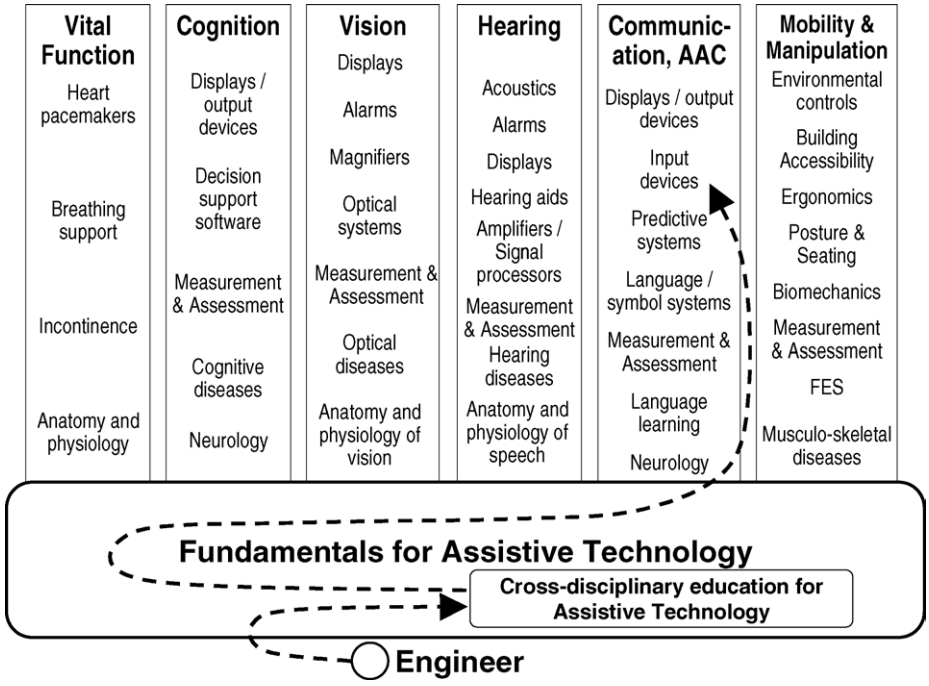

Fig. 2. The relation of Fundamental and Specialist elements in AT education. The broken line illustrates an engineer' path of education to final specialisation in AAC.

Whatever the background, the foundation for all application areas of AT is an understanding of disablement as a phenomenon within a personal, social, medical, environmental and technical context. These topics hold a fundamental place in the education and training of every AT professional. Within this foundation lie programmes of cross-disciplinary education that enable professionals who have been initially trained in other spheres to understand each other's competencies and to communicate and work effectively together.

Fig. 2 illustrates six functional areas in which AT is applied and their relationship to the basic principles of rehabilitation. For example, an engineer wishing to specialise in input devices for Alternative and Augmentative Communication (AAC) would first need grounding in the fundamentals of rehabilitation and an understanding of the disciplines of the other professionals with whom he or she will be working.

Fig. 3 illustrates the classification of courses on the TELEMATE website. Courses are classified firstly under the headings of the six functions and secondly under the context in which the AT is used. Where appropriate, separate modules within comprehensive courses are individually classified. The website specifies

- a classification of course modules by entry requirements and topics;
- a standard to enable mix and match of modules, including cross-disciplinary training;
- a database for tutors and students with:
  - guidance to available courses,
  - recommended approaches and validation procedures and
  - a classified guidance to resource material.

It provides a platform to initiate the dialogue between providers of AT courses and those wishing to find out what is available, with the aim to encourage the creation of appropriate new courses as well as steering students to existing courses.

The matter of course accreditation for European distance education was found to be fairly straightforward on an academic level since the European Credit Transfer System (ECTS) was introduced in 1989 by the European Commission [8]. In ECTS, 60 credits represents the length and workload of a full academic year of studies, half a year gives 30 points and so on. There is also a system to make the different grading scales within Europe more transparent without changing them. Concerning vocational training, there is however no specific procedure for recognition. As the TELEMATE project was mainly concerned with an academic levels 5 and 6, the ECTS scheme is well suited and can be used (see Fig. 4).

3.3. Building of the demonstrator courses

While members of the consortium had a considerable volume of teaching material between them, it was not in a consistent form, or well adapted to telematic presentation. The selection for which two pilot courses should be used was based on courses most in demand, with most material available and able to demonstrate different methods

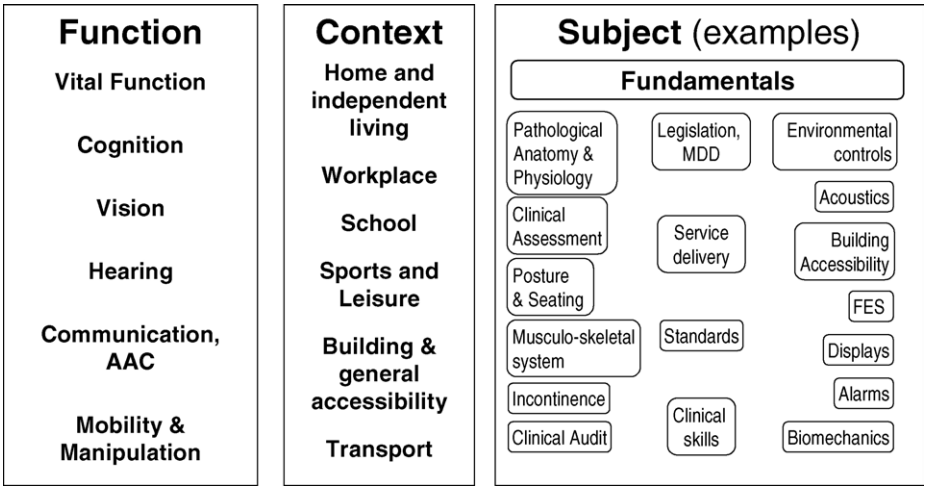

Fig. 3. Classification system for TELEMATE courses.

of presentations. Additional input came from the advisory boards and the HEART line E report [9] of different professional group preferences.

Two demonstration courses were produced:

- The Fundamentals for Assistive Technology;
- Computer Access.

Both courses were realised in html and also adapted for delivery via the teaching software package webCT. Samples of both courses can be viewed at http://prt.fernuni-hagen.de/pro/telemate/main.html. It was determined that the courses should be delivered through a central server on which all additional links are stored. This central server allowed the courses and more especially the links to other resources, to

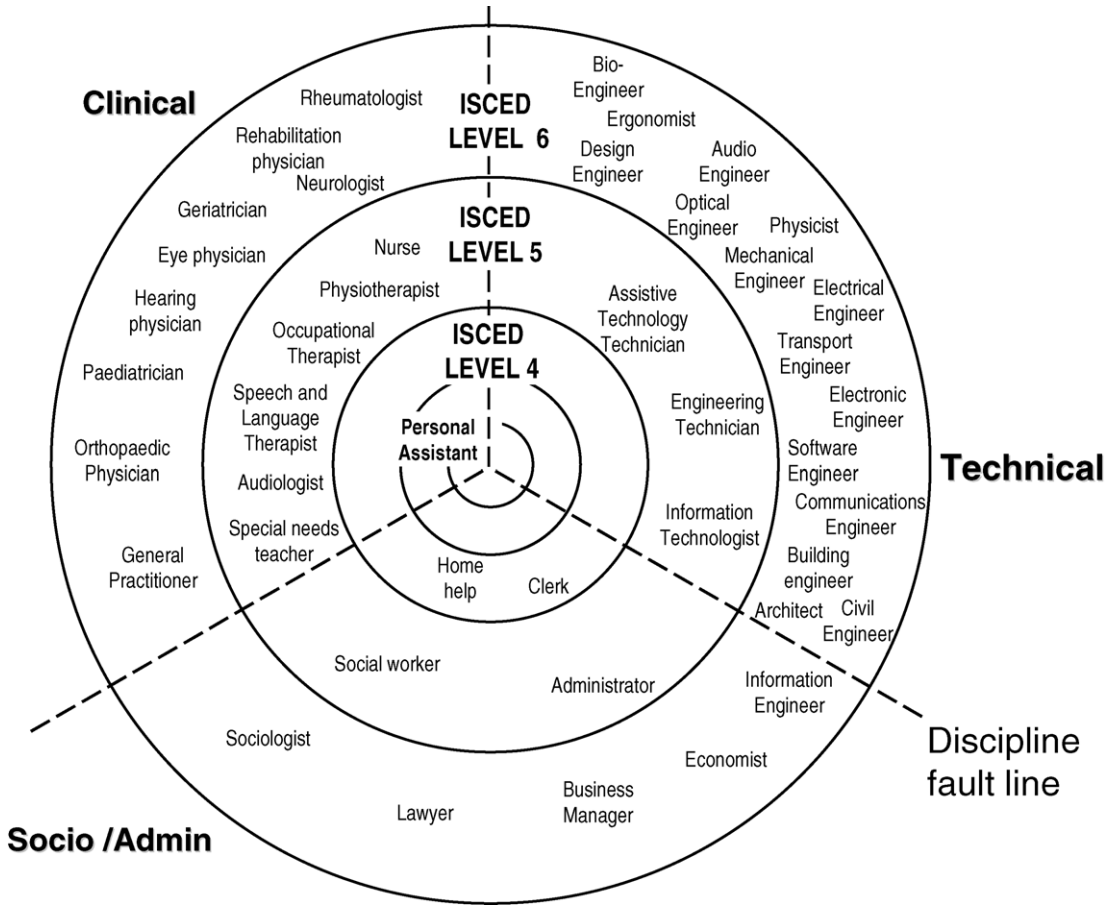

Fig. 4. Examples of AT-related professional specialities and likely academic levels "ISCED" is UNESCO's International Standard Classification of Education.

be kept up-to-date by checking and changing at only one locality.

The Fundamentals for Assistive Technology course had previously been identified as a vital basis on which other Assistive Technology courses should be built. Course material was produced by Rehab-Nor, outside the TELEMATE contract, based upon material and experiences gathered over the years. The goal of the course is to provide a setting for all professionals in rehabilitation and to arrive at a common basic understanding of disability, rehabilitation and assistive technology, and furthermore, to set a scene for discussion and work across disciplines and sectors. The course content consists of the following six modules:

1. introduction to disablement;
2. user and user characteristics;
3. modern rehabilitation principles;
4. assistive technology—definitions and roles;
5. assistive technology—AT service delivery;
6. concluding remark.

The *Computer Access* course was adapted from existing classroom courses offered by several consortium partners, including material originating from SAGO (Italy), Handitek (Sweden) and the ACE Centre, Oxford (United Kingdom). The course is primarily directed to the field of motor and cognitive impaired person and is written from a technical point of view. The course content consists of:

1. basics of computer technology for AT professionals;
2. benefit of computer access;
3. requirements on computer users/which skills are necessary to use a computer;
4. general trends/mainstream;
5. basic principles and devices for computer access (CA);
6. basic preconditions for CA;
7. service preconditions for CA;
8. service delivery infrastructure;
9. case studies.

It was proposed that students would be accompanied by a tutor to guide them through the course, communicating via email.

In addition to flexibility regarding student autonomy of when and where study is carried out, Internet based learning manages the learning process providing both resources and administration [10]. Web pages are exciting and stimulating and present the advantages of hypertext, bulletin boards, graphics, sound and video, “enriching the learning process” [11, p. 29]. However, Nunes and McPherson draw attention to Wills and Alexander [12] who warn “Technology in itself does not change or improve teaching and learning. Attention to management processes, strategy, structure and most importantly roles and skills, are the key to successfully introducing technology in university teaching and learning” [3, p. 430].

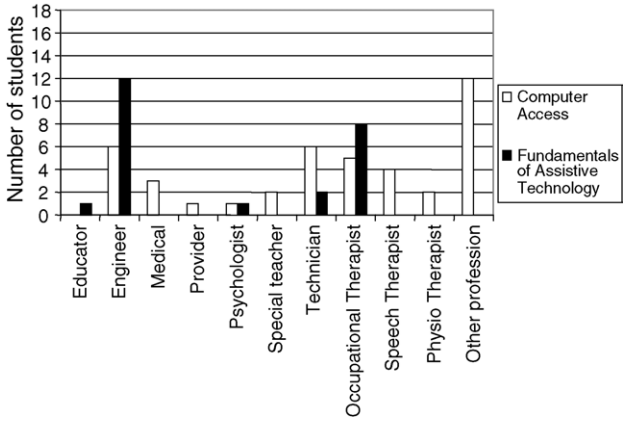

Fig. 5. Professional backgrounds of students who tested the TELEMATE courses.

3.4. Validation of the demonstrator courses

In order to provide the TELEMATE consortium with feedback regarding the effectiveness of the telematic methods proposed and used to deliver the courses, consortium partners (CoRE, CAPS, SAGO, REHAB-NOR, HANDITEK and FERN) delivered demonstration courses at their sites. Data was collected from a total of 66 students/course users, most of whom volunteered with the exception of students at HANDITEK, Sweden, at which both courses were elivered as a compulsory part of the students’ rehabilitation engineering training program in cooperation with the University of Dalarna. The demonstrator courses were hoped to be the first of many courses provided through the TELEMATE framework by the present partners and by future members of the consortium.

Delivery of the courses was mainly telematic (Internet) based, the courses were made available on specific websites of three different partners. Traditional delivery methods were also used, for example CD-ROM format and in some cases face-to-face meetings. The TELEMATE students came from a wide variety of professions and backgrounds as shown in Fig. 5. Engineers, psychologists, architects, technicians and occupational therapists attended both the courses. Two educators attended The Fundamentals in Assistive Technology course. Medical doctors, an assistive technology provider, special teachers, speech therapists, physiotherapists and other professions or fields of study (architecture and students in rehabilitation engineering, computer programming, cognitive science and general economics) attended the Computer Access course. Occupational therapists and engineers represented the highest number of professionals taking the courses. Most of the students were in-service professionals.

Before the course, students completed a questionnaire regarding their backgrounds, the equipments they used during the courses, the time they planned to spend on the course and their expectations. A second questionnaire was completed immediately after the course was completed to gain insight

into the student's opinion of the course, necessary to improve future work.

3.5. Exploitation plan

The TELEMATE consortium recognised the necessity for a formal Intellectual and Property Rights and Exploitation Agreement. It was determined that the European Commission own the IPR of the TELEMATE framework and the consortium will use the results on a non-profit basis. Students wishing to access the course must do so through a tutor and be registered at the tutor's institution and the host institution.

Ownership of material on websites is problematic. To solve this, a set of guidelines were produced. As parts of the TELEMATE framework are structured as a database, they are protected by the "Database Directive" of the European Parliament [13]. This directive enlarges the protection of the intellectual properties on databases and regulates the usage and duplication. That means, every organisation running the TELEMATE framework has to hold the right of use, otherwise no implementation, maintenance and modification would be allowed except directly through the community.

4. Results

4.1. Existing courses and analysis of user's needs

In the TELEMATE project "user" is defined as "user of education/training within the AT field". According to this key user groups in the project are:

- technicians/engineers (working with AT/in AT related fields);
- occupational therapists;
- physiotherapists;
- speech and language therapists;
- special teachers;
- psychologists;
- medical doctors (specialised in relevant areas);
- nurses (working in rehabilitation units and as community nurses);
- nursing assistants (mainly working at community level, in the homes of the disabled persons);
- social workers.

Most of the Assistive Technology education and training identified in the survey is rooted in the basic education of professionals, such as occupational therapists, physiotherapists and speech therapists. At the time of the survey, only a few educational programmes had been established in Europe, leading to a comprehensive educational background in AT, on the undergraduate level as well as the postgraduate level. Several of the sources surveyed claimed that the embedded part of AT in regular training is quite limited. However, in several countries a substantial number of short courses (10–30 h) are given on specific topics, such as on seating, wheelchair provision, AAC, IT—disability oriented topics, AT for cognitive impaired, listening AT, for hearing impaired and others.

Response rates to the courseware survey were lower than hoped. Out of the 25 countries explored information was gathered on 19. One general conclusion drawn from the survey was that the developments in education and training within the AT field had remained very slow in Europe since the HEART Line E study [6]. Thus, there appears to be an overwhelming gap between current needs of professionals in the field and the actual situation today. This was more or less the case in all the European countries.

In line with the deficiency of educational opportunities in the field it was concluded that requirements and framework for accreditation in the partner's countries are almost non-existent (although there have been some very recent developments towards statutory registration for AT practitioners in UK and Sweden). This has an important implication for mobility of staff. Without recognised systems of accreditation in place the competence of staff in one country cannot be judged for application in another. The TELEMATE initiative has helped address this issue by opening dialogue.

The material gathered highlighted several practical challenges that needed to be met:

- Establishment of educational programmes that reflect the characteristics and the fundamentals behind assistive technology, service delivery and its role in habilitation/rehabilitation.
- Provision of educational frameworks for interdisciplinary approaches. Education and training of the many different professionals.
- Provision of a balanced programme between embedded AT education in basic training, special postgraduate AT education of professionals with a multiplicity of professional backgrounds, and in-service training.
- Provision of educational programmes both to support centralised education as well as long distance in service training.
- Rapid development and formal recognition of educational programmes and frameworks to meet the needs if increasing demands and changing national policies.
- Fully utilisation of the potentials of new technologies in effective training of professionals.

4.2. Delivery of the demonstrator courses

Analysis of the Questionnaire responses proved the value of the courses and also provided guidance on the development of further material for the field. The main findings were:

- *The courses have European value*: Independently of their country of origin. The English text was easy to understand.
- *The material was well presented*: (87% of students ($n = 60$) agreed material was well presented) but should continue to be improved to as professional a standard as possible because it will be compared with courses having vastly greater resources (engineering, medicine, etc.).

- *The multidisciplinary approach was successful*: All the professionals involved valued the courses. Different but complementary approaches to the same problems were able to be explored because, at most sites, there were different professionals taking the same courses together. 77% of students ($n = 60$) felt the course had stimulated their interest in AT. More than half of the students thought their knowledge of AT had improved during the course.
- *Telematic delivery was an advantage*: The possibility of working together in different geographical places, the constant availability of the lectures through the Web independently of the time of the day, web links students worked together in widely separated geographical locations, at times to suit themselves. The Internet links were a teaching asset. However, a CD-ROM was a valuable means of overcoming current Internet access problems. 53% of students ($n = 60$) thought it would be important to complement the course with written materials. 25% of students ($n = 60$) thought more multimedia should be used, particularly in the Computer Access course.
- *Supervision is desirable*: Some topics will need more person-to-person interaction than others. Students and tutors value face-to-face meetings.
- *Enough time should be allowed*: 43% of the students ($n = 60$) thought there was too much educational material to be covered within the given time. In relation, 38% ($n = 59$) of students did not submit all the required course exercises.

The questionnaires were required to be sent electronically, which raised some problems for students as the questionnaires were only accepted by the system if all the items were filled in. For example, some students were not able to answer questions about the technical characteristics of the computers they were using. This was later modified so that the system accepted answers to the evaluation questionnaires independently of the number of the number of items filled in. On one hand, this simplified the filling of the questionnaires but on the other, if students did not answer all the items, less data was available for statistical analysis.

Regarding the Computer Access course, as it contained a large amount of data due to many videos that were part of the course, access online to the course's content was very difficult for students who had slow, non-permanent connections. Based on that limitation, some demonstration sites decided to deliver this course on a CD, while still preserving up-to-date links to websites by directing links via a central, well-maintained server.

Some demonstration sites had face-to-face meetings between the students and tutors, while others decided not to. Most who decided to have face-to-face meetings used them at an initial presentation and final conclusion (evaluation) of the course. Besides that, there were always possibilities of contact between the students and the tutor by email. Rehab-Nor held discussions related to basic concepts and fundamentals in rehabilitation. This turned out to be stimulating for the students, however, they reported that there was little time for discussion.

Most students taking the Computer Access course found communication/augmentative and alternative communication to be the most interesting AT aspect, while most considered mobility topics the most interesting element of The Fundamentals for Assistive Technology course.

On the basis of the demonstrator courses, completely new taught courses have been funded in Norway and UK. Rehab-Nor has organised a series of process-oriented courses in the field of rehabilitation for professional staff in municipalities. The courses are based upon the basics of the Fundamentals Course, and have given valuable experiences to Rehab-Nor for further exploitation. CoRE has received a major grant from the UK Engineering and Physical Science Research Council, to develop a masters course in Assistive Technology based on the TELEMATE structure and incorporate its demonstrator courses.

5. Discussion

Six in 10 individuals think it is possible to learn as effectively through e-learning as other means [14]. The growth of e-learning is a phenomenon due to a number of factors, such as the PC boom and rapid development of the Internet [3]. McLucan [15] was the first to use the term "the global village" meaning that with modern technology, the whole world would become much "smaller". A third telling expression is the "virtual classroom" coined by Starr [16] in 1994.

Klein and Ware [17] predict CPD requirements will increasingly be satisfied through the use of learning resources available on-line or packaged into specially tailored e-learning courses. Most of the in-service professionals who would benefit from TELEMATE are those who have been in practice for some years, who have to adjust to education and training once again. In addition, they are generally unable to attend many lectures at a national training site due to the time constraints of vocational and domestic commitments.

However, e-learning is not without its weaknesses. Forman et al. [18] warn that not every student can benefit from e-learning courses. Wheeler states a key difficulty is "The effect of being separated from both peers and instructors" [19, p. 419]. Recent research carried out by the campaign for learning [14] highlights negative aspects of e-learning, particularly that it is often considered impersonal, frustrating and lonely. 46% of respondents to a survey felt the main disadvantages of e-learning is that it is easy to waste time (46%) and that computers crash (30%). There is also some criticism of learning programmes and software that is difficult to find (30%), poor quality (20%) and too gimmicky (20%).

The lack of traditional student contact is also discussed by Kruse [20] who stated "Reduced social and cultural interaction can be a drawback. The impersonality, suppression of communication mechanisms, such as body language and elimination of peer-to-peer learning that are part of this

potential disadvantage, are lessening with advances in communications technologies". Likewise, McVay-Lynch [21] recognised the existence of technological barriers and the need for a positive student experience. Similarly, one of the main conclusions drawn from analysis of student responses to the TELEMATE demonstration course is that interaction with tutors and students is desirable.

The issue of e-learning and retention has been addressed by a number of authors. Jones et al. point out that current levels of retention need to be improved before e-learning can be considered viable by most Higher Education Institutions. Generally, drop out rates ranging from 30 to 75% have been concurrent with e-learning courses in the United States [21]. This problem affected two sites where the demonstration courses were delivered. At Fern University, one out of the nine students who undertook the course did not complete it. At Rehab-Nor, out of the 12 students who originally signed up, 5 withdrew due to a combination of heavy workload and exam study.

Since the TELEMATE project, a study carried out by the University of Glamorgan [2] examined student retention associated with "BA Enterprise" an online programme initiative primarily aimed at creating and improving entrepreneurial and managerial capacity in areas of Wales deficient in such activity. This distance-learning platform (with local partner further education colleges located throughout the areas) was intended to aid individuals and communities to generate their own economic development solutions. The study focused on 44 students within the College Sir Gar, Partner College where 23 students (52%) withdrew from the course due to various work and course related problems. Increased pressure of work was the most frequently identified cause of withdrawal cited by 40% of respondents 96% were employed, 65% were self-employed. 15% identified their IT skills as a reason for withdrawal from the course. Predictably, some students withdrew, as they were unable to complete the required coursework. 30% said it was not the right course for them quoting a variety of reasons including a lack of enjoyment of the subject matter and the method of learning not suiting their learning style. Comments included "lacking interest in subject matter" and "not meeting my needs", lacked applicability to my current job" and preferred the chalk and talk and intimacy of an actual lecture".

In the field of assistive technology, significant developments have been made in Canada. In 1997, The Rehabilitation Centre in Ottawa, affiliated with the University of Ottawa, teamed up with nine other health care facilities to implement a sustainable "Telehealth" system to improve physical rehabilitation services. Today, all partners in the "Physical Rehabilitation Distance Communication Initiative" [22] use the Internet to provide remote clinical consultations and continuing education sessions as part of everyday practice. The site is also accessed by several American Nursing Programmes for task specific training, such as wheelchair transfers. Impressive e-learning material is published on the Rehabilitation Centre in Ottawa website http://www.rehab.on.ca/mobile/present_e.html and is intended for use for continuing education of Health Care providers. Four areas are covered mobility, therapy/treatment, prosthetics/orthotics and general rehabilitation. Topics covered include:

- basic principles of wheelchair seating;
- positioning a person with a stroke when lying in bed;
- donning an above knee prosthesis;
- wheelchair accessibility in the home.

The Centre on Disability at California State University offer an AT Application Certificate Program, earned by following 100 h of study via 52 h of online training and study, 40 h of live training (workshops, etc.) and an eight hour project. Over 1800 graduates have taken advantage of this "blended learning" approach, which combines traditional and e-learning, enhancing the learning experience while preserving traditional values of higher education [23].

A number of other interesting projects have been conducted in America. The Assistive Technology Training Online Project implemented by The University at Buffalo involved the development of a model programme aimed at providing online information and tutorials on the use of AT, particularly adapted computer technology, such as electronic head pointers and alternative augmentative communication, to facilitate disabled school children. The tutorials can be accessed not only by relevant professionals, but also by parents and children. Topics covered include a tutorial on "Braille Note", a note taker providing a portable reading and writing system for blind students.

A similar project called Special Needs Opportunity Windows (SNOW) is a provider of online resources and professional development opportunities for educators and parents of students with special needs. The site http://snow.utoronto.ca produced by several partners in conjunction with the University of Toronto provides information and online workshops, most of which are free of charge and self-paced. The "Introduction to Adaptive Computer Technologies" workshop covers topics including adaptive hardware, input and output devices and recent developments in software. The course format incorporates sample case studies, a review of web-based resources and the opportunity to design a program based on a hypothetical student with special needs.

The "Wheelchair University" an online community developed by the University of Pittsburgh available at http://www.wheelchairnet.org contains a huge variety of online resources including bibliographic databases, a series of slide lectures, article reprints and an active discussion area. It is aimed at rehabilitation professionals, wheelchair users and anyone with an interest in wheeled mobility. The site is intended for use as informal self-education.

An MSc in Assistive Technology, for which the TELEMATE project played a huge role in its creation, is available online within the Kings College London "Virtual Campus". Course news, handbook, timetables, lecture notes and resources, assessment details and information on

research projects are all available electronically. The virtual campus ensures students on placement or at home have access to the same networked facilities as students that are onsite.

6. Conclusion

In summary, the outcomes of the TELEMATE project have been:

- an updated international survey of existing courses;
- A conceptual framework for multidisciplinary education that can be applied in and beyond the field AT;
- guidance documents for the creation and maintenance of compatible courses that can be delivered by telematic means;
- assessment tools for these courses;
- two demonstrator courses (on Fundamentals for Assistive Technology and Computer Access) adapted from pre-existing and separately funded material.

In addition to the contracted products, the TELEMATE partners have

- created an on-line database of courses to which everyone may add freely;
- directly inspired the creation of and support for new high quality AT courses and methods of service delivery in UK, Germany, and Norway;
- provided European support and material to improve existing courses in Portugal and Sweden;
- created an on-going network of educators that bound by an IPR agreement for two years following the project completion.

TELEMATE has spearheaded the way forward for e-learning in the field of assistive technology in Europe and has demonstrated the benefits. Klein and Ware predict "the market will split: traditional learning will increasingly adopt greater components of e-learning, while stand-alone or "pure" e-learning will continue to occupy a viable but niche market position" [17, p. 38]. Despite its limitations e-learning has enormous potential for use as a component of Assistive Technology education.

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