UNITED NATIONS EDUCATIONAL, SCIENTIFIC
AND CULTURAL ORGANIZATION

EXPERT MEETING

INFORMATION AND COMMUNICATION TECHNOLOGIES IN TECHNICAL AND VOCATIONAL EDUCATION AND TRAINING

26-27 April 2002, IITE, Moscow

Final Report and Selected Materials

UNESCO INSTITUTE
FOR INFORMATION TECHNOLOGIES IN EDUCATION

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Issues of the application of information and communication technologies (ICTs) in technical and vocational education and training (TVET) within the framework of the IITE project *Information and Communication Technologies in Technical and Vocational Education and Training* were the subject of the international expert meeting held in Moscow by IITE on 26 and 27 April 2002. Fifteen leading professionals from Canada, India, Italy, Netherlands, Norway, Russian Federation and from such international bodies as International Labour Organisation (ILO), United Nations Industrial Development Organization (UNIDO), UNEVOC-Canada and World ORT gathered in Moscow to discuss these questions. The results of this work are presented in the Final Report and Selected Materials.

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FINAL REPORT

EXECUTIVE SUMMARY

International expert meeting *Information and Communication Technologies in Technical and Vocational Education and Training (ICTs in TVET)* was held on 26 and 27 April 2002 at the UNESCO Institute for Information Technologies in Education in Moscow.

The main goal of the expert meeting was to overview the existing international experience in the sphere of ICT usage in technical and vocational education and training, to determine the most important issues and outline strategic directions of the project development, to create an international expert team for its accomplishment.

To attain this goal, IITE circulated Information Letter among the relevant UNESCO structures, national and international institutions dealing with TVET with the proposal to nominate participants for the expert meeting (see Annex 1. *First Announcement*). After the nomination personal invitations were sent to the experts.

In order to ensure fruitful work and positive outcome of the meeting, information materials and reference documents were prepared and distributed in good time among the participants (see Annex 2. *List of Documents*).

Fifteen experts from Canada, India, Italy, Netherlands, Norway, and Russian Federation, and from such international bodies as International Labour Organisation (ILO), United Nations Industrial Development Organization (UNIDO), UNEVOC-Canada and World ORT met to share their experience at the meeting (see Annex 3. *List of Participants*).

The meeting started with the introductory speech of Prof. Valery Meskov (IITE), who welcomed the participants and spoke on IITE programme activities and development stages of IITE projects.

After discussing the main goals and procedure of the meeting, agenda and timetable were adopted (see Annexes 4, 5). Dr Chris Chinien (UNEVOC-Canada) was elected Chairperson of the meeting and Ms Julieta Leibowicz (ILO) – Rapporteur.

According to the Agenda and the Information Materials prepared by IITE for the meeting and distributed among the participants, the following issues were discussed during the thematic sessions:

Expert meeting. Discussion

- Identification of UNESCO Member States needs for ICT usage in TVET for the 21st century labour market:
  - new world economy and labour market;
  - labour market and job skill trends;
  - workforce development and TVET.

- Evaluation of ICT role in TVET:
  - TVET and general education;
  - role of ICTs in methodology, didactic and TVET content;
  - role of ICTs in TVET management and delivery.

- Main trends and perspectives of the IITE international project *Information and Communication Technologies in Technical and Vocational Education and Training (ICTs in TVET)*:
  - national and international projects and success stories;
  - IITE international project *ICTs in TVET* – goals and target groups;
  - terms of reference for the project and working group programme.

First Thematic Session

Dr Chris Chinien opened the first thematic session *Identification of UNESCO Member States Needs for ICT Usage in TVET for the 21st Century Labour Market* with his presentation *Assessing the Effectiveness and Efficiency of ICTs in Technical and Vocational Education and Training* (see Selected Materials). Dr Chinien gave a brief description of knowledge-based economy and its influence on the structure of labour market. The changes in technical and vocational education arising from ICT implementation in teaching-learning process were discussed together with the possible roles of ICTs as a technical assistance for teaching, a teaching tool, a working tool for students, and a system control or a workshop tool. The expert touched upon the difference between effectiveness and efficiency, the matters of insufficient effectiveness of ICT usage in TVET and tried to reflect on the reasons of this insufficiency, suggesting the weakness of learning theories to be one of them.

**Dr Ch. Chinien,
UNEVOC-Canada**

As a means to solve this problem the mechanism of formative evaluation was proposed and described in details. Main features of good practices of ICTs in TVET were listed, including the issues of cost evaluation and effectiveness.

Challenges of widespread technology implementation in education were discussed with respect to hardware and software outlays, equal access insurance, appropriate strategies of technology integration across curricula, availability of teaching-learning materials, copyright issues, teacher training and development.

A framework for assessing the effectiveness of prototypical ICT learning materials for technical and vocational education and training was presented and discussed by the experts with great interest.

During the general discussion the lack of governmental control over educational software production was stated as one of the reasons for its poor quality. The experts agreed that only elementary school software could be considered more or less suitable. Single examples of successful software for learning are known in international educational practice of the last several decades. In this realm a very close contact between education software producers, decision-makers and end users becomes a crucial factor.

Dr P. Kommers,
University of Twente, Netherlands

Dr Piet Kommers continued the first thematic session with his presentation *Virtual Environments for Flexible Industrial Vocational Training – New Media Scenarios for Embedded Corporate Training and Life-Long Learning* (see Selected Materials). The expert briefly demonstrated the role of University of Twente in educational research in the Netherlands and introduced his own vision of the expert meeting goals. Short historical retrospective of Media and Learning interaction was given and illustrated with glaring examples of information and media technology influence on education and everyday life.

Depicting globalization, liberalization and expansion of information technology (IT) as the basic trends of societal development, Dr Kommers described the transforming nature of life-long learning in the modern society. Alternative evolution of teaching-learning models was presented as a basis for learning and schooling evolution.

New teaching-learning models and solution examples of graph computation, virtual reality and Internet-based decisions were shown.

Dr Alexandre Giglavy finalized the reflection on the problems of new world economy, labour market, job skill trends and workforce development in his report *Managing Teenagers' Research Projects: Productive Workforce Development Paradigm*.

Dr Giglavy introduced the experience of the Moscow Lyceum of Information Technologies in the application of project-based learning and practical training methods in ICT-based education, and described current trends in workforce development and particular features of the vocational education for high-technology economy. Main features of ICT-based projects were presented and discussed in details with the examples of real projects developed by students of the Lyceum. The information on educational publications and resources on the Internet caused great interest of the audience.

Dr A. Giglavy, Lyceum of Information Technologies, Russian Federation

Second Thematic Session

Ms J. Leibowicz,
International Training Centre of the ILO

Ms Julieta Leibowicz started the second thematic session *Evaluation of the Role of ICTs in TVET* with the presentation *Training Technology Competence Standards* within the framework of the International Training Centre of the ILO *Distance Education and Learning Technology Applications* (DELTA) programme. Having described the tasks and functions of the programme, Ms Leibowicz introduced a systematic dynamic pattern for organization and management of technical and pedagogical contents of training technology based on the demand-driven approach. The functional maps (see Selected Materials) were presented, including designing training programmes; designing, producing, and adapting learning media; delivering training programmes; evaluation of training programmes for various kinds of training personnel. Databases of training modules and assessment tools were described. These databases together with the functional maps constitute a competency-based model, which provides the following advantages:

- selection and recruiting of personnel engaged in training;
- individual career planning and progression;
- identification of training needs;
- assessment and certification of competence;
- increased training evaluation capabilities for individuals and organizations.

The forces driving and opposing the application of ICT competence approach were discussed in the framework of training projects for open and distance learning.

Dr Sergey Gorinskiy continued the second thematic session with his presentation *ICT Usage in Technology Education and Vocational Training: World ORT Experience* (see Selected Materials). He emphasized the difference between technical and technological education describing technology, as "...a creative purposeful activity aimed at meeting needs, wants and opportunities through making products and offering services according to previously defined goals." Then he gave a brief discourse into historic roots and main features of technological education and accentuated the importance of *technology education* in the knowledge society.

Dr S. Gorinskiy, World ORT

The history of World ORT education system was presented and directions of ICT usage at ORT Technology Schools and Centres were described as:

- a part of general technology education;
- specialized pre-vocational training at high schools;
- educational technology for teaching;
- e-learning technology;
- means for student project development;
- media for school information space;
- means for teacher training programmes;
- school technology centres' facilities.

Each direction was described in details and illustrated with the examples.

Dr Gorinskiy concluded his presentation denoting that the *technology education* is an integral part of modern general, higher, vocational education, training and retraining; and that ICT usage in technology education is an integral tool for the development of modern educational system.

Prof. K. Subramanian, National Informatics Centre, Ministry of Communication and IT, Government of India

Prof. Krishnamurthy Subramanian proceeded the second thematic session presenting *IT as a Catalyst for Human Resource Re-engineering in Knowledge Networked Environments*. The expert introduced a professional pyramid of principal levels and types of vocational skills and described the application of different generations of computers for IT solutions in re-engineering and development of these skills. Prof. Subramanian spoke on the main tasks of industrial reforms in relation to specific situation in India and other developing countries and countries in transition. Virtual education was proposed as a means to implement these reforms; a structure and main functions of a virtual university were given. Prime challenges of the 21st century knowledge societies were discussed and specific features of knowledge management systems were described in connection with open education and virtual universities. Future road-map for the development of ICTs in education was suggested, including:

- careful selection of appropriate technologies;
- cost-effective implementation criteria usage;
- sharing of possible resources;
- cooperation and partnership approach;
- decentralization and distribution of responsibilities.

Mr O. Johannessen, Technical and Vocational College of Haugaland, Norway

Closing the second thematic session Mr Odd Johannessen spoke about his experience of ICT implementation in TVET in his presentation *How to Organize Schools in Order to Facilitate a Pedagogical Use of ICTs in the Learning Process* (see Selected Materials).

He shared his personal professional experience that made him realize vital importance of ICT usage in everyday vocational activities.

Speaking about the organization of the educational process in Technical and Vocational College of Haugaland, he pointed out that alongside with school architecture and organization, there should be proper equipment to stimulate learning. In relation to the purposes of vocational education and its content, it was noted that alongside with the necessary practical skills, a successful contemporary worker must acquire responsibility, creativity, will to learn, teamworking skills, independent thinking, flexibility, ability to solve problems and find smarter decisions, ability to obtain and process information. To achieve these goals, the contemporary ICT-based educational media should be implemented into educational process to stimulate process-oriented, problem-based, and project-oriented learning. The role of Intranet was mentioned to be a platform for learning, which provides more flexibility in obtaining information, in communication between a teacher and a student, and realization of individual approach to each student. In this connection the new role of a teacher was noted that implies supervision and guidance in acquiring information instead of being a source of information.

Third Thematic Session

This part of the expert meeting covered the experiences of various institutions involved in education:

– Dr Alexandre Dolgorukov, "Open College" Centre of Intensive Technologies in Education;

– Mr Yuri Balyberdin, Head Organization of Pre-license Education;

– Mr Pavel Belkin, Federation of Internet Education;

– Dr Alexander Zimin, Bauman Moscow State Technical University;

– Mr Tjerk Busstra, University of Professional Education (see Selected Materials).

Mr T. Busstra, University of Professional Education, Netherlands

The experts took part in the final discussion on main trends and perspectives of IITE international project *ICTs in TVET*. In the course of the discussion the Recommendations for IITE international project *ICTs in TVET* were presented by the Rapporteur. After the debates these recommendations were approved by the experts.

The participants expressed much content with the results of the meeting. They agreed that cooperation is needed for further development of IITE international project *ICTs in TVET*. They also expressed their gratitude to the IITE administration and organizers of the expert meeting who provided the opportunity to share visions and experiences on the problems of ICT usage in TVET, which are of great importance for UNESCO Member States.

Expert meeting. Discussion

ANNEX 1

IITE/MOS/ME2/02/INF.1

FIRST ANNOUNCEMENT

Dear Sir/Madam,

I am very pleased to inform you about the expert meeting *Information and Communication Technologies in Technical and Vocational Education and Training* to be held by the UNESCO Institute for Information Technologies in Education (IITE) in Moscow on 26 and 27 April 2002.

In line with the UNESCO **Major Programme I *Education*** and **Major Programme V *Communication and Information*** IITE has launched an international project *ICTs in TVET*. This work regards the problems of life-long learning, education for all, 21st century new literacy in a convergent media world.

In the framework of these activities the Institute has already started to prepare information materials on existing experience and best practice of ICT usage in technical and vocational education and training all round the world. We believe that consistent and deep research performed by multiple profile specialists is necessary.

The following issues will be discussed during the meeting:

- Identifying the needs of UNESCO Member States for the development of ICT usage in TVET.
- Elaboration of indicative methods for evaluation state-of-the-art, needs and perspectives of ICT usage in TVET.
- Familiarizing the specialists from UNESCO Member States with IITE research findings on ICT usage in TVET.
- Preparation of a set of teaching/learning materials for evaluation of ICT usage in TVET.

We would also appreciate your proposals to add to the mentioned above.

IITE plans to publish and disseminate the materials of the expert meeting among UNESCO Member States.

The working language of the meeting is English.

If you are interested in taking part in the expert meeting, please inform us as soon as possible, and we will send you an official invitation, provisional agenda, other informational and reference documents.

Thank you in advance for your attention. For further information please contact Dr Boris Kotsik, IITE Project Manager (Boris.Kotsik@iite.ru).

Yours faithfully,

Vladimir Kinelev
Director of IITE

ANNEX 2
IITE/MOS/ME2/02/INF.5

LIST OF DOCUMENTS

IIITE/MOS/ME2/02/DOC.1	AGENDA
IITE/MOS/ME2/02/DOC.2	RECOMMENDATIONS OF THE EXPERT MEETING *Information and Communication Technologies in Technical and Vocational Education and Training*
IITE/MOS/ME2/02/DOC.3	RECOMMENDATIONS FOR THE IITE PROJECT *Information and Communication Technologies in Technical and Vocational Education and Training*

INFORMATION DOCUMENTS

IITE/MOS/ME2/02/INF. 1	FIRST ANNOUNCEMENT
IITE/MOS/ME2/02/INF. 2	TIMETABLE
IITE/MOS/ME2/02/INF. 3	LIST OF PARTICIPANTS
IITE/MOS/ME2/02/INF.4	INFORMATION MATERIALS
IITE/MOS/ME2/02/INF. 5	LIST OF DOCUMENTS

REFERENCE DOCUMENTS

IITE/MOS/WP2000/INF. 1	CD-ROM "EDUCATION AND INFORMATICS" Proceedings of the Second International UNESCO Congress, 1-5 July 1996, Moscow, Russian Federation
IITE/MOS/ME2/02/INF.6	SET OF SUCCESS STORIES

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ANNEX 4

IITE/MOS/ME2/02/DOC.1

AGENDA

1. Opening of the expert meeting

2. Adoption of the agenda

3. Election of the Chairperson

4. Election of the Rapporteur

5. Issues for the thematic discussion:

   - Identification of the UNESCO Member States needs for ICT usage in TVET for the 21st century labour market:
     - new trends in world economy and labour market development
     - labour market and job skill trends
     - workforce development and TVET

   - Evaluation of ICT role in TVET:
     - TVET and general education
     - role of ICTs in methodology, didactic and TVET content
     - role of ICTs in TVET management and delivery

   - Main trends and perspectives of the IITE international project *ICTs in TVET* development:
     - national and international projects and success stories
     - the IITE international project *ICTs in TVET* – vision and target groups
     - terms of reference for the project and programme of a working group

6. Approval of the recommendations of the expert meeting

7. Closing of the expert meeting

ANNEX 5
IITE/MOS/ME2/02/INF.2

TIMETABLE

April 25, Thursday

Arrival of the participants

April 26, Friday

09.30 – 10.00 Registration of the participants

10.00 – 10.40 Opening of the expert meeting
Welcome addresses and introductory speech
Introduction of the participants
Adoption of the agenda
Election of the Chairperson
Election of the Rapporteur

10.40 – 11.00 *Coffee-break*

11.00 – 12.30 Main issue 1:
Identification of the UNESCO Member States needs for ICT usage in TVET for the 21st century labour market:
- New trends in world economy and labour market development
- Labour market and job skill trends
- Workforce development and TVET

Key-note speakers:
- Dr Ch. Chinien. *Assessing the Effectiveness and Efficiency of ICTs in Technical and Vocational Education and Training*
- Dr P. Kommers. *Virtual Environments for Flexible Industrial Vocational Training – New Media Scenarios for Embedded Corporate Training and Life-Long Learning*
- Dr A. Giglavy. *Managing Teenagers' Research Projects: Productive Workforce Development Paradigm*

12.30 – 13.30 Thematic discussion on main issue 1

13.30 – 15.00 *Lunch time*

15.00 – 16.40 Main issue 2:
Evaluation of ICT role in TVET:
- TVET and general education
- Role of ICTs in methodology, didactic and TVET content
- Role of ICTs in TVET management and delivery

Key-note speakers:
- Ms J. Leibowicz. *Training Technology Competence Standards (Framework for Training of Trainers)*
- Dr S. Gorinskiy. *ICT Usage in Technology Education and Vocational Training: World ORT Experience*
- Prof. K. Subramanian. *IT as a Catalyst for Human Resource Re-engineering in Knowledge Networked Environments*

- Mr O. Johannessen. *How to Organize Schools in Order to Facilitate a Pedagogical Use of ICTs in the Learning Process*
- Dr A. Dolgorukov. *Efficiency Evaluation of ICT Usage in Vocational Education: Practice, Problems, Perspectives*

16.40 – 17.00 *Coffee-break*

17.00 – 18.00 Thematic discussion on main issue 2

April 27, Saturday

10.00 – 11.00 Main issue 3:
Main trends and perspectives of IITE international project *ICTs in TVET* development national and international projects and success stories.
Key-note speakers:

- Mr Y. Balyberdin. *Experience of the Head Organization of Pre-license Education in Creation and Maintaining of the System of Russian Regional Centres for Professional and Pre-license Education and Certification*
- Mr P. Belkin. *Experience of Federation of Internet Education in Teachers' Training on ICT Usage in TVET*
- Dr A. Zimin. *The Advantages of Remote Practical Labs in Higher School Technical Studies*
- Mr T. Busstra. *ICTs and their Relative Impact on the Organization and Content of Vocational Training: Examples from the University of Professional Education*

11.00 – 11.20 *Coffee-break*

11.20 – 12.00 Thematic discussion on main issue 3:

- IITE international project on *ICTs in TVET* – vision and target groups
- terms of reference for the project and programme of a working group

12.00 – 13.00 Adoption of Recommendations

13.00 – 13.30 Closing of the expert meeting

April 28, Sunday

Departure of the participants

ANNEX 6

IITE/MOS/ME2/02/DOC.2

RECOMMENDATIONS

of the Expert Meeting
Information and Communication Technologies in Technical and Vocational Education and Training

The participants of the IITE expert meeting *ICTs in TVET* held in Moscow on 26 and 27 April 2002 recommended that:

1. Special efforts be made to assist UNESCO Member States to adapt national education policies, systems and programmes to prepare young people for the labour market and further learning;

2. In view of a large scale and multidisciplinary nature of the realm, the existing experience and proficiency of various specialists be integrated to produce valuable solutions and suggestions to develop national education policies;

3. Special IITE project *ICTs in TVET* be developed with the assistance of an international working group;

4. Main tasks of the international working group be identified, project objectives and target groups defined;

5. The IITE information system be implemented with a mechanism for data support and exchange within the *ICTs in TVET* project activities;

6. A policy paper and a set of training materials for policy- and decision-makers be considered as a goal for further development of the IITE project *ICTs in TVET*.

ANNEX 7

IITE/MOS/ME2/02/DOC.3

RECOMMENDATIONS

for the IITE Project
Information and Communication Technologies in Technical and Vocational Education and Training

According to the recommendations of the IITE expert meeting *ICTs in TVET* held in Moscow on 26 and 27 April 2002 in order to outline the IITE project activities, the participants of the meeting worked out the following suggestions:

1. TO FORM A WORKING GROUP FOR ANALYTICAL SURVEY PREPARATION

The main task of the working group covers the following areas:

- setting objectives and scope of the project;
- setting the objectives, overall framework, structure and content of the analytical survey;
- planning a preparation mechanism of the analytical survey;
- allocation of efforts and elaboration of the working plan.

2. TO DEFINE CATEGORIES OF THE PROJECT OBJECTIVES AND THEIR LOGICAL STRUCTURE

It was emphasized that the project course should:

- determine a general framework of the project;
- set the priority of objectives;
- define the project input for UNESCO objectives;
- identify the needs of UNESCO Member States to develop ICT usage in TVET;
- elaborate indicative methods to evaluate state-of-the-art, needs and perspectives of ICT usage in TVET;
- familiarize the specialists from UNESCO Member States with research findings on ICT usage in TVET;
- overview difficulties and challenges for the developing countries and countries in transition;
- provide feedback and means for evaluation;
- rubricate the policies and managerial approaches;
- provide metadata and methodology for experience description;
- share success stories and good practice examples via IITE clearing house.

3. TO DEFINE TARGET AUDIENCE FOR THE PROJECT

The target audience for the project will be:

- policy- and decision-makers in the sphere of general education and TVET;
- managers and administrators of pedagogical institutes and training centres for trainers in TVET;
- developers of instructional materials and educational software;
- trainers of trainers, tutors, mentors, coaches for vocational education and training;
- heads of TVET institutions;
- corporation managers responsible for in-service training and staff development.

SELECTED MATERIALS

Tjerk J. Busstra
Senior Manager
University of Professional Education
Postgraduate courses, Hogeschool
Netherlands

ICTs and their Relative Impact on the Organization and Content of Vocational Training: Examples from the University of Professional Education

Introduction

It was not so long ago when promises and expectations ruled reality with regard to the ICT world. This was true for the e-business industries, until a few years ago the NASDAQ stock exchange was constantly breaking records, while a lot of companies working in the e-business were actually not making any profit at all; on the contrary, many of them were and are still suffering big losses, but these industries were promising, they would beyond any doubt bring a golden era of gigantic profits, so the banks and other investors kept investing in these industries. Nowadays NASDAQ again is breaking records almost daily, but by going down.

Not to the same extent, probably, but the same story holds true for the use of ICTs in education and training. It would cause a revolution and, if we did not join, we would be not only old-fashioned individuals, but even worse, in a few years these institutes would be out of competition in the educational market. Promises of tremendous opportunities offered by the use of ICT in education and the fear of losing competitive advantages created a climate for enormous investments, and as it goes with promises, some of them come true, some of them do not. Nowadays we are dealing with these questions more down to earth.

That is why the title of my presentation today is focusing on the relative impact of ICTs. This certainly does not mean that I underestimate the importance of ICTs, but from my point of view it is a ‘related issue’, many times including important choices. In this presentation I will discuss some of these issues, choices involved and also – to be honest and down to earth – dilemmas unsolved.

Our mission

I will start with a very simple and basic statement: our institute is a school! To be more precise, our institute is a university for professional education, which means that we want to serve our clients, our students to develop the competences they need to start a professional career in a specific job or position, or upgrade their competences, if they are already working. This implies that we have defined our educational objectives in terms of professional competences, a competence being an integrative combination of cognitive, social and affective elements of job requirements. The choice for this educational approach and philosophy has enormous consequences for the organization of our education, including the use of ICTs as an educational tool. I will touch this later.

We do this with regard to many different jobs and professions. Our students learn to become an accountant, a banker, a nurse, a marketer, a facility manager and so on. Being such school in our country means that, offering our students a favourable learning environment to acquire the competences needed is our major concern and our core business. It also means that we are a part of a legal and administrative setting; government is paying us and we have to fulfill the obligations that go with it.

I am telling you this because it is the starting point; if we want to use ICTs, it has to serve these basic starting points. In our university we, of course, experience the technology push, but we have made the strategic choice that ICTs must fit into our mission. I must admit that sometimes this is difficult.

Our new masterplan

At the moment we are in the middle of renewing our strategic plan for the development and use of ICTs at our university, we will develop a new masterplan for the next five years. I will offer you a view from our kitchen by presenting some of considerations which influence our final decision-making.

We have distinguished three types of so-called business drivers for the development of our new ICT strategy, namely:

- those that impact the educational/learning environment;
- those that affect the administrative environment;
- those factors which originate externally from our institute.

Of course, these elements are not exclusive categories, they are to a certain extent interdependent.

Educational factors

The educational factors are those impulses from educational units or faculties that drive the ICT strategy:

- desire to integrate ICTs into the course curriculum;
- desire to cater the educational experience to particular types of students and their respective requirements; tailor-made education, commercial education paid for by individual students themselves or the companies they are working for;
- desire (from faculties and students) for educational information services that allow both real time access to a student's educational progress as well as to the products they have developed during their education. In effect, the faculties and students are asking for a real-time link between administrative and educational systems;
- growth of educational networks and partnerships throughout the world;
- demand for timely and effective communication between the faculty and the students;
- growing ICT awareness among the student population, who see ICTs as a necessary and essential tool;
- student's desire to take courses time- and place-independent.

Administrative factors

The administrative factors are those impulses from faculties, students, administration or from an external source that drive the ICT strategy with regard to the use of technology in administration. Some of these factors are:

1. Student's desire to control his or her personal information such as address, telephone number, etc. From the student's perspective this information belongs to them and they should be able to control it. Furthermore, they want one-stop-shopping, i.e. they want to be able to mutate information once and have that automatically done throughout all systems.
2. Demand by all users for data integration. The divergence in the method and location of data storage for each system works contrary to the drive towards efficiency and effectiveness. In other words, the addition of each new system is creating more duplicative processes instead of streamlining the existing ones.
3. Demand from students, administrators and professors for an access to real-time information regarding courses, financial information, system user id creation, etc.
4. Requirement to reduce the budgets for administrative functions; popularly expressed, more money for real education and less for overhead and administration.

External factors

External factors are those impulses or forces that originate from outside our institute, but which impact or impose rules upon the manner, in which the university functions. This implies that these factors will also have an impact on the deployment of ICTs within our institute. Examples of these factors are:

- government's new financial model, which will impose a credit hour reimbursement system on the schools;
- rise of new types of educational models, in which companies team up with schools in order to upgrade their personnel in a tailor-made way;
- new technologies offering a greater opportunity for integrating ICTs in the classroom;
- reduced costs and a greater abundance of basic ICT facilities such as bandwidth, computer power, etc.;
- growing market trend towards offering web-based education;
- shift of primary and secondary schools from lecturing-based learning towards problem-solving-based learning;
- trend towards international accreditation of bachelor and master degrees;
- entry of commercial or privately financed competitors in the market;

- high rate of technological evolution (i.e. tremendous growth in storage capacity, tempo of new software versions, etc.).

These different types of factors will definitely influence our decisions with regard to our ICT Masterplan, in which we will deal with different functions of ICTs related to our educational mission and objectives. Several functions of our institute involve:

- management and administrative processes;
- communication and information processes;
- educational processes.

We certainly need to find and arrange the ways to deal with dilemmas such as:

- standardization and flexibility;
- top down and bottom up development;
- need for integration of (sub)systems and relevant consequences with regard to security, investments involved, etc.;
- own development or interuniversity cooperation.

Above all, education is peoples' business, which definitely implies that our human resources policy will have to include how we will work together and train our staff. Already at this moment we have a very well functioning ICT helpdesk. In this department we have introduced the concept of action learning, which means that when a teacher is dialing the helpdesk number, the IT specialist and the teacher first try to define the problem and then solve it together in order to promote the capacity of a teacher to solve the problem him- or herself next time. Only as a last resort or if the problem is too complicated, the helpdesk specialist will from his workstation take over the control of the teacher's computer and solve the problem. Now it is our policy, that each major change in our system or applications relevant for our staff will be followed by special courses or workshops we organize for all of them. We consider this HRM policy very crucial in implementing our ICT policy.

Competences-oriented learning and e-compact

I already mentioned before that we have chosen competences-oriented learning to be our educational philosophy. The use of ICTs has to follow this choice. Competences-oriented learning has a lot consequences for contents and organization of the educational process and for the roles of students and teachers. Some examples:

- a teacher is a coach, a supervisor and an expert, but from time to time also a self-learner;
- a student is no longer primarily focused on listening to a teacher, he or she has to accomplish tasks, is very active, is in a certain way building, constructing knowledge;
- a teacher no longer offers and explains texts but is offering experiences, tasks;
- contents of the learning process is multidisciplinary, integrating knowledge, skills and attitudes;
- testing is not purely aiming at selection, but at diagnostics and measuring progress;
- learning environment is based on a small scale, a lot of interaction, a lot of information sources and only a few teacher's orders.

I give you these examples to illustrate that, if you want to use ICTs to support and facilitate this educational concept, it definitely implies the type of ICT usage other than the traditional classroom-based, teacher- and knowledge-centered philosophy.

Nevertheless, we have tried to realize this concept in an e-learning setting, named e-compact. It is an e-learning course on business studies; the target group, the students are employees, so people are already working. Right from the start we have made the choice to combine face-to-face learning and e-learning, because we were very much aware of the restrictions and limitations of e-learning, for instance with regard to the learning of social skills (negotiating, etc.). To a certain but never to the full extent, training of these kinds of skills may be replaced by such means as video conferencing, but for us this was not really a compatible alternative to face-to-face training. So, we decided to include in this e-compact curriculum the face-to-face contact once in two weeks during one day. Really these hours must be of added value, compared to what can be achieved by e-learning. So, most of these hours are dedicated to, for instance:

- training of social skills in which verbal and non-verbal communication is of crucial importance;
- training of highly integrative and complex modules.

Within this e-learning setting we have created a virtual platform consisting of several compartments:

- studying information, course guide;
- library;
- assignments, tasks;
- 'classroom and grouprooms' with opportunities for communication with regard to tasks, exchanging knowledge and points of view;
- teacher consultations.

Deliberately we did not include textbooks. We found out that most of the students do not prefer reading a book behind their computer.

So far, we have evaluated this e-compact course with regard to costs, time and convenience/ pleasure. Our e-compact course is definitely not cheaper than the price of traditional education. Not only did it require a huge investment (which was partly subsidized because it was an experiment), but time consumption for a teacher is definitely not less; one of the main reasons being that in this system of e-learning the number of one-to-one contacts between a teacher and a student has increased compared to traditional classroom teaching. This certainly is improving the degree of satisfaction on the students' side and, probably, has a positive influence on the quality, but we will have to deal with an acceptable limitation of teacher's involvement. For students it is saving time already for a simple reason that they do not have to travel and so far they are quite satisfied with this course. So far we have concluded that compared with the traditional part-time courses we lose less students in this concept.

Though we really experience ICTs as a challenge for our institute and try to realize the advantages, we are also very much aware of all dilemmas which need to be solved, not only at our institute but I think more widespread. I sincerely hope that this expert meeting and the platform offered by IITE will contribute to a responsible use and development of ICTs in TVET.

Chris Chinien
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Canada

Assessing the Effectiveness and Efficiency of ICTs in Technical and Vocational Education and Training

Our society is continuously moving towards a knowledge-based economy: an economy, in which the application of knowledge replaces capital, raw materials, and labour as the main means of production. The synergy of combining new information and communication technologies with human skills has dramatically altered job content and skills requirements at the workplace. Good jobs have become technologically complex and are demanding sophisticated work skills. Simple, routine and low-level functions are diminishing.

In the re-engineered workplace, the perception of the role of human interventions in the economic transactions has also changed. The potential contribution that an individual can make in acquiring and applying knowledge for improving processes, products and services is becoming more important than physical labour. The knowledge embodied in a product has become a key element of production.

As these fundamental changes take place, corresponding changes are occurring in public expectations of our education and training systems (Council on Learning Technologies, 1998, p. 1). The increased demand for initial and lifelong education and training calls for flexible access programs. There is a growing interest for employing ICT to replace the just-in-case learning with just-in-time learning that is independent of time, place and pace.

The use of ICTs in TVET can be classified into 4 main categories, namely: (1) technical assistance for teaching; (2) teaching tool; (3) a work tool for students; and (4) system control tool or workshop or laboratory tools. (Chomienne, 1990). ICTs are also used to support the education system in such areas as administration, communication and curriculum development (Honey, McMillian, Carrigg, 1999).

While a general consensus is emerging regarding the need to integrate ICTs in teaching and learning, there is little empirical evidence to support the decision-making process. In fact over 350 research projects conducted during the past 70 years fail to establish a significant difference in effectiveness between ICTs and traditional methods (Baalen and Moratis, 2001). While these findings tend to suggest that ICTs do not make a considerable improvement to teaching and learning, the fundamental question that remains unanswered is if the researchers were assessing the effectiveness of ICTs or they were simply assessing the effectiveness of instructional products, which were less than perfect.

In spite of considerable progress made in the development of instructional materials through the adoption of systematic instructional design, practitioners still have difficulty in producing efficient and effective instructional materials because our knowledge of human learning is still limited. Many of the critical assumptions that are made during the design and development of instructional product are based on learning theories that are weak. The final product is therefore less than perfect (Dick & Carey, 1985, Gagne & Briggs, 1979). Conscious of this inherent difficulty, and recognizing that the design process is not foolproof, instructional developers have included a formative evaluation component in their models (Geis, Weston & Burt, 1984). Earlier attempts for trying out and revising instructional materials date back to the 1920s, with educational films and radio (Cambre, 1981).

The purpose of formative evaluation is to provide instructional developers with an opportunity to identify and correct errors and problems within a set of instructional materials, while they are still in a developmental stage (Baker & Alkin, 1984).

Formative evaluation attempt to appraise such programs in order to inform the program developers how to ameliorate deficiencies in their instructions. The heart of the formative evaluator's strategy is to gather empirical evidence regarding the efficacy of various components of the instructional sequence and then consider the evidence in order to isolate deficits and suggest modifications (Popham, 1975, p. 14).

There are two broad questions addressed by formative evaluation activities. The first relates to content and technical quality of the material, and the second pertains to its learnability. The evaluation of content and technical quality is addressed through expert verification and revision. It is generally believed that students are most qualified for providing feedback data to assess the learnability (Nathenson & Henderson, 1980). Formative evaluation activity must establish standards in terms of utility, feasibility, propriety and accuracy (The Joint Committee on Standards for Educational Evaluation, 1981).

Expert Verification and Revision

The use of experts' opinion in assessing the worth of an instructional product is probably the oldest evaluation strategy used in education. Experts' opinion is an important evaluation tool because it is quick, it is cost-effective and it tends to enhance the credibility of an instructional product. Additionally, experts' opinion can be used to modify a product before it is used by students (Nevo, 1985). Six types of experts are commonly used for the evaluation process, namely: (1) content, (2) language, (3) target population, (4) media, (5) format, and (6) delivery system experts.

- A content expert will ensure that the content is relevant, accurate and up-to-date.
- A language expert will ensure that the language used is appropriate for the target population.
- A target population expert will ensure that the material is appropriate for the designated group that will use it. If the target population is adult learners, then the expert will ascertain that the material being evaluated is in agreement with the basic principles, philosophies, assumptions, and establish theories in adult education. The five philosophies in common use in adult education – behavioral, liberal, progressive, humanistic and radical – consist of beliefs systems about human learning, roles of learners and values attributed to learning. These philosophies can have a strong influence on the orientation given to the learning process, such as active learning, transformative learning or self-directed learning, just to name a few.
- A media expert will assess cost-effectiveness of the proposed materials. Typical cost consideration includes capital costs, installation/renovation costs, time cost, support personnel, training, maintenance, cost of alternatives as well as shared costs. The expert can also assess the societal costs of not implementing a technology-based product. The media expert assessment will be directed to the particular characteristics of the learning technology in order to determine its appropriateness for addressing the learning needs of the target population.
- A format expert will determine, if the material has been packaged to maximize its effectiveness and efficiency.
- A delivery expert will ascertain that the material meets the standards established from good practices.

Good Practices for ICTs in TVET*

• Inclusivity	• Skills building
• Affordable	• Critical thinking
• Any place	• Information appraisal
• Any time	• Culture building
• Warm wane	• Helps learning
• Enabling	• Student-faculty contact
• Multidimensional	• Active learning
• Learner active	• Prompt feedback
• Learner driven	• Time on task
• User control	• High expectations
• Engagement	• Respect diverse talents
• Interactive	• Collaboration

*Source: EVNET (2002). Best and Bad Practices in ICTs, Ottawa, Canada.

The effectiveness of an instructional material depends to a large extent on how well instructional developers have been able to support internal learning processes with external events. Research has identified nine critical events of learning (Gagne and Driscoll, 1988). Delivery expert evaluation must ascertain that all these events of learning are available.

Events of Learning

1. Gaining attention
2. Informing a learner of the objective
3. Stimulating recall of prior learning
4. Presenting the stimulus
5. Providing learning guidance
6. Eliciting performance
7. Providing feedback
8. Assessing performance
9. Enhancing retention and transfer

Cognitive Divide

We all know that UNESCO Director-General has made a strong commitment to education for all. Considerable efforts and resources are being devoted to provide equal educational opportunities to all. However, having equal educational opportunities now means more than having access to training programs and resources. It also means that a person has the cognitive skills needed to learn and to succeed in a learning environment. Many individuals lack these essential "cognitive literacy skills". As adult educators we need to be vigilant of this *cognitive divide*, which contributes to the widening inequalities in income and employment prospects between highly skilled and less skilled workers.

Individual differences among learners regarding their preference for various modes of gaining, storing, processing, and using information constitute sources of considerable variation in learning (Witkin, Moore, Goodenough, & Cox, 1977). Some students are unable to accomplish a cognitive task simply because they lack the necessary information processing skills (Regan, Back, Stansell, Ausburn, Ausburn, Butter, Huckabay, & Burkett, 1979).

Cognitive-based research over the past 15 years has demonstrated that one of the most important factors contributing to achievement differences is the cognitive skills that a student brings to academic tasks (Letteri, 1992). In order to succeed, a student must possess a repertoire of thinking skills that meet the cognitive demands of learning and performance tasks. Without appropriate cognitive skills information may be rejected, lost, translated incorrectly or stored incorrectly. This is due to the rapidity, by which information is processed, and the very limited capacity of various parts of the information processing system.

Aptitude by Treatment Interaction (ATI) research indicates that instructional treatments differ in the information processing demand they place on learners. A learner may fail to master an instructional task simply because she/he lacks the necessary information processing demands imposed by that particular task. There are two fundamental ways to address this need. The first is by applying the deficit model, where the environment is adapted to meet the learners' needs. A second approach is to alter the cognitive style of the learners so that they can become more adaptable to the needs of the learning environment (Ausburn & Ausburn, 1978). The delivery expert must ensure that instructional materials are not debilitating for particular group of learners.

Learner Verification and Revision

Learner Verification and Revision (LVR) consists of a three-stage approach (Dick and Carey, 1985). These are (1) one-to-one evaluation; (2) small group evaluation; and (3) field test.

One-to-one evaluation

The one-to-one evaluation occurs in the earlier phase of development (Dick and Carey, 1985). It serves to "identify and remove the most obvious errors in the instruction, as well as to obtain the initial students reaction to the content" (p. 199). At least three students, who are representative of the target population, should be selected for this process; preferably, students of above average ability, average and below average ability. In a one-to-one evaluation a student is exposed to the instructional materials as well as to all pre-tests, post-tests and embedded tests within the material. The one-to-one evaluation is an interactive process between a student and an evaluator. Data are collected through observation, interview, embedded tests, post-test and attitude questionnaire. The data can either be for making on-the-spot revisions for minor problems or delayed revisions for more complex ones (Thiagarajan, 1978), Table 1.

Small Group Evaluation
The second stage of formative evaluation is conducted with a group of eight to twenty students representative of the target population (Dick and Carey, 1985). The small group evaluation has two main purposes: (1) to validate modifications made to the material following the one-to-one evaluation and (2) to ascertain, if a student can use the material without the help of an evaluator.

The term "small group" refers only to the number of students involved in the evaluation process. Small group evaluation does not imply that all students should be assembled in one location and at one time to conduct the evaluation. In small group evaluation, the students are provided with all instructional materials and tests. They are instructed to study the material at their own pace. The evaluator intercedes only if a major problem occurs prohibiting the student from proceeding without help. After interacting with the materials and tests, an attitude questionnaire is administered to the students in order to obtain their reactions. Data gathered during the small group evaluation are used for further refinement of the instructional material (Table 2).

Field Test
The field test or summative developmental evaluation is designed to verify the effectiveness of previous verifications and revisions performed during earlier phases of evaluation. The field testing also helps to ascertain, if the instructional material will function smoothly, and whether it will be accepted by students, teachers and administrators in the intended setting (Dick and Carey, 1985). The focus of the evaluation is on the merit of the instructional product in terms of achievement, attitude or study time. These three measures have been traditionally used for assessing the effectiveness and efficiency of instructional products, however, due to dramatic changes in workplace requirements other indicators are being added to the standard, such as the development of higher order skills, critical thinking skills, problem solving skills, decision making skills, analytical skills, communication skills, research skills and social skills (Heinnecke, W.F., 1999).

Risk Assessment

In spite of the importance of formative evaluation, research indicates that less than 1% of instructional products used in the USA have been systematically evaluated. The costs involved and time commitment are two main deterrents for not including formative evaluation in the instructional development process. A risk assessment can help to weigh the time and the costs constraints against the consequences of making an inappropriate decision in adopting a technology-based learning product.

Although most experts recommend a three-stage formative evaluation process (Geis et al., 1984), there is some empirical evidence in the literature (Wager, 1980, and Kanswamy 1976) suggesting that small group evaluation can be eliminated without significantly affecting the overall effectiveness of the revised product. This is an important consideration, given that cost and time are two main deterrents for including formative evaluation in instructional development.

Conclusions

While technology-enhanced education holds great promise, its widespread implementation also poses some immediate challenges with respect to (1) capital outlays hardware and software; (2) equal access to ensure that there are no technological "haves" and "have-nots"; (3) appropriate strategies for integrating technology across curricula; (4) copyright issues; (5) availability of pedagogically sound materials; and (6) teacher training and development. Given all these issues, it is critical to assess the worth of technology-based learning before its adoption and implementation. It may be wise here to recall long-term effects of a hand calculator. Educators in the USA believed that closing the access gap to calculators would close the performance gap in mathematics of underachieving learners. The Third International Math and Science Study revealed that students, who were using calculators at the highest rate (50 per cent of African American, 44 per cent Hispanics), had the lowest performance on standardized test (Light, 2001).

Although the importance of formative evaluation is well evidenced in the literature, the state-of-the-art is still an underdeveloped, underconceptualized field of inquiry. There is a paucity of empirical foundations or rationales to support the guidelines and recommendations for the process. Research efforts are needed to improve and validate formative evaluation methodologies in current use, so as to give more credibility to the formative evaluation process.

In spite of these shortcomings, formative evaluation does work. Research indicates that instructional materials evaluated by even one learner is significantly more effective than the original unrevised version. Let us hope, the educators will make more extensive use of formative evaluation, so that the use of ICTs in TVET will not compromise previous commitment and progress made regarding education for all. Formative evaluation can assist us to identify and remove dispositional, institutional, situational and informational barriers that could prevent some groups of people from participating in training designed for high-demand, high-skills and high-wage occupations.

Table 1

Framework for Assessing the Effectiveness/Efficiency of Prototypical ICT Learning Materials in Technical and Vocational Education and Training

ADULT LEARNING IN TVET

- Principles
- Philosophies
- Assumptions
- Theories
- Approaches
- Types of Learning
- Skills
- Knowledge
- Attitudes

NINE EVENTS OF LEARNING

- Gain attention
- Inform learner of objective
- Stimulate recall of prior learning
- Present stimulus
- Provide learning guidance
- Elicit performance
- Provide feedback
- Assess performance
- Enhance retention and transfer

RISK ASSESSMENT FOR STRUCTURING EVALUATION DESIGN

FORMATIVE DEVELOPMENTAL EVALUATION

Expert

Evaluation and Revision

- Content
- Technical quality

—

- Inclusivity
- Affordable
- Any place
- Any time
- Warm wane
- Enabling
- Multidimentional
- Learner active
- Learner driven
- User control
- User control
- Engagement
- Interactive
- Collaboration
- Skills building
- Critical thinking
- Information appraisal
- Culture building
- Helps learning

—

Revision and rejection of instructional product

LEARNER EVALUATION AND REVISION

- Learnability

— LEARNABILITY

- Scores
- Attitude
- Study time

— One to One — Small group

SUMMATIVE DEVELOPMENTAL EVALUATION

— EFFECTIVENESS/EFFICIENCY

- Achievement
- Attitude
- Study time

— Field Test

SUMMATIVE ADOPTIVE EVALUATION

UTILITY – FEASIBILITY – PROPRIETY – ACCURACY

CHARACTERISTICS OF LEARNING TECHNOLOGIES

- Print
- Audiotape
- Radio
- Slide
- Film
- Video
- Television
- Computer
- CD–ROM
- Internet
- Multimedia

EDUCATION FOR ALL

COGNITIVE DEVIDE

COSTS CONSIDERATIONS

- Capital costs
- Installation/renovation
- Time cost
- Support personnel
- Training
- Maintenance
- Societal costs
- Costs of alternatives
- Shared costs

Table 2
Experts' and Students' Evaluation of Prototypical Products

Data Source	Questions Asked	Methods of Collecting Data	Types of Data Collected	Data utilization
Expert				
Subject Matter Expert	Is content adequate, accurate, up–to–date, and relevant?	Check list Panel discussions Interviews	Feedback information in form of narrative reports and/or completed checklist Records of panel discussions Recommendations Interview transcripts	Feasibility analysis for implementing recommendations Modify material Discontinue, if revision is too involved and costly
Language Expert	Is reading level appropriate?			
Delivery Expert	Is delivery medium appropriate and cost–effective and meets quality standard?			
Pedagogical Expert	Are objectives, content appropriate? Is the material appropriate for the target population?			
Instructional Design Expert	Were instructions designed according to systematic process and on the basis of sound theories of learning?			
One–to–One Evaluation				
Select learners representative of population. Include learners of high, medium, and low ability. Males and females. Young and inexperienced, mature and experienced learners.	Is the material learnable? What are the most obvious errors, problems and weaknesses within the material? What are the learners' reactions to the material? Are pre–, embedded and post–tests appropriate?	One–to–one leaner/evaluator interaction Think–aloud procedure Learners' verbal feedback, body language Observation, interviews Unobtrusive measures Reaction questionnaire Pre–, embedded, and post–tests Debriefing interview	Think–aloud protocols Comprehension Appeal Errors Problems Weaknesses Pre–, embedded and post–tests data	Analyze learners' feedback and make inferences for changes During each try–out implement, minor revision on the spot and present modified version to learners for confirmation After each try–out revise material on the basis of learners' feedback
Small Group Evaluation				
Select 10 to 20 learners representative of target population	How effective are changes made during one–to–one evaluation? Are there additional problems and errors in the material? Can learners achieve objectives? Were exercises, tests and feedback appropriate and adequate?	Material is handed to test subjects. Evaluation intervenes only when test subjects need assistance Pre–, embedded and post–tests Observation Unobtrusive measures Attitude questionnaire Debriefing interview	Pre–, embedded and post–tests scores Observation records Interview data Learners' reactions Non–verbal data	Analyze learners' feedback data and make inferences for revisions Modify material on the basis of inferences made from learners' feedback data
Field Test				
Select one or more groups of learners (30 each) representative of the target population from urban and rural areas	Can learners achieve objectives when using material alone? Are previous revisions effective? Will material be accepted by learners, teachers, and administrators?	Evaluation of material in natural setting and context Pre–, embedded and post–tests Attitude questionnaire	Pre–, embedded and post–tests scores Reactions of learners, teachers and administrators to material	Analyzed feedback data and implement any additional revisions necessary to address new problems

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ICT Usage in Technology Education and Vocational Training: World ORT Experience

Introduction

Technology is a creative, purposeful activity aimed at meeting needs, wants and opportunities through making products and offering services according to previously defined goals.

Technology knowledge is primarily *practical* knowledge which essential role was firstly expressed by Plato, who twenty five hundred years ago wrote that the knowledge how to make is useless without the knowledge how to use. The role of such knowledge, which Peter Drucker entitles *specialized knowledge*, is extremely important in modern *Knowledge society*. He writes: "In this society, knowledge is the primary resource for individuals and for the economy overall. Land, labour, and capital - the economist's traditional factor of production - do not disappear, but they become secondary. They can be obtained, and obtained easily, provided there is specialized knowledge... For the knowledge of the knowledge society is fundamentally different from what was considered knowledge in earlier societies, and in fact, from what is still widely considered knowledge. The knowledge of the German *Allgemein Bildung* or of the Anglo-American liberal education had little to do with one's life work... Whatever the base, knowledge in application is specialized".

The transfer of technological knowledge from generation to generation existed for thousands years only in the form of vocational training. Nowadays the situation is dramatically changing.

Firstly, the average life cycle of key technologies is now less than an average man's lifetime. So, the problem of retraining has appeared.

Secondly, the 20th century technology has become a kind of general knowledge which may be not less important for society than scientific one. As a result, technology has now become a compulsory subject for school national curricula in many countries the world over.

So, now we may speak about three kinds of technology education:

a) general technology education in school aimed at giving pupils basic technological knowledge and skills – *technological literacy*;
b) vocational education, training in vocational schools, colleges and universities;
c) life-long retraining and in-service training.

The rapid pace of technological change has lead to fast changes in both content and methods of technology education. Information and communication technologies (ICTs) play a special role in technology education: they are the subject of education and the instrument for it.

World ORT has worked in the domain of technology education since 1880, when *Obshestvo Remeslennogo Truda* (ORT, translated as the Society for handicraft labour) was organized in Russia.

Today, World ORT is one of the largest non-governmental educational and training organisations in the world, with past and present activities in over 100 countries. A non-profit, non-political organisation, ORT's objective is to meet the educational and vocational requirements of diverse students throughout the world. Currently, ORT educates or trains more than 300,000 students annually, through its network of programmes, training centres and schools. World ORT is responsible for coordinating international activities of its associate bodies, national ORT organisations that span five continents.

World ORT is incorporated in Geneva, Switzerland, with main administrative offices in London.

ORT runs its own primary, comprehensive and technical high schools and colleges, and offers post-secondary training, practical engineering degrees and bachelors' degrees for technical teachers within its own teacher training institutes.

In addition to establishing its own schools, ORT supports training programmes in host schools creating and developing programmes, providing equipment and training local staff.

1. ICTs at ORT Technology Schools and School Technology Centres

ORT Technology Schools and School Technology Centres operate in Argentina, Brazil, Britain, Cuba, France, India, Israel, Italy, Mexico, Republic of Moldova, Latvia, Peru, Russia, South Africa, Spain, Ukraine, United States, Uruguay, and Venezuela.

1.1. *ICTs as a part of general technology education* are studied in all ORT schools and centres. The *Technology and Science* project developed by the ORT Moshinsky Pedagogical Centre for Research and Development (Israel) in collaboration with The Hebrew University of Jerusalem and Tel Aviv University is an example of ICT integration into the technology curriculum. This curriculum includes seven main study topics: materials and energy; technological systems and products; the Earth and the Universe; phenomena; structures and processes; ecological systems and *information and communication*.

ORT Israel's *Science and Technology* project prepares curricula aimed at teaching technological skills and training students to function in a technological environment and views technology as an integral part of daily culture.

The *Information & Communication Technologies* unit focuses on understanding the processes, systems and mechanisms pertaining to information processing. At its focal point are information storage, absorption, transfer, presentation and processing through understanding the scientific principles, methods and technologies that form the basis for modern systems, that handle and process information. This study unit completes the learning environment on the subject of information and communication in new science and technology curriculum for junior high school students in Israel. The learning environment includes a CD entitled *Information and Communication System in Action* and learning activity web site at the ORT-Aviv Virtual School (see 1.4.).

1.2. ICTs is a main *specialisation of pre-vocational training at high school*. For example at Russian, Ukrainian and Moldovan ORT schools, students between the ages of 10 and 11 (12th grade) study programming, computer design, web-design, video technology as well as the basics of CAD/CAM.

1.3. The essence of ORT curricula lies in close interaction between *technology education and educational technology*, i.e. the use of modern technologies in education. The ORT students do not just study ICTs, but use ICTs for studying other subjects as well as technology. For instance, in the preparation reports and presentations they make use of MS Word and MS Excel, CorelDraw and Corel Photo-Paint, electronic dictionaries and encyclopedias as well as the Internet, digital photography and scanners.

Created by World ORT, "DO I.T." (http://doit.ort.org) is a foundation course in Information Technology and a typical example of educational software, which is used in ORT schools. "DO I.T." provides a stimulating environment for students and teachers to learn about Information Technology today. An exciting and interactive experience is delivered through the use of the latest multimedia techniques.

1.4. *E-learning* is one of the perspective ways of ICT use in general school education.

Created by World ORT, the "*EnglishSpace* course" (http://www.englishspace.ort.org) is a free Internet resource for students and teachers of English as a Foreign, Second or Additional language. In *EnglishSpace*, students can learn English with the aid of a computer together with their friends and teachers. It costs nothing to join *EnglishSpace* and lessons are free.

Distance learning project "*Aviv* virtual school" is another example of e-learning usage in general technology education. The ORT Israel network and Snunit Information Systems of The Hebrew University of Jerusalem collaborated to establish Israel's first virtual school to provide education for students all over Israel through the Internet (www.aviv.org.il). Educational programmes are incorporated into existing schools' curricula and partially replace traditional modes of learning. *Aviv* offers intensive courses corresponding to the subjects in the Ministry of Education's official curriculum.

At *Aviv*, students experience innovative learning methods, teachers function as guides in computer laboratories, and all participants receive support from virtual teachers on the web site.

It is possible to view sample courses at the following web sites:
course in design: www.aviv.org.il/edesign;
course in journalism: www.aviv.org.il/journalism/index.html;
course in translating from English to Hebrew: www.aviv.org.il/tirgum/main.html.

1.5. ICT usage in students' projects is a very important part of the educational process at ORT schools. In carrying out educational projects in different subjects such as technology, science, history, music and design, students acquire skills in searching, assessing and selecting information as well as in the use of different computer based tools and techniques.

1.6. Another example of ICT usage at school is its information space arrangement. This project is being implemented at ORT-Russia schools in St. Petersburg, Moscow, and Samara. The idea of *school info space* encompasses complete information tracking of all creative activities of both students and teachers together with free information exchange between the parties involved in education. It provides monitoring of curriculum and recording progress in studies, disciplines, and scheduling and includes two-way real-time information connection between school administration and student's parents.

Each centre taking part in the project has developed a dynamic Intranet site based on an SQL database that holds the complete portfolio of each student. Pupils can find their current time-table, e-books, structured educational resources, knowledge marks and ratings. Teachers can add methodological and didactical materials, obtain lists of forms and groups and input knowledge evaluation results. Filtered resources from the Internet are available for students, their parents and teachers.

The idea of school information space is closely connected with e-learning (1.4) and Infoteka service. From 2001 to 2002 the ORT - St. Petersburg Resource Centre within the grant of Open Society Institute (Soros Foundation) developed an *Internet library of educational resources for secondary schools (Infoteka)*. Within this project a system was created for structuring, accumulating, analyzing and distributing didactical and methodological material for secondary schools. The information was in the form of computer files and was integrated into the structure of the Virtual Internet-Centre at (http://www2.infoteka.spb.ru/). Current educational resources were systematized in order to develop an infill mechanism of the Infoteka for different school subjects and for training of teachers to use the service Infoteka as a structured system with a scaled search engine, where a teacher is able to find useful material.

1.7. Effective ICT use at school is impossible without strong teacher training programmes, and accordingly, it forms an important part of most ORT projects. There are several examples of such programmes which World ORT offers to its school teachers:

- Annual Wingate ICT Seminar (London, ORT-House).
- Annual national seminars for ICT teachers (for instance, ORT-CIS seminars).
- Local introduction training for schools and centers newly opened.

1.8. In order to provide students and teachers with all necessary skills for the use of ICTs in education, ORT created a model of a *School Technology Centre (STC)*. Designed by ORT Russia within the frameworks of *Technology for All* projects, the STC consists of one *Technology Lab*, one or two Information and Communication Technology Labs (*ICT Labs*), *Resource Centre*, *Media Library*, and *Network Centre*. STCs are located in secondary schools and through their use students are able to improve radically their technological literacy. The STC can be also augmented by a *Video Lab* for teaching video technology as well as its use in teaching other high school subjects.

2. ICTs at ORT Colleges and University Centres

Technology colleges and university centres are main vocational training units of the World ORT educational system. They successfully operate in Argentina, Belarus, Israel, France, Russia, United

States, Ukraine, and Uruguay and offer a wide and varied range of subjects from Fashion Design to Biotechnology.

2.1. ICTs is a significant specialisation offered at ORT colleges and university centres. For example, Bramson ORT College (New York) offers five different programmes, including Computer Technology. The major modules of this programme include Introduction to Data Processing, Introduction to Computer Programming, Computer Architecture, Operating Systems Concepts, UNIX Operating System, Advanced Computer Applications for Business, Microcomputers Multimedia Applications, Computer Maintenance Operations, Computer Network Operations, WEB Design, Internet Programming, Visual Basic Programming and Introduction to Data Communications.

2.2. The essence of ORT's approach at its colleges and university centres lies in how ICTs are integrated into 'traditional technologies' and educational technology. The Moscow ORT Technology College is an example of such integration. There are three faculties at the College: Advertising, Design, and Economics. The period of learning takes from three to five years and depends on the specialization. Students' age ranges from 16 to 20. ICTs are used here as a new element of a future profession (e.g. computer-aided fashion design, video & computer design in advertising, economical data processing) and as an educational resource in its own right. For example, students use the Internet for searching information globally while studying the history of costume.

The ORT Centre at the Ural State Conservatory was established in 1999 and is another example of the use of ICTs in traditional education. This centre provides Computer Literacy courses for students, professors and teachers of Conservatory and regional music schools and colleges, develops training curricula on *information technology usage for music and art*.

3. ICTs in ORT Vocational Training and Retraining System for Adults

In implementing the idea *of life-long learning*, ORT has established a network of ICT Centers all over the world. One of the largest systems of vocational training and retraining is currently being organized in the CIS and Baltic States.

The ORT Moscow Vocational Training Centre (VTC) is the main methodological centre of the network, which includes centers in Russia and Ukraine. The VTC includes two ICT Labs, Laboratory of Computer Graphics and Video Editing, Hi-Tech Lab and a department for methodology. The technical equipment at the Vocational Training Centre is configured to provide for teaching high technologies in computer design and video montage. The list of courses, which Moscow VTC offers in the 2001-2002 academic year, consists of 12 items ranging from Computer Literacy for beginners to Video Filming and Video Editing for experienced ICT users.

In coordinating training activities in many disparate locations, ORT faced the problem of providing and enforcing common educational standards. ORT considers *e-learning* and *e-exams* the most effective way to solve this problem.

CONCLUSION

1. Technology education is a vital part of modern general school education, higher education and vocational training and retraining.

2. ICT use in technology education includes both the study of ICTs as a subject in its own right as well as a vital tool for modern education. Integration of these two approaches is an essential factor of the ORT educational system.

3. Today, e-learning and school management information systems are key areas in the use of ICTs in technology education and vocational training and retraining.

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How to Organize Schools in Order to Facilitate a Pedagogical Use of ICTs in the Learning Process

Prior to my current position as a headmaster of a large technical college in Norway, I spent the past 13 years working in different management positions in the offshore industry. Before this I had 13 years of combined experience working both as a teacher and a headmaster in secondary and grammar schools and as a director of education – before ICTs have become an option in education.

Most of my time spent in the offshore industry was as a personnel manager combined with the responsibility for professional training, management training and organizational development. The company I worked for (Aker Stord) was the biggest offshore company in Norway, building huge platforms for the North Sea. As part of the Aker group we had many international engagements. I worked closely with the manager of the ICT department during these years, because computer technology was a very important aspect of organizational development. For some time I was also responsible for the ICT department, in addition to personnel and training.

These past few years we have often heard that the use of ICTs in education would open the gate to the "promised land" and solve most problems. I have heard the same prophecies over the years in the offshore industry. Of course, I have witnessed a fantastic technical progress, but there was always a human element to it that seemed to be neglected that caused problems. Since we never seemed to be willing to invest enough resources to teach people how to use new computer technology properly, we actually never managed to take out its full potential.

Much of the motivation for investing in organizational development in the offshore industry is the possibility to achieve rationalization through more effective production and cost cuts. So, through different organizational changes I took part in the processes, where old hierarchical structures have been changed and reduced in order to build organizations based on teamwork and networking. Through these organizational processes, where ICTs and technologies have always been very important issues, we have cut managerial layers and reduced the number of experts.

One of the aims was that a number of the engineers, planners and first-line managers that we needed to plan, manage and make work packages for the pipefitters, welders, plattenworkers, etc. eventually would be made redundant. In the 90-ies the vision was that ordinary workers in the offshore yard, should have access to a computer with a 3D model of the platform, where they could take out their own drawings and other information needed to do the job. Now nearly 10 years later, Aker Stord is about to realize this. But the challenge still is to get hold of or educate workers with sufficient computer knowledge to carry out these jobs.

Since we educate this category of skilled workers, it is a challenge for our school to give the students sufficient education in the use of ICTs, so that they have necessary qualifications to operate computers and programmes in future, once they get an apprenticeship or a job. That is why we now give all new students an initiation programme during the first year at school, two lessons a week, where we teach how to use the Internet along with the most common computer programmes they are likely to meet in the workplace. Of course, we also use ICTs as a tool at ordinary lessons as well.

How do we organize schools in order to facilitate a pedagogical use of ICTs in learning process ?

Before trying to answer this, I think it is important to take a look at what kind of skills/competence business and industry are looking for when they employ people. I have made a survey of different vacant position advertisements in several newspapers, and can conclude that it is no longer enough to be a skilled worker. In addition you need to be responsible, creative, willing to learn, cooperative, independent, flexible, able to solve problems, make decisions, adept, satisfy the customer and find smarter and better ways to do the job.

So, alongside with basic knowledge, it is important to teach students social and methodical abilities and the right attitudes so that they will later succeed at work.

The traditional view of competence in education has been to stress subject skills and knowledge. Today in our school system we need to take into account one's attitudes to work and fellow workers, the way to acquire insight from experience, ability to learn, and last but not the least, the ability to use other peoples' skills and insights through cooperation and teamwork.

In the technical education students learn to programme the machines. Before starting the production, we often use computers in the adjacent theory room, to simulate and learn different programmes.

The question is how we shall succeed to give students skills in cooperation and teamwork, if the schools are organized in the old hierarchical and traditional way, where individual work and abilities alone are rewarded? The traditional way to organize educational work at most levels has been:

- one room;
- one class;
- one lesson;
- one teacher;
- one subject.

And if teachers have cooperated, the focus has seldom been across subjects and on things other than subject matter.

The organization of a learning process is decisive for how much the pupils learn. Consequently, it is important how we organize the classrooms and the teaching process. In order to stimulate learning we must focus on how the school is organized and how it is structured:

- architecture;
- organization of teachers and classes;
- information technology.

In order to achieve the above mentioned aims, and because an increasing number of international companies use teamorganization, we have decided to teamorganize our school. From six to eight teachers now form teams that have full responsibility for teaching all subjects in 3–4 classes, 15 students each. They make cross-curricular surveys and try to integrate the teaching process in different subjects, to give students a better opportunity to see the connection between different subjects/facts/abilities they have to learn. We also try to restructure the classrooms and to create different kinds of rooms, where different kinds of student activities can take place: individual work, group activities, projects, working with computers, etc.

The teachers now have to take on a new role and work more as a guide, supervisor and mentor. We are currently trying out the use of a mentor programme as a tool to follow up and guide the students. The mentor system is very much like the tutor system that many universities already use, however, the focus is more on the development of personality, social skills and coping with group activities, cooperation, conflicts, and life at school in general.

Our mentor system is based on weekly morning meetings to discuss issues of importance with the students, that aims at:

- establishing closer relationship with each student;
- checking out plans, progress, need for help, etc.;
- giving students better possibilities to fulfil their tasks;
- establishing good relationship among the students in the team and enabling them to deal with conflicts in a constructive way;

– strengthening the student's abilities to communicate, listen, participate in debates, converse and relate with other students.

The mentor will also use ICTs to communicate with the students in-between the weekly meetings to give instructions, provide the agenda for the next meeting, answer questions, follow up and give feedback on things that have been taken up during the meetings or at the compulsory colloquium that teachers have with students at least twice a year.

The benefit of using computers and other media is in its ability to present different subjects with more variations, and thereby, motivating students to be active in the learning process:

– process-oriented learning;
– problem-based learning;
– project-based learning.

It is important that we use ICTs in a pedagogically justifiable way. Therefore, the teacher must be sure to ask certain questions before using ICTs:

– How easy is it to use the equipment/programme?
– Is it interesting and motivating?
– Will it contribute to improve the learning results?
– If so – in what way?
– Is it possible to transfer and use what you have learnt through ICTs in other areas of education?
– Are there any advantages using ICTs compared to other educational methods?
– How can we make sure that the students look in the right places and don't get lost on the Net and spend a lot of time without finding what they search for?
– Do students have the ability to assess the knowledge they find on the Net – do they have the necessary techniques to adapt the information they find in a sensible way?

We use problem-based learning, or PPD (planning, production, documentation), where students through the learning tasks have to be very active. They can choose to work on their own, but most of the time they work together in small groups. They continually discuss the goals of the assignment with the teacher(s) – aim, time and place, literature, product, guiding, evaluation. They have to document the learning process. In addition to the literature in the textbooks, they will be guided to where they can find more about the subject: books, periodicals, Internet links, etc.

All our classrooms are now connected to the school's local area network and the Internet. We have at least two computers in each classroom. In addition we have established a resource centre connected to the school library, where students can spend part of their study time (25% of total time at school), and where they have access to computers. Since 70% of our students have access to the Internet at home – 90% of them have computers – it is possible to carry on with their work from home. It is one of our aims that students will have the possibility to access the school's network from home. In addition, we plan to open the school several nights a week in order to give students further access to the resource centre and the school library, and to give them better opportunities to use school's computer facilities.

At the library we have some computers for short-term use. That's why the students can not sit down here.

As it has been mentioned, we created the school home page, which is continuously updated, where students as well as parents can find information about the school and what is going on. There are also pages for teachers only, where they find information, learning tasks, pedagogical tips, etc.

In future we see Intranet as a good platform for learning, which provides:

- a new and better way to communicate with pupils and their parents;
- school open for students 24 hours a day;
- more flexible solutions and a possibility of learning tasks adjusted for each individual student;
- easier availability of students when you need to communicate with them.

So, ICTs surely offer opportunities for teaching and learning, but it is important that we focus on using ICTs in a pedagogically sensible way, where we ask the necessary critical questions before using them as one of many other pedagogical tools.

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Virtual Environments for Flexible Industrial Vocational Training – New Media Scenarios for Embedded Corporate Training and Life-Long Learning

Abstract

As computer-based visualizations like those in VR (Virtual Reality) and modeling for design and idea generation become more common, the research interest may shift forward into a new and highly intriguing field. It is the question how to promote a new type of visualization that is based upon human conceptual imagination rather than the conventional perception of the 3D world around us. It is not an essentially new step since we extended our naturalistic way of displaying what we saw into the more or less abstracted indication of what we take as crucial behind the meaning and impact of the issue; quantitative graphs, schematic displays of complex functioning and not to forget the topographical map itself. Maps may suggest that you see a landscape from a bird's perspective. However we soon perceive that without filtering and articulation there is no conveyance of thought and navigation. As visualization techniques develop, we attempt to display conceptual entities rather than reminiscences to objects and physical space. Concept mapping is the more salient exemplar in this new line. The paradigm is that any mental entity or process may appear in a spatial configuration of both concrete and abstract ideas. The further formalisms how to control expressiveness and topology by pruning and zooming is a matter of conventions that should fit in the contract between a task, its user and the concrete representational device like a white board or a computer screen. Some tasks inherently aim at configurational awareness like planning, decisions making, etc. Some tasks address the more intuitional stages of human thinking like learning, persuasion or worshipping. Concerning learning and teaching, the so-called instructional approach has almost become synonymous with effective cognitive growth. In more recent years we see, however, that the cybernetic aspiration of the 60-70ties has mainly led to an over-organization of study programs and students complaining that school is like a factory and at the same time like a hospital. The term 'existential learning' attempts to indicate its complement, the student being the main character of his longer-term development. We again start to accept that learning has a lot to do with mental and emotional growth, in which information access plays only a subordinate role.

From an Informational to a Conceptual Approach

Before further highlighting the need for conceptual rather than instructional representations it is useful to stress that already in pre-instructional learning theories the notion of meta-cognition has played a dominant role. Ann Brown has systematically brought forward the dominance of cognitive development, intentional learning, transfer of learning, meta-cognition and self-regulation.

> "… Learners came to be viewed as active constructors, rather than passive recipients of knowledge. Learners were imbued with powers of introspection, once verboten. One of the most interesting things about human learning is that we have knowledge and feeling about it, sometimes even control of it, meta-cognition, if you will. We know that small children understand a great deal about basic principles of biological and physical causality. They learn rapidly about number, narrative, and personal intent. They entertain theories of mind. All are relevant to concepts of readiness for school, and for early school practices. Those interested in older learners began to study the acquisition of disciplined bodies of knowledge characteristic of academic subject areas (e.g. mathematics, science, computer programming, social studies, and history). Higher order thinking returned as a subject of inquiry. Mind was rehabilitated…"
>
> Ann Brown, The Advancement of Learning.
> Educational Researcher, November 1994

> The cognitive apprenticeship model (Collins, Brown & Newman, 1989) is another illustration of the shift from guidance to self-control; it claims that effective teachers involve students in learning by problem confrontation even before fully understanding them.

Essentially you may say that learning is, in fact, the recreation of earlier cultural processes and evidences. Though this is an expensive phenomenon, it has the power of revalidation, as learners will also check the presented expertise against their own experiences. Also the regeneration facilitates the knowledge activeness during life. Simply storing and remembering transmitted ideas is less adequate to pop-up in new problem settings. The intriguing question for this position paper is how we rely on pictorial, schematic and iconic images during this process of intellectual “reverse engineering”. Is there any pre-arranged repertoire of visual grammar or should we stimulate learners to re-invent one's personal semiotics for conveying the learning process?

Concept–Orientation for Problem Solving

More and more we see the element of learning shifting towards real-life problem situations. An example of such a development is in the project “SMILE Maker” by Svetoslav Stoyanov. SMILE Maker is a web-based performance support system facilitating managers in solving ill-structured problems. It could be considered a substantial part of HRD agenda (Human Resource Development) responding to the increasing needs nowadays to deal comfortably with complex, vague, and messy, information in order to survive in a very competitive unpredictable business environment. Ill-structured or open-ended problem situations might be for example making a new strategic plan, promoting a new marketing strategy, developing a new training program, inventing a new product, making decision on new organizational design, etc. One of the most reported issues of HRD paradigm is that managers, otherwise very good subject matter experts, struggle to shape their problem solving activities in the effective and efficient way (De Bono, 1990; Wagner 1991).

SMILE provides managers with a systematic rational approach to problem solving. Problem solving is considered as a general process encompassing the activities such as collection and analysis of the available information; generation of alternative solutions, while breaking the established patterns and escaping from the traditional way of looking at the problem; selection of the most appropriate solution candidate and planning necessary steps to implement it into practice. SMILE could prevent managers from some individual problem solving style syndromes like 'analysis paralysis', 'functional fixedness', 'lack of insight', 'one idea', 'too many ideas', and 'premature judgment', (Wodtke, 1993) and from some negative effects such as perceptual defense, stereotyping, and expectancy as well. SMILE capitalizes on the strong points of the rational approaches to problem solving such as explicitness, generality and scientific soundness (Wagner, 1991), but also takes into account the intuitive, non-linear and thinking-while-doing ways managers solve the problems (Mintzberg, 1992). SMILE provokes the elicitation of managers' tacit knowledge.

Primarily SMILE is targeted to the group of senior managers, but put the matter in a more long-term business agenda, all people in a company might benefit from SMILE. Systematic problem solving is one of the substantial building blocks of learning organization along with experimentation, learning from past experience, learning from others, and transferring knowledge (Garvin, 1998). SMILE proposes good opportunities for those activities. SMILE stands for Solution, Mapping, Intelligent Learning Environment. At the first and very rough approximation, it is both a problem solving and learning tool. As a problem-solving tool it provides a user with the opportunity to apply a particular concept mapping method when ill-structured problem occurs. As a learning tool it builds up an intelligent user-centered learning environment for studying what the SMILE concept mapping technique is and how it is to be applied when needed. SMILE tries to combine the advantages of some dominant educational doctrines. It attempts to set up an adequate balance between Instructivism and Constructivism educational philosophies, Content Treatment Interaction and Aptitude Treatment Interaction instructional design paradigms, and System Locus of Control and User Locus of Control in human computer interaction. The four theoretical models behind the SMILE reflect this challenge. It consists of four sub-models: Content or SMILE Concept Mapping Method, User’s Profile, Learning Events, and Facilitator. The SMILE concept mapping method is a member of the concept mapping family and approaches some of them, but is not limited to mind mapping (Buzan, 1996), cognitive mapping (Eden, et.al., 1995), process mapping (Hunt, 1998) and “flowscaping” (De Bono, 1994). All of them have been recognized as useful business problem solving techniques. Mapping approaches can be defined as kinds of soft models in management science. Soft Operational Research/Management Science is relatively new theoretical perspective in the domain of management science (Pidd, 1998). Since recently, managers have been recommending to use formal models based on hard data and visually represented mainly by matrices or charts (market segments/market power, Boston Consulting Group's market share/market growth, General Electric's business screen, competitive advantage/competitive scope, Arthur Little's life cycle portfolio, Gantt diagram, Pareto analysis, etc.). Mapping approach has some obvious advantages over matrix and chart:

- it models the way the human mind organizes information;
- it reflects a close correspondence between psychological constructs and their external mode of representations;
- it integrates two kinds of coding - verbal and visual;
- it externalizes cognitive and affective processes;
- it stimulates self-appraisal and self-reflection;
- it provides a whole picture of problem situation;
- it presents the relationships between components of the situation;
- it uses a simple formal convention - nodes, links and labels on the links;
- it supports mental imagery (Stoyanov, 1999);
- some representatives of the mapping approach in the management soft methodology are cognitive mapping (Eden et al., 1995), process mapping (Hunt, 1998), mind mapping (Buzan, 1996), and flowscaping (De Bono, 1994).

The SMILE concept mapping method is a synergy of mapping approach and some creative problem solving techniques. It combines objective 'hard' data and personal interpretative schemes in an idiosyncratic way. SMILE supports what managers really do every day when trying to deal with different ill-structured business situations. Formally, SMILE concept mapping method consists of four types of units: map information collection, map idea generation, map idea selection, and map idea implementation. Each map has a particular purpose, and some creative problem solving techniques are incorporated in it.

The map information collection is to get all available information in problem space. Map idea generation is aimed at producing as many problem solutions as possible. Map idea selection has to find the best candidate among the alternatives. The objective of map idea implementation is to operationalize a problem solution in the terms of sequence of activities and events. Because SMILE is both learning and problem solving tool, the user profile sub-model is divided into learner and problem solver sub-models. Learner sub-model is defined by four learning styles: activist, reflector, theorist and pragmatist (Honey & Mumford 1992). What is important here is that each learning style reflects the subject's preferences to one of the learning events. A theorist is very likely to choose any explanation. A reflector should look for an example. A pragmatic should start with a procedure, and an activist should go directly to practice. Problem solver sub-model describes four problem-solving styles: seeker, diverger, converger, and practitioner. Each of them demonstrates a bias to one of the stages of SMILE concept mapping method. A seeker has preferences to map information collection, a diverger feels comfortable with map idea generation, a converger is strong in idea selection and a practitioner might go fist to the implementation. SMILE identifies explicitly or implicitly a user according to either a problem solving style or a learning style. In the second version of the SMILE there are two more characteristics: locus of control and prior knowledge. SMILE Maker proposes an option for selecting a scenario that matches the user's individuality best. Scenarios are particular modes of interrelationship between four sub-models. Four scenarios are put in disposition: ready-made, tailor-made, self-made and atelier. In the '*Ready-made*' scenario '*Content*' units are presented in a predetermined order starting with '*Map information collection*' and finishing with '*Map idea implementation*'. The order of '*Instructional Events*' is also fixed. '*Explanation*' is the first and '*Practice*' is the last one. A user should start with map information collection, and then each page is associated with a particular instructional event. When a user enters the '*Practice*', a graphical editor is opened automatically, and he/she could apply what has been learned. The '*Tailor-made*' scenario adapts instruction to the learning preferences. The user gets an opportunity to identify him/herself as one of the learning styles and then is assigned to a specific path. It is conditioned by the user's fixation to a learning event. What makes difference from the first scenario in respect to '*Learning Events*' is that each path is self-contained. It is dominated by one of the instructional events, but also includes pieces from other events. The sources of variation in the '*Self-made*' scenario are both '*Content*' and '*Learning Events*', there is no pre-defined sequence of problem solving maps. However, the content is still SMILE concept mapping method. The user can start picking up any of the SMILE concept maps and then select any of the learning events. The assumption is that the user selects a specific option because of the need to perform specific actions.

'*Atelier*' scenario might be appropriate for people who are self-confident in building up own concept mapping approach. There are several components, which a user could select from: Ideas, Maps, Templates, and Software. '*Ideas*' stands for creative problem solving techniques. '*Maps*' presents some mapping approaches like concept mapping, cognitive mapping, mind mapping, and flow-scaping. '*Templates*' shows some examples of combinations between mapping approaches and problem solving techniques. '*Software*' gives opportunity to select and download concept mapping software - Inspiration, Decision Explorer, Mind Manager, Axon Idea Processor, Smart Ideas, '*Atlas.ti*').

Concept Mapping for Navigation in a VR Learning Environment

The fast growing attention to multi-modality, full three-dimensional VR (Virtual Reality) and the avoidance of anisotropy has partly supplanted the designer's attention to students' conceptual states. One additional promising aspect is to prepare and structure the VR course for Educationalists on the Web and bring an overview of ongoing research into the urgent question, how to orient students in conceptually complex domains using VR. The central theme is to give an overview of VR learning environments that enable learners to explore new physical spaces, but what is more important – to let them experiment with new materials, complex processes like kinesthetic, extruding, casting, etc. VR becomes a substantial and ubiquitous technology and subsequently penetrates applications for education, learning and training. In addition to multimedia, VR places the user in a three-dimensional environment. The user feels 'in the middle of another environment'. Most of the VR systems allow the user to travel and navigate. More promising for learning purposes is to let the user manipulate objects and experience the consequences. Especially, fast propagation of WWW-based tele-learning can benefit from the VR prospects in the coming years, as VR programs can now be accessed by the most common web browsers like Netscape and Explorer.

Throughout many stages of media they have helped us to extend our perception, imagination and manipulation. VR is just an extra step on the long road bringing the imagination as close and making it as realistic as reality itself. After the first experiments in the fifties with complex kinesthetic devices like multiple cameras, senso-motoric devices and even smell generators, more elegant head-mounted devices were developed in the early nineties. Both defense research and computer games industry were main stimulators of VR so far. It is hard to describe what VR is not: it encapsulates all previous media, even books, slides, pictures, audio, video and multimedia. The typical contribution of VR is its effect of 'immersion'; the user feels as if (s)he is in a different world. Both the sensations and actions of the user should resemble as much as possible human's normal physical environment; seeing, hearing, feeling, smelling, tasting; but also speaking, walking, jumping, swimming, gestures and facial expressions. The VR utopia means that the user does not perceive that a computer detects his behavior, and also that he perceives the real world. The generation of proprioceptive and kinetic stimuli is only possible, if the user is placed in a tilted room like hydraulic controlled cabins for flight simulators. The generation of taste and smell, and the realistic enervation of human skin, as if one touches an object or another person, may be one of the most challenging and complex steps for VR to take in the next years. Augmented reality occurs when the user faces the real world, but on top of that the VR environment superimposes a computer-generated message in order to assist the user to perform the right operations.

VR is a desired technology for those applications, in which reality itself does not exist (yet), cannot be accessed, or is too dangerous or expensive to betray. As for many of the today VR proponents '*Reality*' sounds as the only inevitable physical world, they rather prefer '*Virtual Environments*'. This leaves behind the idea that there is mainly one real world. Because of its widespread usage we will maintain the term VR, however. Computers are inherently tools to emulate situations and environments, which are not there in reality. VR in its current shape suggests the user that (s)he is in a fictitious environment. The next generation of VR suggests that you can really walk around there, and can manipulate and experiment. This environment does not necessarily need the same properties as the real world. There can be different forces, gravity, magnetic fields, etc. Also in contrast to the real solid objects, in VR the objects can be penetrated. The properties of a good VR are like those of a good teacher; it allows the student to explore the basic laws of a new domain; location, scale, density, interactivity, response, time and level of intensity can be varied. It is not necessary to explain what the VR user sees, hears, feels and finally smells. Textual descriptions are not optimal for this learning by intervention either, as text (and also hypertext) is essentially not apt to describe complex spatial phenomena. In this sense, VR gives a substantial contribution to interactive learning environments; it combines realism (like in a video recording) with manipulative (fictitious) reality like in simulation programs. We may expect that within 10 years VR could be the default presentation mode of computer applications in general. Besides the visual/auditory and spatial aspects, VR can also provide support in the navigation through concept space. In this case, the dimensions are no longer corresponding to the Euclidean geometry; they can represent mental perspectives, rules and dependencies. In other words, virtual space allows traveling through a three-dimensional concept map. VR is a three-dimensional simulation technique, which becomes more important as:

- mistakes during the learning process become more dramatic;
- reality itself cannot be accessed;
- emulated reality has to be smudged.

There are at least four VR aspects of importance for the perception by a learner:

1. The mechanism of avatars. They represent the user in a fictitious environment.
2. The mechanism of affordance. This is the user's ability to orient in a new world based upon distinguished features, according to Norman (who refers back to J.J. Gibson (See Beck & Cunningham, 1989), affordance is a relation between an object in the world, and the intentions, perceptions and capacities of a person. As an example, he mentions that a door with a push button instead of a handle for pulling, has the affordance to push the door.
3. The man-machine interface gets an ever more prominent position. Initially the user interface was a kind of serving hatch between the user and the system. In case of very interactive systems sometimes one speaks about user **intraface**; in this case the whole application establishes the manipulation space for the user. The user's intuition then needs to be sufficient to instruct the user. The user should not need meta-communication in order to understand the program's potential.
4. The confrontation between a learner and a new (physical) environment should be 'immersive': rather than seeing a flat display, the user should feel himself **in** the VR. Especially, if the task concerns complex three-dimensional orientations, like surgery and rescue expeditions in complex areas, a VR exercise is quite useful before going into reality itself.

Concerning the relevance of VR for education and training, two aspects have to be taken into account:

1. VR is a default component of the user interface in the future. The desktop metaphor was a revolutionary one, as it took the human's physical (spatial) reality for the organization of information in general. As long as it concerns 2D documents, this is a lucky choice. As soon as the user behaves in a 3D world, a more dynamic representation is needed. Also the acoustic consequences of moving through space should fit; the sounds' amplitude, reverberation- and Doppler effects, as one recedes or comes closer to the sound source, should resemble the reality.
2. The second is that the ability to increase realism also implies the possibility to introduce a specific element of non-realism. One can confront the student with an alien world and make it stepwise more or less realistic. Basic laws of nature can be explored, like mechanics, chemistry, electromagnetic fields, etc. Viewed from a constructionist perspective, VR has an important function in the realization of complex understanding processes; the student is allowed to orient in several directions and, subsequently, find a way through the information space.

Educational VR systems seem to be a natural extension of computer-based simulations nowadays. The basic approach is to allow students to explore and discover the fundamental laws in a new environment and domain. For the initial confrontation with new tasks and for the stage of exercising, this approach seems logical and consequent. The effectiveness of training for the mastery of the final task in reality is a subject for further research. Based on similar developments in interactive video, multimedia and telematics it is not desirable to wait-and-see, until the technology development has 'finished'. Educational and training research should keep pace with the newest VR systems and think over its new potential for learning. Can VR be an Effective Tool for Education or Training? The answer depends partly on one's definition of VR and partly on one's goal for the educational experience. It may not be worth the cost, if the goal of the educational experience is simply to memorize facts. However, if the goal of the educational experience is to foster excitement about a subject, or to encourage learning through exploration, or to give students a taste of what it is like to be a research scientist, then VR may be worth the expense. It seems an interesting option to take the VR technology a candidate metaphor for learning environments in general. That's why we introduce a more generic idea of '*Virtual Learning Environments*' in later stage of this article. Today it is a developing technology seen primarily in research labs, theme parks, and trade shows. Tomorrow it may be as common as television. Lanier (1989) likes to say that VR is a medium, whose only limiting factor is the imagination of the user.

Thinking as a Result of Experimental Gaming

Exploring the laws of mechanics, getting acquainted with basic formulas and progressively handling complexes of variables are parts of the Physics curriculum. Interactive Physics is a learning tool that elicits a student to build up experimental configurations. The system provides multiple representations that facilitate different learning styles. The model animation helps students to visualize abstract concepts, building models, allows a student to observe changes in the key variable while running the simulation. Besides the actual behavior of the mechanism, the vectors will be shown, and the tables with the sampled parameters can also be exported for analysis in Excel, MathCAd or a statistical package.

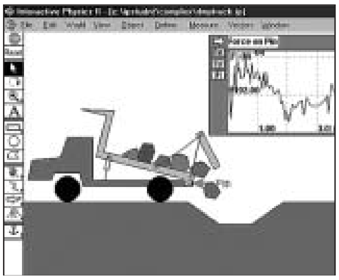

Figure 1. Animation of the rolling, sliding and dumped stones in relation to the force to the pin

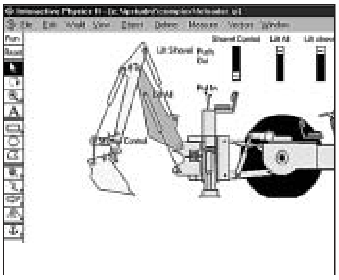

Figure 2. Multiple representations of the hydraulic taps, position of shovel vectors and evolving oscillations

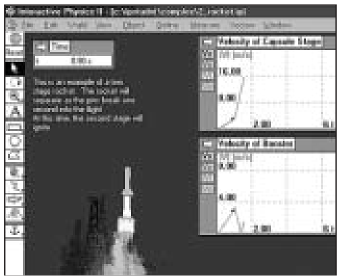

Figure 3. Embedded simulation models in rich environments. The parameter values can still be seen in two graphs simultaneously

Interactive Physics[1] allows a student to draw and manipulate models directly, closely to the way a normal physical experiment is arranged. The program provides springs, ropes, dampers, slots, joints, pulleys, actuators, meters, buttons, sliders, bodies and allows to change continuously its properties like chosen material, elasticity, density, its texture and electromagnetic value. The primary approach in term of learning attitude is discovery learning. It is a 'contract' between the program and the student to repeat investigations after each other so that gradually the understanding arises from the link between the stated hypotheses and the observed processes. The importance of the simultaneity of displaying the manifested behavior and its constituent parameters has been indicated by Min (1992, 1994 and 1995) in the 'parallel instruction theory'. The students' study approach can be articulated further by, for instance, tutoring guidance; a peer student who has a certain formalized understanding. A typical directive from the tutor's side is to make systematic increments of one key parameter and try to formulate its effects on other variables. The accompanying description in the Interactive Physics program formulates its goal as:

> *...model-building for active, constructive problem solving. Modeling tools highlight important relationships and dependencies while filtering out distracting information...*

The overall metaphor of explorative modeling tools is Collaborative Mechanical Simulation: Draw it. Move it. Break it. Control it!

[1] Interactive Physics, (http://www.workingmodel.com/index.html)

An example of learning with Collaborative Mechanical Simulation:

> *At a planned height of 508m, the Taipei Financial Center will be the world's tallest building. Because of its height and location in a typhoon region, it is subject to wind-induced sway motion, resulting in high accelerations that could cause occupants of the upper levels to feel discomfort. To solve this problem, engineers at Motioneering, Inc. used MSC.visualNastran products to design a tuned massed damper that would disperse the energy caused by wind acceleration.*

The key mechanism in the tool-based provocation is learning by demonstration, memorization, explanation, theoretic proof, and the challenge to 'make what you mean'. As formulated by J. Fox at SED: "We have a new mechanism with a very unique motion that requires people to think in 3D in order to understand it. That can be really difficult, but MSC.visualNastran 4D enables us to demonstrate the concept with a virtual prototype. By speeding the understanding of our mechanism, as well as verification of the analysed stress and strain on the parts and bearings, we are able to engage in collaborative relationships with the manufacturers substantially quicker". The students' attitude is to ask: "What if?", while the tool's metaphoric role is to say: "Why not?" all the time. The learning is in the short-time span between student exploration and the execution of its consequences in the model on the screen.

From Mechanics to Kinematics

The traditional task of conceiving a mechanic construction relies upon one's experience with similar solutions in the past. Mechanics and kinematics in themselves are not sufficient to get at the right ideas.

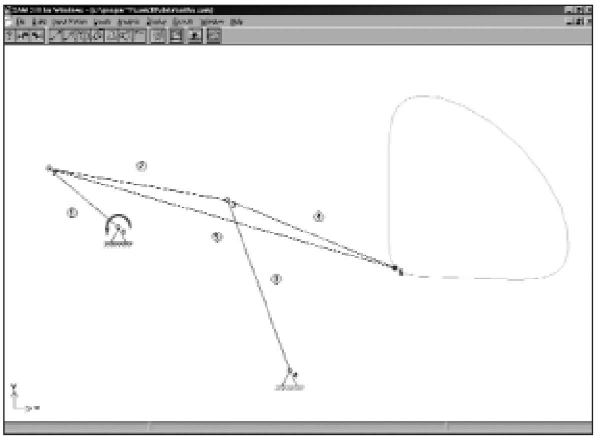

Figure 4. Rendered movement by the SAM system

SAM software (http://www.artas.nl/main_de.html); (Simulation and Analysis of Mechanisms) is an interactive PC-software package for the motion and force analysis of arbitrary planar mechanisms. The enclosed rational is that the first step in the design cycle consists of the synthesis phase, in which the designer attempts to find the type of mechanism and its dimensions, such that the requirements are met as well as possible. The traditional 'learning by experience' is no longer postponed into the stage of 'learning on the job'; it is accepted as a valid and necessary component of learning the formalities like in handbooks. Traditionally, designing constructions are the result of "having the right template in mind", conceptual design, and behavioral modeling techniques. Most available software on dynamics or kinematics is used to analyze the behavior of a mechanism. However, to start with, the Engineer has to 'invent' a mechanism before he can analyze it. This is not a trivial task. With available methods and handbooks this can take several days, if not weeks.

Learning by Gaming in the Behavioral Modeling Software

Learners have not only incomplete knowledge; they lack the confrontations with the problem field so that new information is not even an answer to formulated questions. A large proportion of the initial learning is in the teasing between an expert and a novice to make the novice conscious about what actually has to be mastered. Preconceptions about 'solid' and 'safe' constructions have to be supplanted by new concepts like 'elegance', 'autopoetics' and 'sustainability'. The Watt Mechanism Design Tool helps this process. From specification of the required movement and constraints on pivot locations, transmission coefficients, dimensions, etc. it searches and finds a variety of solutions within minutes; http://www.heron-technologies.com/support/index.html. Students can specify and decide upon his/her correctness and precision. The learning is no longer restricted to the validity of underlying formalisms like the Burmester design rules; in fact it stimulates the learner to participate in the community of best practice, as there are no formal restrictions to the scope of solutions, as long as they provide acceptable results for the posed goal.

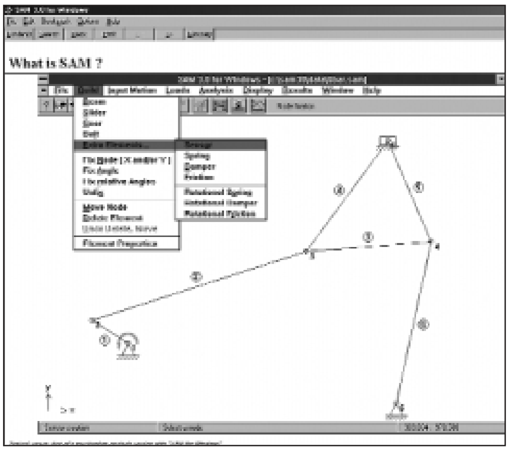

Figure 5. Students building the model for the motion and force analysis of arbitrary planar mechanisms

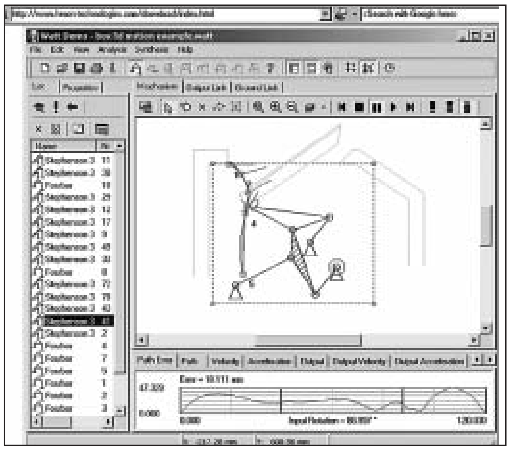

Figure 6. Watt Software elicits a student to experiment and prompts unforeseen mechanisms beyond the student's current intuition

The solutions displayed in the list at the left side of the screen are labeled as Stephenson (1..x) and FourBar (1..x). In this case solution Stephenson 41 has been selected and its execution can be seen in the main window. The bottom window allows checking of various parameters on the time scale c.q. the rotational angle: the path error, the path, velocity, acceleration, output, output velocity, output acceleration, etc. Twelve partial screen dumps below display the breadth in solutions. The student's task is to optimize his/her navigation. Using the Watt design programme as a learning environment the learner should attempt to meet given constraints like the available space around the construction, the weight of the construction and the easiness of the final construction.

The constructions under concern have in common that they produce the vertical curve at the left. Besides the practical implications like the needed amount of material, it is also possible at this point to drag some elements manually and regenerate the entire solution process from scratch. This iterative approach is an important factor in the student's learning; it coaches the student to distinguish relevant from peripheral factors from the beginning and will reduce the problem space considerably in the future. The perceived added value from the 'what-if' exploration is the heavier responsibility for the student, not just the created freedom that is often associated with constructivism. An often-overlooked aspect is the role of these modeling tools as demonstrators during the lectures by the teacher. Here, we can perceive that the explanatory approach is soon supplanted by the exploratory approach. It frees time and mental load for new goals, like restructuring of counter-intuitive solutions and trust that you as a learner may go in directions that are unknown to you and the teacher as well. The teacher and the student at that moment are swimming side by side. The benefit is that the learning will cover a larger domain of notions for the application of formal knowledge. The price is that students may finally not be keen enough on the typical problems that can await at the final examination. It is clearly not a trivial problem what to do, if a certain assessment regime tends to obstruct the natural evolution into new ways of learning and learning outcomes?

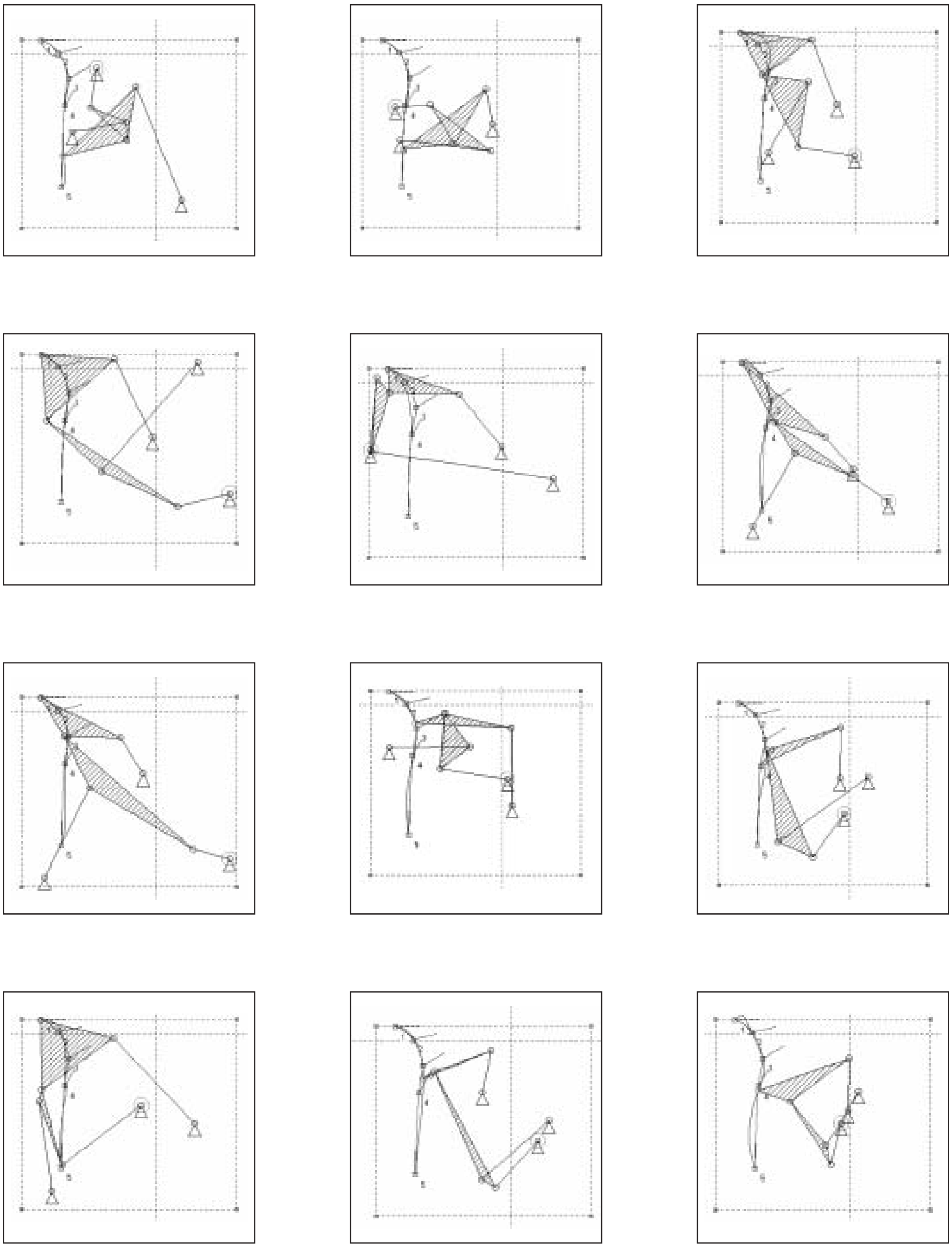

Figure 7. Twelve constructions generated by the Watt system

Virtual Reality for Immersive Experiments

Though dynamic modeling for learning physics' laws brings immediate response to the students' intuitive hypotheses, it is a rendered 2D view on the consequences of the prior intervention. The added facility of virtual reality is that one can actually fly, walk or swim in the target world, and experience the friction between imagined and perceived views during traveling and rotations. In a number of ongoing research projects we aim to provide constructional, theoretical and empirical evidence for the assumption that students' control of visual and acoustical articulation in a virtual environment affects the quality and effectiveness of the learning process. The articulation strategy (described as an explicit model) is verified in terms of perception, interpretation, usability, cognitive compatibility and learning effects.

Towards VR-based Learning Paradigms

The inherent role of ICT in learning environments also manifests itself in virtual environments for teaching, learning and training. Virtual environments are a blend of art and science as they add new dimensions like immersion, transparency, free 3D navigation and amazement. As a new technology for visualizing scientific data, this application does not only give more emphasis on visualization but the possibilities to add other senses such as hearing (both naturalistic and synthetic sound) and feeling/touch (proprioceptive and kinesthetic). The implementation of virtual environments in educational and training areas has arrived and moves quickly in an attempt to extend the control range as far as it can be perceived in virtual environments. Virtual environments offer a great potential to computer-based systems. The realistic visual environment that is offered together with its intuitive forms of interaction, makes it attractive for a variety of both learning and teaching applications. In order to ensure a successful transfer of knowledge in a learning system, the system itself must mimic the real environment within the limits of the available technology. Hence, issues such as responsiveness, quality and accuracy of the virtual environment and the realism of the user interface need to be considered. Recently, virtual environment has demonstrated its potential in the field of computer-based learning. The reason is that it offers the most important factors needed in learning field: realism and interaction. Another major issue in virtual environment is the fidelity of the system. Fidelity refers to the combination of accuracy and realism. The type of the objects performed in the virtual environment determines the need for accuracy or realism.

Prior Research into VR-Supported Learning

In order to enhance the likelihood of a more effective learning process, it is essential to gain a better understanding of how students learn. VR is a research area that focuses on identifying and describing the object, in which students are able to orient and control themselves in order to improve learning effects. Visualizations of data and virtual systems in the context of the real world can make information spatially indexed and more understandable. Rather than relying solely on a verbal description of the scene and problem, the advanced technology produces a three-dimensional image of objects and its surroundings. With this capability, the problems are more naturally and clearly communicated and resolved as if the remote expert was physically there. These new models of learning and assessment are also required to measure student progress, and to guide through a learning and problem-solving process. Virtual environment addresses a wide range of interaction and immersion capabilities. Interaction in virtual environment plays an important role in varying learner control during the virtual environment experiences. Visual, auditory and haptic interactions and sensations are dominant communication modalities due to their familiarity and rich expressiveness. The senso-motoric interface is an important part in virtual environment because it allows sensing, synthesizing, manipulating, and brings rather 'total' visual, aural, and haptic sensations subject to the user’s preferences and complete control.

The Applications and Benefits of Virtual Learning Environments

The term 'virtual environment' refers to a human-computer interface that facilitates a highly interactive control over three-dimensional scenes and its components with adequate detail so as to evoke a visual response similar to that of real scenes. Virtual reality is an advanced technology to produce a virtual environment that users perceive as comparable to real world objects and events. Users can interact with displayed images by turning, twisting, tilting or zooming in a way that creates a feeling of actual presence in the simulated presence. In educational and training area, virtual reality applications appear to be most promising for visualization and representation.

NASA had started the usage of applications in VR areas many years ago. Nowadays, virtual environments have been used for medical training and education, science education, engineering training, even for disabled users. In the field of science, this new technology provides students with a new learning experience in order to see the ‘unseen’ side in science world.

Virtual environments are split into two areas, immersive and non-immersive system elements; both with advantages and disadvantages. Recently, the non-immersive system has been more popular, more often used and more appropriate for learning and teaching knowledge at school or university because it can be used at little additional cost to a typical computer. The non-immersive system that sometimes is called "desktop virtual environment" can be defined as a subset of virtual environment that does not require all four conditions of full immersion:

- a full field of vision display;
- tracking of the position and attitude of the participant's body;
- computer tracking of the participant's movements and actions;
- negligible delay in updating the display with feedback from the body's movements and actions.

The key characteristics of virtual reality are visualization and interaction. Visualization aims at representing information in a visible format, makes the unseen be seen. The interactive nature of virtual environments enables the user to visualize real life structures and events, although sometimes the high level of realism in virtual reality environment doesn't give a guarantee for learners to gain a better understanding.

The usage of an external articulation database in VR helps to learn simple components of more complex tasks or to react with infrequently occurring situations such as the preferred response to unusual events. An advantage of using articulation templates in virtual reality environment is that it enables the user to interact with the real-time animation to conceptualize small part relations rather than a complex one, or to leave away parts of models that are difficult to visualize in a normal way. Moreover, by allowing users to select their own preferred articulation parameters, virtual environment can promote a more responsible cognitive attitude of the learner.

Virtual environments highlight various articulation parameters that are understood by the student and the teacher to improve the quality of learning process. An important part of the learning process is the application of the theory to 'realistic' virtual environments. Relevance of the theory to 'real' virtual environments is understood to make the learning process more interesting and efficient. Learning and understanding can be made easier and more interesting with visual support such as pictures and models as long as students can carry out independent control to enhance their understanding.

Articulation in VR also involves the ability to see how things relate to each other. From the point of understanding, providing students with VR facilitates learning by adopting an appropriate articulation, and by providing a comfortable control device. Nine factors that influence learning processes in VR include:

- articulation;
- interaction;
- exploration;
- navigation;
- freedom;
- orientation;
- immersion;
- spatial ability;
- imagination.

Articulation in a virtual environment has influence on the cognitive ergonomics, usability and quality towards the learning process. Here, the importance of thirteen articulation parameters comes into play:

- realism level of the objects;
- textual labels;
- shape distortion;
- shading;
- color;

- view points;
- texture mapping;
- size;
- animation;
- appear and disappear;
- sound effects;
- jaggedness;
- pulling away certain parts.

The advantages of the usage of external articulation in virtual environment are:

- focusing the attention;
- supporting learning-by-doing through experimentation;
- enhancing learning experiences that progress from simple to complex situation;
- enhancing students' creativity and logic thinking.

Articulation control term in VR is broader than the navigation term. Navigation control focuses on the way users can alter their viewpoint position and orientation in VR, while articulation control addresses freedom/responsibility for the users to optimize the articulation parameters for the sake of learning.

There are three possibilities for articulation control modes in virtual environment:

- structured (algorithms/program control);
- semi-structured (teacher control);
- unstructured (student control).

Knowledge is comparatively easy to define and measure. It is more difficult to define and measure understanding in a way that distinguishes it from knowledge. Learning is a process of development and it is different for each individual. By tradition, educationalists emphasize the importance of understanding. Learning processes are influenced by individual learning styles. There is no evidence that one style is more effective than others, but there is evidence that individuals learn better when allowed to recognize and utilize their personal preferred learning style. External articulation should be integrated in a way that allows freedom to choose other ways to learn. Learning is an iterative process, so that it is important for the student to feel a sense of achievement at each stage. Many virtual environment-based teaching and learning packages have a procedural nature. The navigational control is often limited to standard VRML (Virtual Reality Modeling Language) navigation (see Web3D repository[2] on the WWW).

They are designed to achieve specific objectives, usually to teach the user in particular structures and processes. The usage of an external articulation database is event-driven. The external database does not have a pre-programmed sequence, through which the user must navigate. External articulation models make it easier for users to take active control of the learning process, choosing which problems to solve, and which information to view, but there is a risk that the user will be overawed by the complexity of the environment. How students go experiencing with the particular articulation in virtual environment is related to how the learning task is perceived by students. Learning processes can be categorized in two different ways:

1. Learning is seen as the memorization of information. Learning in this approach is seen in quantitative terms as an accumulation of knowledge relevant to what is required to complete the lesson unit. The focus in this category is on content significance given by the teacher.
2. Learning is seen as understanding information. Learning here is viewed as understanding information and can be categorized into:

[2] Web3D repository (http://www.web3d.org/vrml/vrml.htm)

- understanding is facilitated by adapting information to suit personal cognition;
- understanding is facilitated by the ability to visualize the problem as a whole;
- understanding is facilitated in an experiential way by attempting to relate things to past experiences;
- understanding is facilitated by practical examples.

VR and the Need for an Exploratory Spatial Didactics

Currently we are in the middle of a project to investigate the effect of using an explicit articulation control mode in order to improve the learning process. In the master thesis *Educational Technology* Sylvia Dewyanti developed three stages of the heart in the fetal, the neonate and mature stage. Just after birth the open connection between two atriums is closed to enable double circuits in blood streams. The students in biology and medicine need to spatially and schematically understand the consequences of the constellations before and after the closure of this *foramen ovale*.

"...In this preliminary investigation, three prototypes had an implicit articulation. It was developed with the purpose of improving the subject *Human Blood Circulation* for the Groningen University biology curriculum in animal physiology. The experiments were restricted to a series of interactive visualization modules. They aimed at supporting the role of a teacher during lecturing, and to assess its value of student-centered interactivity, both in individual settings as well as in collaborative learning. The next step for this investigation is to build an external articulation database support system in a VR environment".

Articulation can be described as jointed parts or components in virtual environment that function to express ideas clearly and understandably. The articulation in virtual reality environment includes three-dimensional objects, color, texture, animation, sound, etc. In virtual environment technology, articulation has a close relationship with the philosophy behind virtual environments: to give the illusion of immersion in an environment mainly computer-generated and maybe augmented with reality.

Articulation could be varied from an abstract into a realistic level. The availability of an external articulation database could provide users with a more flexible individual control to determine in which level they want to start learning. Flexibility in control provokes users to structure their personal interests in learning certain new notions.

The first level of interaction in virtual environments needs a user interface that allows you to walk through a virtual world, interact with its content, trigger animations and listen to 3D sound effects. The external control of the articulation in virtual environment system addresses the second level of interaction in which users can customize and modify the articulation model in the virtual reality environment that matches the user's momentary interest.

A virtual environment is a dynamic and responsive presentation medium. It has a particular effect called "immersion", in which the user will interact with learning environment. Virtual environments are created from diverse components using contiguity and articulation. Articulations determine the presentation accents and also the allowed degree of interactivity, realism and im mersion. In order to provide users with simulated experiences in virtual environment system, control modes for articulation parameters make a possibility for users themselves to experience autonomy.

Immersive Experiences for Prerequisite Learning

Sivia Dewyanti started her master thesis based on the question, how VR models of the heart of a mammal should be built, in order to promote a swift and enduring understanding of a student. Experts in Biology teaching claimed that the 'foramen oval' and its subsequent blood streams during and right after birth needs a complex imagination, that will only survive, if its simultaneous performance can be seen.

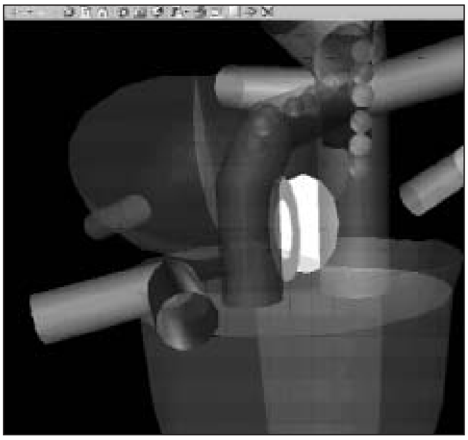

Figure 8. Entering the pumping heart and witnessing the effect of the foramen oval

VR provokes us to express our momentary understanding of, for instance, a human heart in a dynamic 3D model, where flow and pressure are articulated and where transparency allows to visualize processes in several layers at the same time. Our experiments intend to find adequate rules of thumb how to facilitate navigation and how to sequence the graphical articulations in order to promote the students' intuitive understanding of its functioning.

VR environments influence learning outcomes, especially in cognitive abilities such as spatially related problem solving, memory retention and memory recall. Other advantages in using virtual environment for education and training are pleasure, enjoyment, fluency of understanding how to perform tasks and see what is going on. Virtual environment has produced a number of applications both in education and training fields by bringing experience-based learning to all students and addressing the needs of students with alternate learning styles.

The research outcomes of virtual environment effectiveness have been expressed as follows:

- Cognitive factors, that is influencing virtual reality learning in relation to the substantial body of research on the psychology of learning (Wickens & Baker, 1995).
- Student responses to the experience of being immersed in virtual reality (Taylor, 1997).
- Virtual reality roles for teaching and training in engineering education (Pantelidis, 1997).

This research project searches theoretical and empirical evidences of the effects of control modes for external articulation in virtual environment in order to increase the quality of the learning process. The expectations are that the external articulation control mode should offer more flexible methods to express complex realities like the ones going on in natural tissues and organs. They are also expected to yield a better visualization of scientific ideas like inertia, entropy, simultaneity, etc. In this context the term 'Visual Intelligence' should also be taken into account; it seems not to be a gratuity donation to mentally benefit from rich visual grammars and expressions (Kommers & Zhiming, 1998). Also this trade-off between short- versus longer-term effects should be considered during the planned experiments.

Conclusion

The re-introduction of gaming and experimentation as valid modalities of learning will further propagate through many new-coming WWW-based learning tools. The main contract between a learner and a learner tool is to explore, discover and formalize the basic laws in a certain knowledge domain. The learning tools help a learner to transform intuition into understanding and to consolidate certain experiences into pervasive rules. Concept mapping can best be applied when a computer program assists in updating the dynamic links between concept entities. Especially, the (meta-) cognitive support during conceptual change as happens during experimentation is an important function of concept mapping. Virtual Reality is becoming more and more standard user interface for immersive learning experiences. The combination of VR and constructivistic contracts for experimentation will get momentum and require in-depth experimentation in the coming years.

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Training Technology Competence Standards (Framework for Training of Trainers)

The International Training Centre of the ILO

http://www.itcilo.it

DELTA
Distance Education and Learning Technology Applications

Objectives

- To examine how TOT programmes are planned and delivered at the ITC/ILO
- To consider the training technology competence map as a framework for evaluating the application of ICTs competence in TVET

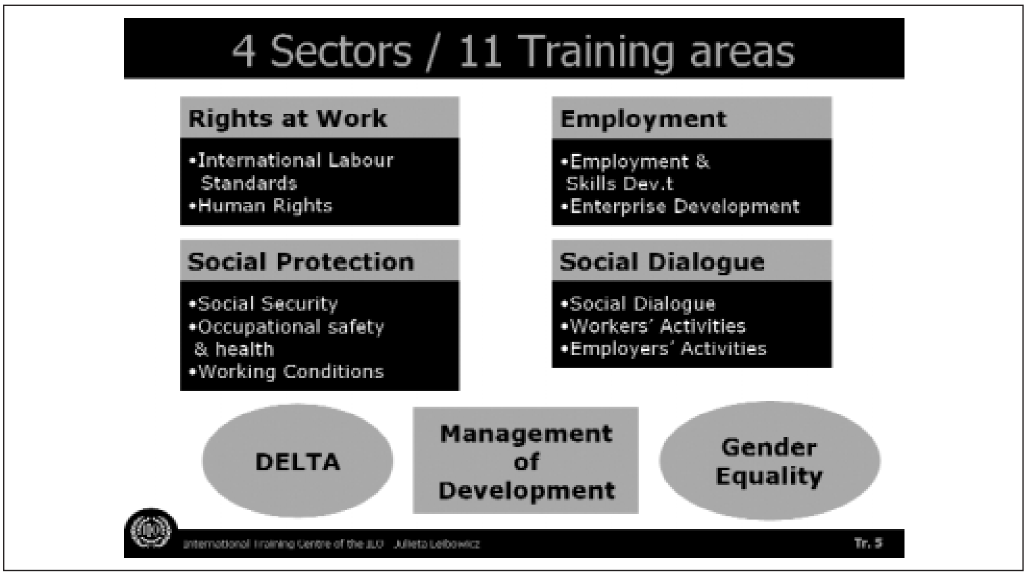
International Training Centre of the ILO Julieta Leibowicz Tr. 2

Issues

1. Who are we?
2. What are the DELTA's functions?
3. The competency-based approach to training of trainers

International Training Centre of the ILO Julieta Leibowicz Tr. 3


The ILO Training Centre
Training ILO constituents and partners
On all main issues of ILO concern
In 8 working languages
On campus, in the field and at a distance
400 courses a year
8,000 participants from 170 countries
International Training Centre of the ILO Julieta Leibowicz
Tr. 4


4 Sectors / 11 Training areas
Rights at Work
•International Labour Standards
•Human Rights
Employment
•Employment & Skills Dev.t
•Enterprise Development
Social Protection
•Social Security
•Occupational safety & health
•Working Conditions
Social Dialogue
•Social Dialogue
•Workers' Activities
•Employers' Activities
DELTA
Management of Development
Gender Equality
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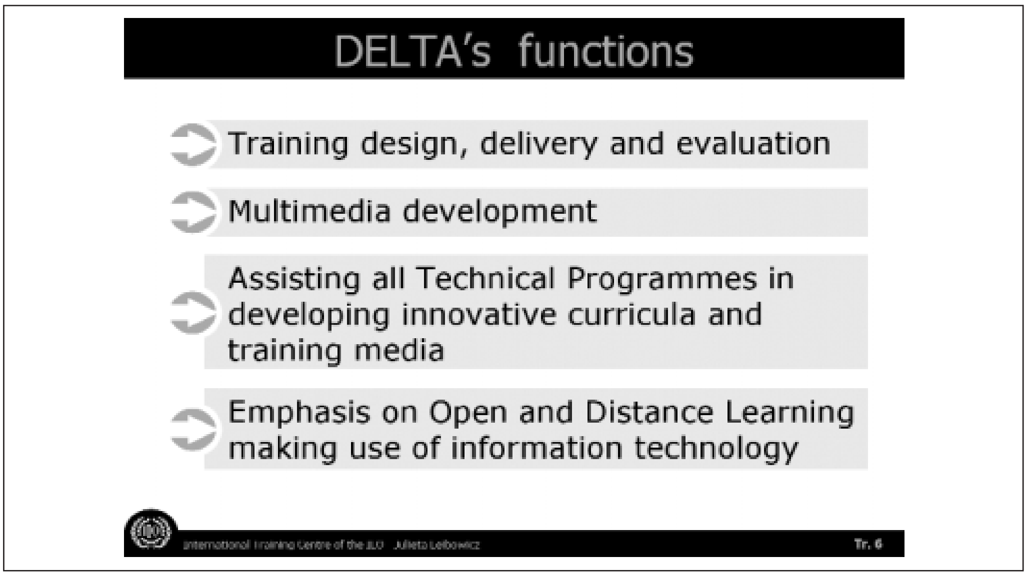
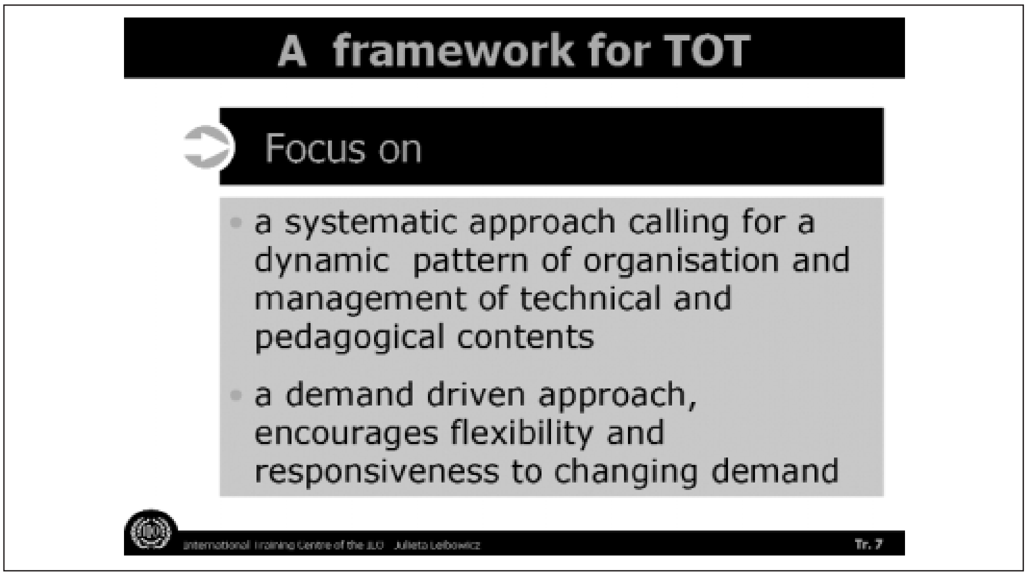
Tr. 5


DELTA's functions
Training design, delivery and evaluation
Multimedia development
Assisting all Technical Programmes in developing innovative curricula and training media
Emphasis on Open and Distance Learning making use of information technology
International Training Centre of the ILO Julieta Leibowicz
Tr. 6


A framework for TOT
Focus on
a systematic approach calling for a dynamic pattern of organisation and management of technical and pedagogical contents
a demand driven approach, encourages flexibility and responsiveness to changing demand
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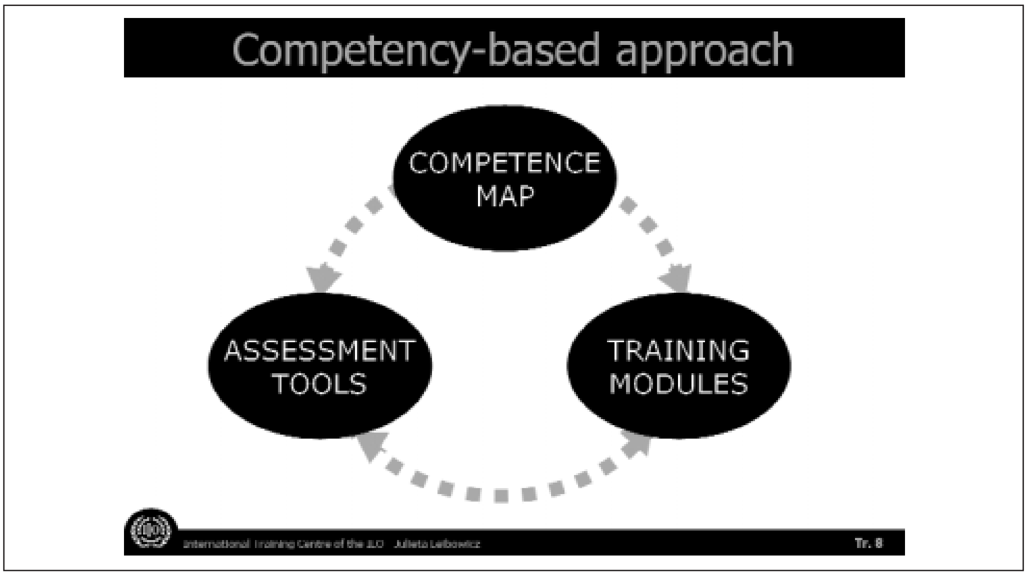
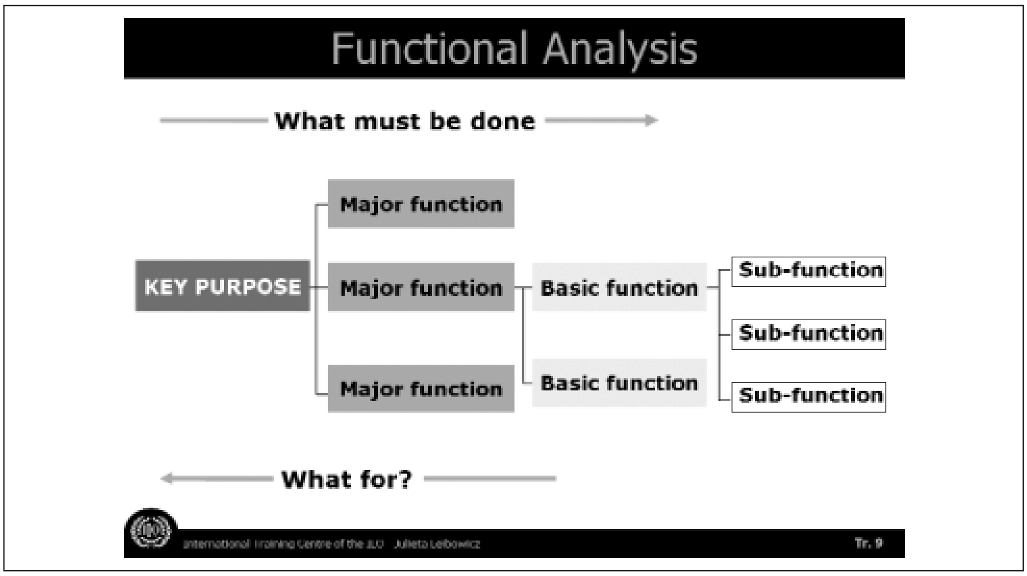
Tr. 7


Competency-based approach
COMPETENCE MAP
ASSESSMENT TOOLS
TRAINING MODULES
International Training Centre of the ILO Julieta Leibowicz
Tr. 8


Functional Analysis
What must be done
KEY PURPOSE
Major function
Major function
Major function
Basic function
Basic function
Sub-function
Sub-function
Sub-function
What for?
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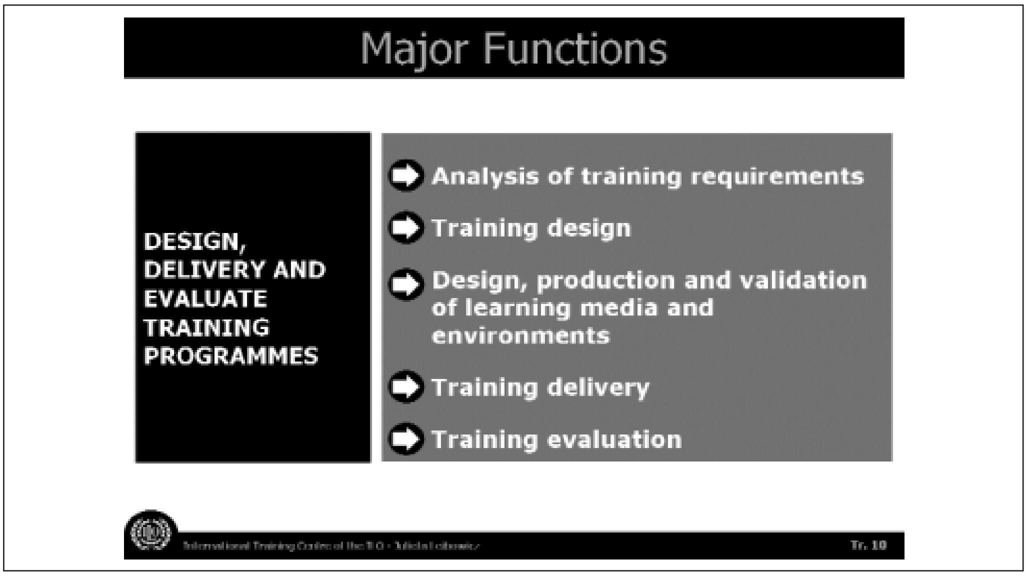
Tr. 9


Major Functions
DESIGN, DELIVERY AND EVALUATE TRAINING PROGRAMMES
Analysis of training requirements
Training design
Design, production and validation of learning media and environments
Training delivery
Training evaluation
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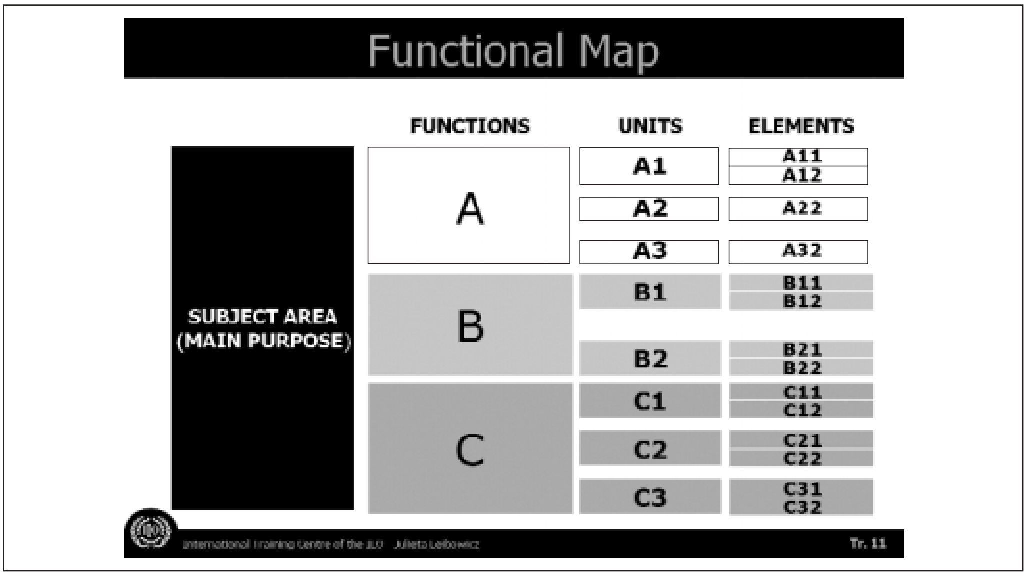
Tr. 10


Functional Map
FUNCTIONS
UNITS
ELEMENTS
SUBJECT AREA (MAIN PURPOSE)
A
A1
A11
A12
A2
A22
A3
A32
B
B1
B11
B12
B2
B21
B22
C
C1
C11
C12
C2
C21
C22
C3
C31
C32
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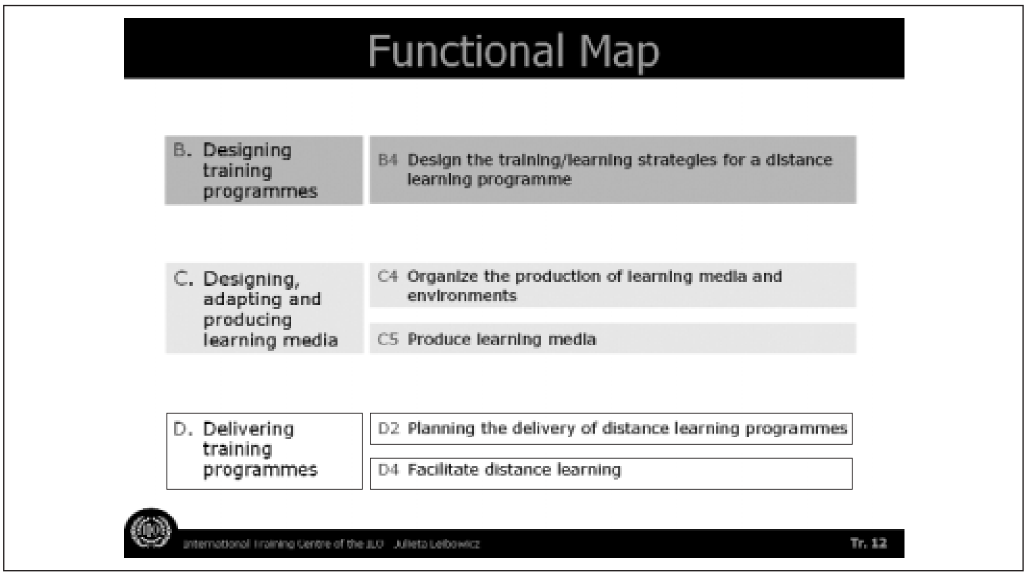
Tr. 11


Functional Map
B. Designing training programmes
B4 Design the training/learning strategies for a distance learning programme
C. Designing, adapting and producing learning media
C4 Organize the production of learning media and environments
C5 Produce learning media
D. Delivering training programmes
D2 Planning the delivery of distance learning programmes
D4 Facilitate distance learning
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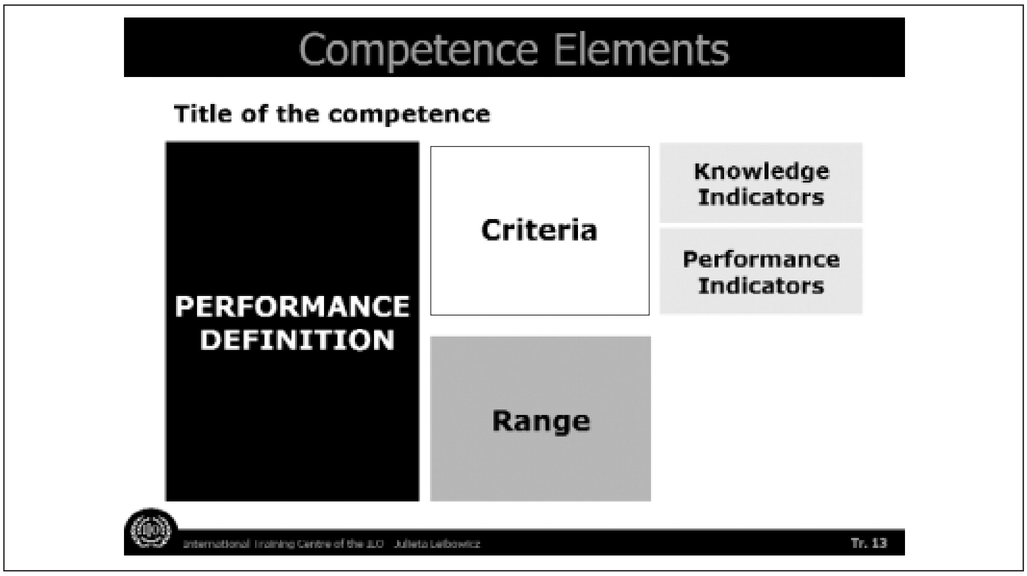
Tr. 12


Competence Elements
Title of the competence
PERFORMANCE DEFINITION
Criteria
Knowledge Indicators
Performance Indicators
Range
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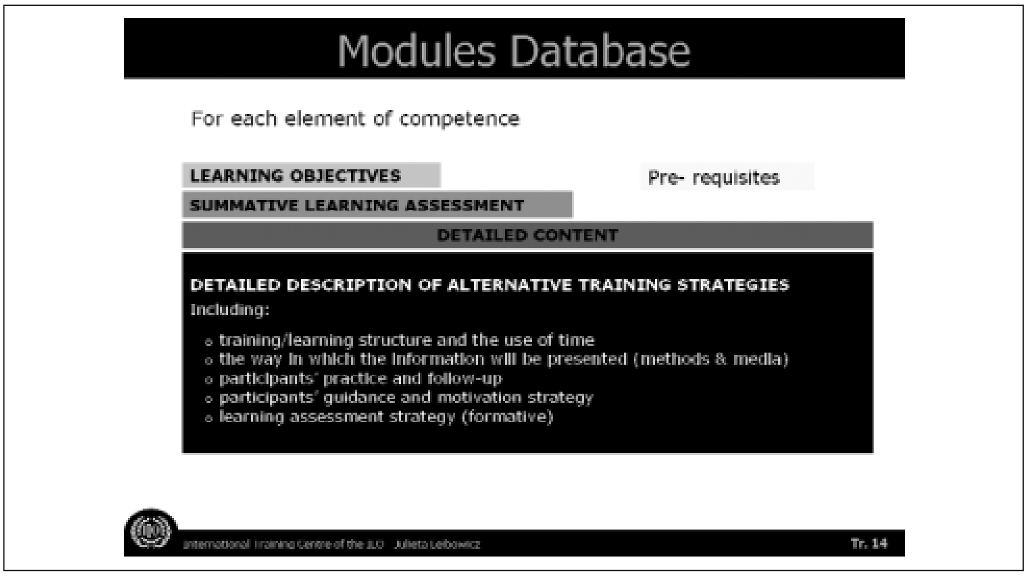
Tr. 13


Modules Database
For each element of competence
LEARNING OBJECTIVES
Pre- requisites
SUMMATIVE LEARNING ASSESSMENT
DETAILED CONTENT
DETAILED DESCRIPTION OF ALTERNATIVE TRAINING STRATEGIES
Including:
training/learning structure and the use of time
the way in which the information will be presented (methods & media)
participants' practice and follow-up
participants' guidance and motivation strategy
learning assessment strategy (formative)
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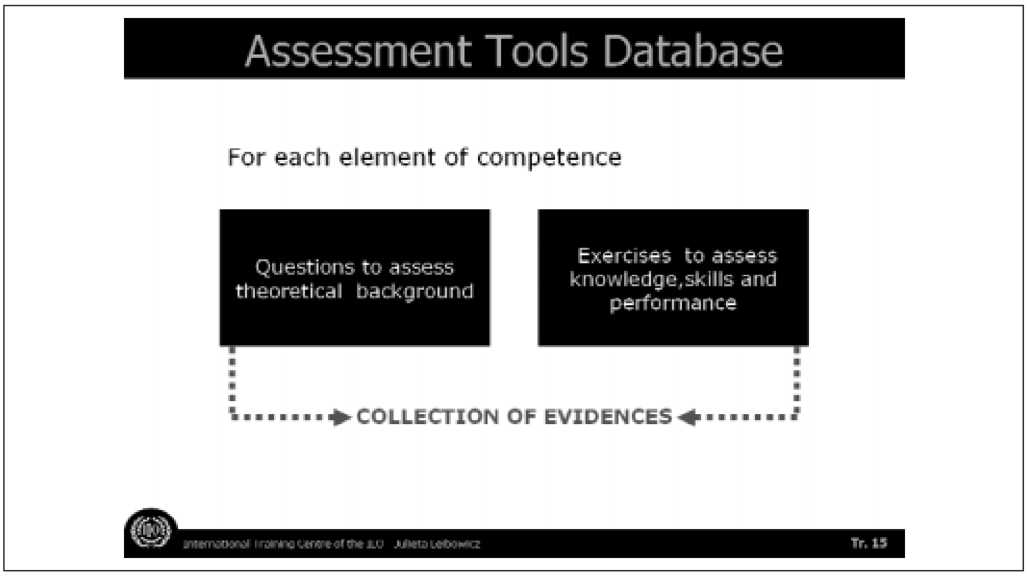
Tr. 14


Assessment Tools Database
For each element of competence
Questions to assess theoretical background
Exercises to assess knowledge,skills and performance
COLLECTION OF EVIDENCES
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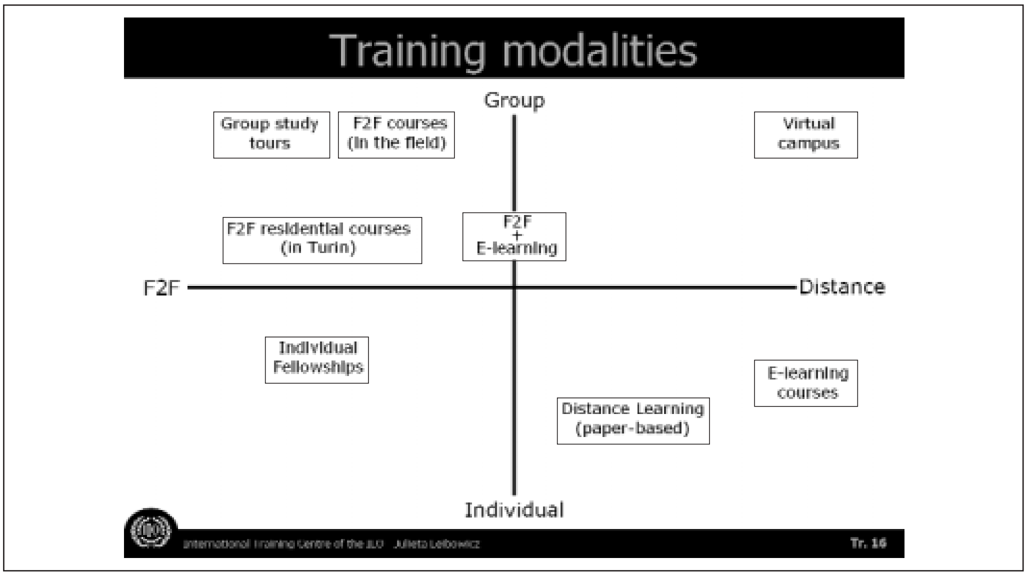
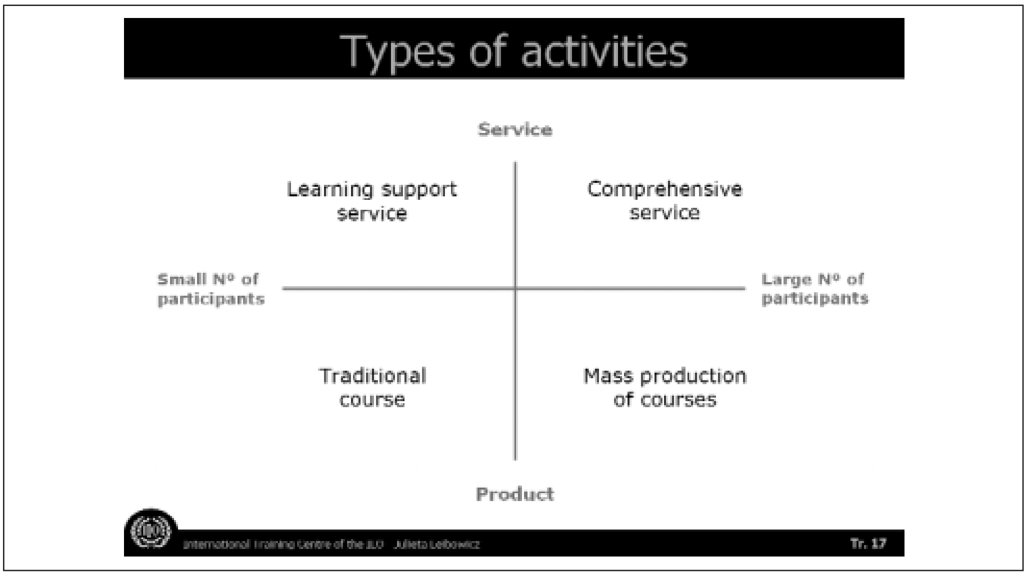
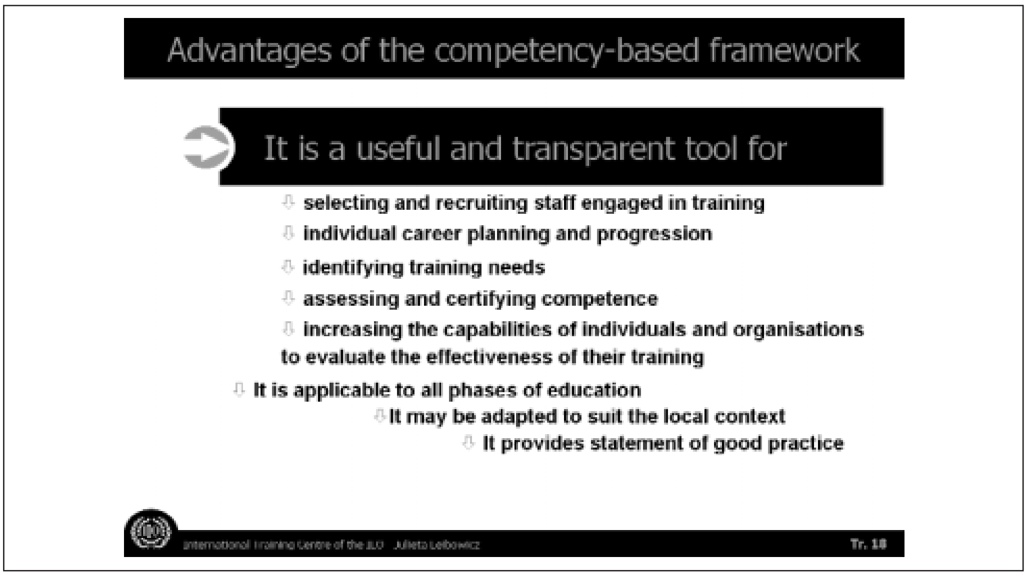
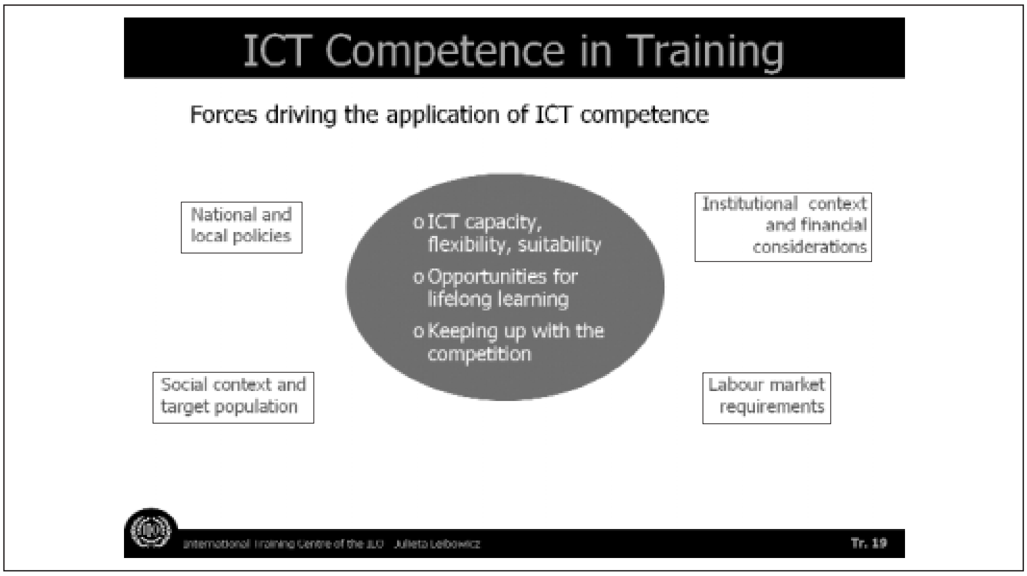
Tr. 15


Training modalities
Group
Group study tours
F2F courses (in the field)
Virtual campus
F2F residential courses (in Turin)
F2F + E-learning
F2F
Distance
Individual Fellowships
E-learning courses
Distance Learning (paper-based)
Individual
Tr. 16


Types of activities
Service
Learning support service
Comprehensive service
Small Nº of participants
Large Nº of participants
Traditional course
Mass production of courses
Product
Tr. 17


Advantages of the competency-based framework
It is a useful and transparent tool for
selecting and recruiting staff engaged in training
individual career planning and progression
identifying training needs
assessing and certifying competence
increasing the capabilities of individuals and organisations to evaluate the effectiveness of their training
It is applicable to all phases of education
It may be adapted to suit the local context
It provides statement of good practice
Tr. 18


ICT Competence in Training
Forces driving the application of ICT competence
National and local policies
o ICT capacity, flexibility, suitability
o Opportunities for lifelong learning
o Keeping up with the competition
Institutional context and financial considerations
Social context and target population
Labour market requirements
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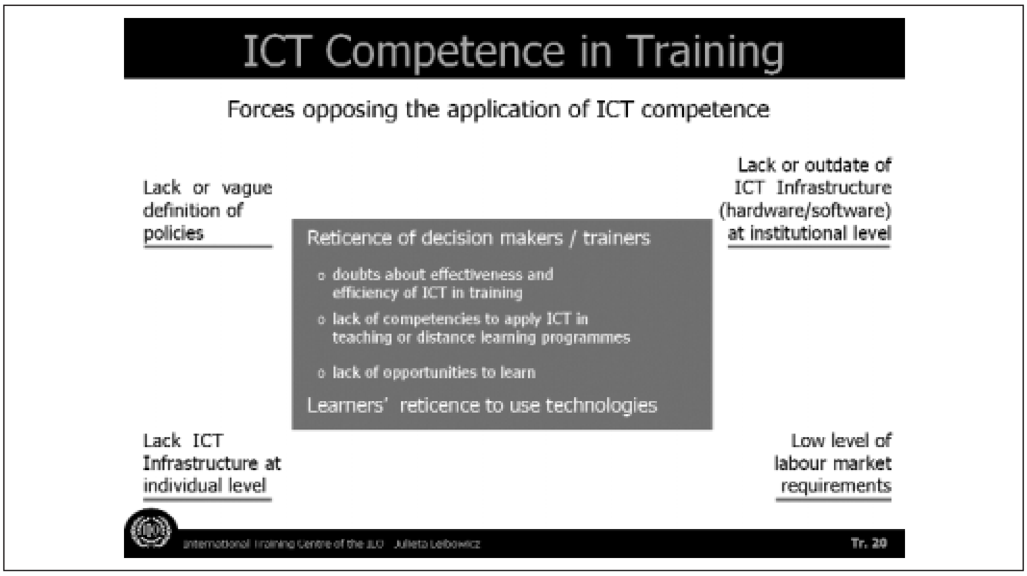
Tr. 19


ICT Competence in Training
Forces opposing the application of ICT competence
Lack or vague definition of policies
Lack or outdate of ICT Infrastructure (hardware/software) at institutional level
Reticence of decision makers / trainers
o doubts about effectiveness and efficiency of ICT in training
o lack of competencies to apply ICT in teaching or distance learning programmes
o lack of opportunities to learn
Learners' reticence to use technologies
Lack ICT Infrastructure at individual level
Low level of labour market requirements
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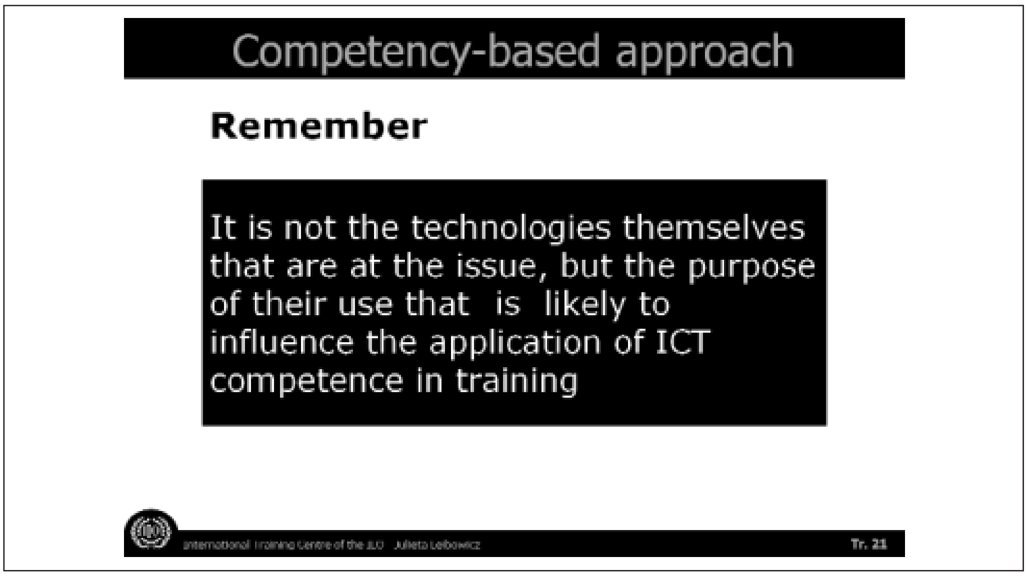
Tr. 20


Competency-based approach
Remember
It is not the technologies themselves that are at the issue, but the purpose of their use that is likely to influence the application of ICT competence in training
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Tr. 21

Detailed functional map for the management of technical and pedagogical contents of training technology

A. ANALYSING TRAINING REQUIREMENTS

A1 Define a training problem within a geographic area:
- A1-1 Identify the problem that motivates a training programme within a geographic area.
- A1-2 Justify the need for a training programme within a geographic area.

A2 Define a training problem within an organization:
- A2-1 Identify the problem that motivates a training programme within an organization.
- A2-2 Justify the need for a training programme within an organization.

A3 Identify and analyze competence standards:
- A3-1 Identify competence standards' units and elements (functional analysis).
- A3-2 Describe competence units and elements.

A4 Assess training needs within a geographic area:
- A4-1 Analyze the training demand within a geographic area.
- A4-2 Analyze the training supply within a geographic area.
- A4-3 Identify training needs within a geographic area.

A5 Assess training needs within an organization:
- A5-1 Analyze jobs.
- A5-2 Identify training needs within an organization.
- A5-3 Identify training needs within a group of organizations with similar characteristics.

A6 Analyze the population targeted by a training programme:
- A6-1 Analyze the physical characteristics of a target population.
- A6-2 Analyze the educational, professional and cultural characteristics of a target population.

A7 Analyze the resources available and the constraints for the design and implementation of a training programme:
- A7-1 Identify the human resources available for the design and implementation of a training programme.
- A7-2 Identify the physical and financial resources available for the design and implementation of a training programme.
- A7-3 Identify the information resources available for the design and implementation of a training programme.
- A7-4 Identify the constraints that need to be considered in the design and implementation of a training programme.

B. DESIGNING A TRAINING PROGRAMME

B1 Select the training modalities for a training programme:
- B1-1 Identify the requirements for a training programme to be considered in the selection of a training modality.
- B1-2 Select a training modality.

B2 Define the learning objectives, pre-requisites and contents of a training programme:
- B2-1 Formulate the general objectives of a training programme.
- B2-2 Formulate the specific objectives and pre-requisites of a training programme.
- B2-3 Select the contents and define the sequence of a training programme.
- B2-4 Define the learning approaches for a given training programme.

B3 Design the teaching/learning strategies and the learning assessment strategies for a face–to–face training programme:

B3-1 Select the teaching/learning methods and media to be used in a given face-to-face learning situation.

B3-2 Design the formative learning assessment strategies and tools to be used in a given face-to-face learning situation.

B3-3 Design the teaching/learning situations to be developed in a given face-to-face training programme and estimate the comprehensive use of time.

B3-4 Design the summative learning assessment strategies and tools to be used in a face-to-face training programme.

B4 Design the teaching/learning strategies and the learning assessment strategies for a distance learning programme:

B4-1 Select the teaching/learning methods and media and the learning environment to be used in a given distance learning situation.

B4-2 Propose the motivation strategies to be used and the meta-cognition strategies to be developed (amongst the participants) within a given distance learning situation.

B4-3 Design the formative learning assessment strategies and tools to be used in a given distance learning situation.

B4-4 Design the teaching/learning situations to be developed in a given distance learning programme and estimate the individual average learning time.

B4-5 Design the summative learning assessment strategies and tools to be used in a distance learning programme.

B4-6 Identify the information and communication means and the learning management parameters to be applied in a. given distance learning programme.

B5 Validate a face–to–face training programme:

B5-1 Validate the coherence amongst the components of a face-to-face training programme.

B5-2 Validate, in a face-to-face programme, the pertinence of the teaching/learning methods and the pertinence and quality of the learning media.

B6 Validate a distance learning programme:

B6-1 Validate the coherence amongst the components of a distance learning programme.

B6-2 Validate, in a distance learning programme, the pertinence of the teaching/leaning methods and media, motivation and learning assessment strategies and tools, learning environments and communication media.

C. DESIGNING, ADAPTING AND PRODUCING LEARNING MEDIA AND ENVIRONMENTS

C1 Define a project for the production of learning media and environments:

C1-1 Identify the demand and needs for learning media and environments.

C1-2 Prepare a proposal for the development of learning media and environments in response to identified demands and needs.

C1-3 Present and negotiate with the parties involved a proposal for the development of learning media and environments.

C2 Define the modifications to be introduced in learning media and environments and its integration into a training programme:

C2-1 Acquire existing learning media and environments.

C2-2 Define the necessary modifications of existing learning media and environments, and/or their integration into a given training programme.

C3 Design learning media and environments:

C3-1 Select the technical standards to be adopted in the production of learning media and environments.

C3-2 Define the content structure for learning media.

C3-3 Define the structure for learning environments.

C4 Organize the production of learning media and environments:

- C4-1 Define the technologies to be adopted for the production of learning media and environments.
- C4-2 Plan the production of learning media and environments.
- C4-3 Identify the human resources to be used in the production of learning media and environments.
- C4-4 Define the management and follow-up modalities for the production of learning media and environments.

C5 Produce learning media and environments:

- C5-1 Organize and coordinate working groups for the production of learning media and environments.
- C5-2 Manage and control the production of learning media and environments.
- C5-3 Integrate the sub-products of the different phases in the production of learning media and environments' final version.

C6 Validate learning media and environments:

- C6-1 Organize the analysis of prototypes of learning media and environments.
- C6-2 Organize the final validation of learning media and environments.

D. DELIVERING A TRAINING PROGRAMME

D 1 Plan the delivery of face–to–face training:

- D1-1 Plan face-to-face training sessions.
- D1-2 Prepare learning materials and media for face-to-face training sessions.
- D1-3 Organize learning environments in face-to-face training situations.

D2 Plan the delivery of distance learning:

- D2-1 Plan individual and group distance learning activities.
- D2-2 Prepare pre-work information and supplementary learning materials for distance learning.
- D2-3 Test distance learning environments.

D3 Facilitate face–to–face training:

- D3-1 Build good working relationships in face-to-face training situations.
- D3-2 Implement appropriate interventions in face-to-face training situations.
- D3-3 Monitor the learning process in face-to-face training situations.

D4 Facilitate distance learning:

- D4-1 Build good working relationships in distance learning situations.
- D4-2 Support individual and group learning at a distance.
- D4-3 Monitor the learning process at a distance.

D5 Assess the individual achievement of competence:

- D5-1 Agree and review a plan for assessing performance.
- D5-2 Collect and judge performance evidence against criteria.
- D5-3 Make performance assessment decisions and provide feedback.

E. EVALUATING A TRAINING PROGRAMME

E 1 Validate the design of a training programme:

- E1-1 Evaluate to what extent a training programme responds to the identified training needs.
- E1-2 Validate the content of a training programme.
- E1-3 Evaluate the quality of a training programme.

E2 Evaluate the implementation of a training programme:

- E2-1 Evaluate the coherence between the design and the implementation of a training programme.
- E2-2 Evaluate the participants' satisfaction in a training programme.

E3 Evaluate the results of a training programme:

E3-1 Evaluate the effects of a training programme.
E3-2 Evaluate the impact of a training programme.

E4 Evaluate the cost of a training programme:

E4-1 Analyze the cost of a training programme.
E4-2 Analyze the cost/benefit ratio in a training programme.
E4-3 Analyze the cost/effectiveness ratio in a training programme.