METABOOK.
EVALUATING THE POSSIBILITIES OF E-BOOKS IN SCHOOLS

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ABSTRACT
The objective of METABOOK project is to investigate the possibilities of e-books in the classroom and in the education field in general, as a possible replacement of traditional “paper books”, in order to minimize the cost of reprinting books every year and to achieve better educational results by offering to students and teachers, interactive and continuously updated information and knowledge. During the project, the latest computer technologies were used (Internet, Java, DHTML, virtual experiments, wi-fi LANs) and the latest devices were evaluated (e-books, tablet PCs, PDAs, touch screens e.t.c.). The software of the project (12 lessons of high school physics) was localized and adapted into two languages and three different curricula and was evaluated within real class environment in different schools, even with handicapped students. The conclusion so far is that e-book devices in schools have many critical advantages over traditional paper books, technically, financially and educationally. Thy can very well act as a partial replacement or even better an additional educational tool but there are many more things that should be evaluated. Technologies are changing so fast, new and cheaper devices appear every year and a wider evaluation in more subjects and more ages should be undertaken in the future.

KEYWORDS
Metabook, e-book, learning, school, education, Internet

INTROCUCTION

Education of Yesterday

The primary goal of education has always been to prepare students for their role as active, effective members of society. Schools tend to reflect the societies in which they are embedded. As society changes and therefore the needs of the students change, historically, so have the educational models that teach them.

When the students' society was based on agriculture, their needs were limited to *basic reading, writing and mathematic skills,* and those were the skills they were taught. Higher level thinking and communication skills were not needed by the majority, and were taught only to an elite few.
As the industrial age appeared in the late 19^{th} century, schools responded by developing the "factory" model, where orderly rows of students quietly absorbed basic facts and skills. (Fig.1.) As industry strived for quality control and consistency in its products, so did education. *Efficiency* and *correctness* were stressed, while *creativity* was discouraged. A student should either strive for perfection and uniformity, or had to give up after realizing that he would never "fit the mold."

Education of Today

Today, we are poised on the brink of another revolution, that of technology. In today's world, technology impacts our daily lives from our conception to our demise, in ways never thought possible. In order to prepare our students for the role they will play in such a society, as educators, we are compelled to restructure our curriculum to bring technology into our classrooms in a meaningful way. The outdated *"factory model"* no longer fits the image of modern society, and no longer serves our students. Though this model of education has proven effective at teaching basic skills to students, it is not suited to a society in which individual success often depends on a person's ability to adapt to change.

Today's students will need to understand and operate complex technological concepts and tools. They will need to be flexible and creative in their thinking, and able to communicate effectively with the global community. Today's classroom must reflect the image of today's society. The learning that goes on must be fluid and dynamic in nature, open to creativity and independent, with critical thinking. It must foster communication on a global scale.

The most important driving force behind expansion of computer communications has been the Internet, a "network of networks" now used by million people around the world. It provides a means for collaboration research and learning not bound by walls, distance, or time. Technology is the key to modern school reform, but it must be used in an effective and meaningful way.

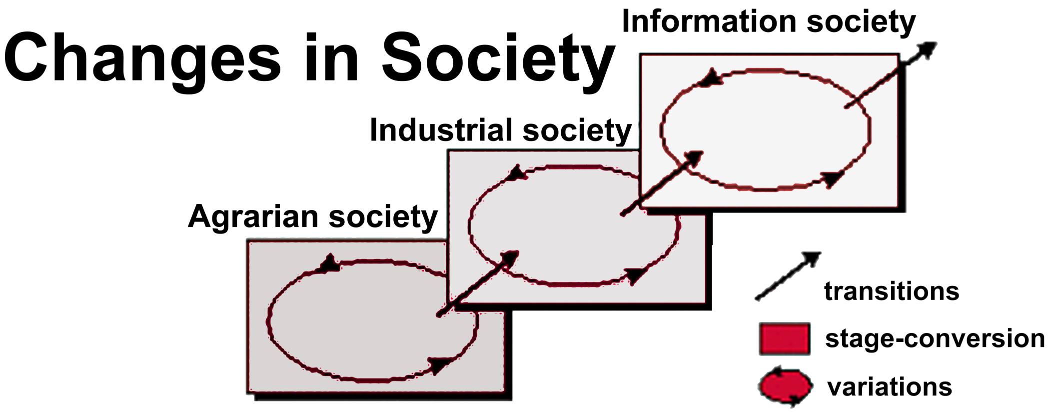

Figure 1

ADVANTAGES OF TECHNOLOGY

Technology offers unlimited new ways of learning, of teaching, and of running schools, and our classrooms must be ready for it. Just as the printing press enabled standardization and mass production of educational materials for the "factory" schools of the industrial age, telecommunication technology, in particular the Internet, will foster the creative and independent thinking skills needed by today's students. In order to meet the needs of students in the technology age, and to be an effective facilitator of their learning, the modern educator must take an active role in infusing technology into their curriculum.

In an effort for self-preservation, industry needs to take a more active role in contributing to and reforming education. Governments must make efforts as well, to support and fund the technological tools and software needed to bring about these changes in education, and to assure equity of access to the new technologies for all students.

With the proper support, technology offers one of the most powerful means available for breaching the barriers of class, race, and income that divide students, thus, ensuring equity.
At the school level, fundamental changes must ensure that the school system will adapt to change and demand access to the technologies they need for educational reform. A significant hurdle to realizing school reform is the knowledge and skill level of the educator. Prior to the technological revolution in

the late 20th century, the largest body of knowledge was static. Once a teacher learned this information, he was able to disseminate it sufficiently to his students through lecture and demonstration.

Today, knowledge and learning are fluid and dynamic in nature, growing and changing at an exponential rate. Even the youngest students come to school with quite sophisticated theories about the world, and have an intuitive understand of language, numbers, and science based on their previous experiences. These experiences have given children a different way of interacting with information compared with previous generations (The Nintendo Generation).

The great majority of teachers will not be able to take full advantage of technology that is now available without technical support, thus, we need to invest in teachers. The teachers themselves must then take an active role in incorporating their newly learned skills into their curriculum with purpose and meaning.

For students this practically means that they will formulate concrete learning goals and activities (plans), subsequently work on useful products in a learning environment created by the program (execution), and, finally, they will evaluate the degree to which those activities have contributed to the realization of their learning goals and the acquisition of competencies.Figure 2.

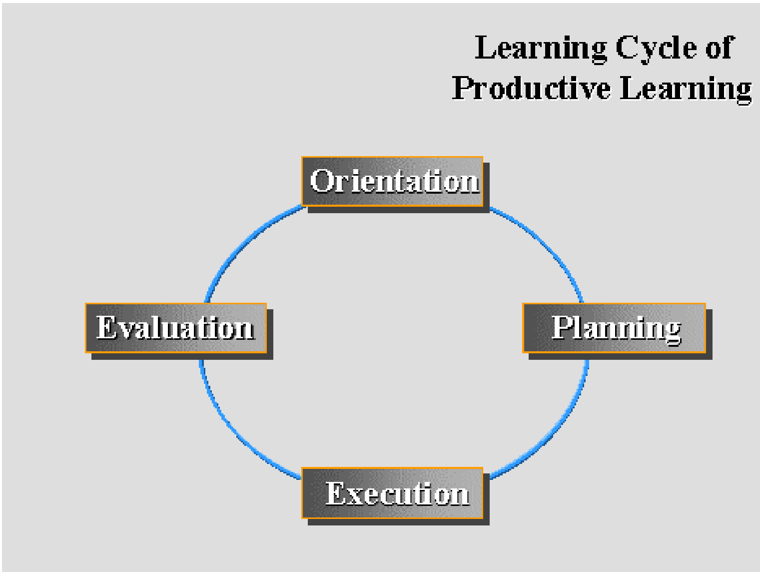

Figure 2. Learning cycle of productive learning

Computers have failed to deliver the transformation in learning that has been promised and promoted over the past fifteen years. Walk into most any classroom in most any school in Europe or America today and you'll walk into a time warp where the basic tools of learning have not changed in decades. While it is true that students in countless schools have computer experiences of varying degrees, the fact is that those experiences are usually not wed to the "normal" academic life of the rest of the school. Teachers simply have not embraced the computer as a basic tool of learning.

It is no secret, of course, that one of the biggest failures is the lack of appropriate staff development.[16] And of course, when one talks about technology and staff development, the focus is often on "training" teachers how to use the technology and what is known as "how to integrate it into the curriculum." Unfortunately, these tasks are exactly what most schools... and most teachers... are not equipped to accomplish.

Today, we find ourselves in the best of times, and in the worst of times. Never before have teachers had so much real potential to fully exploit the "tool" capabilities of the new technologies. We see real evidence around us every day that the World Wide Web is actually beginning to change our lives. However, the schools are still stuck in an outdated paradigm more akin to the 19^{th} Century than to the 21^{st}

We now have the perfect choice in our hands, to help both the education process and the teachers. Technology can provide us with a tool that can bring together old and modern educational concepts. Traditional paper books, with the unleashed power of computers and Internet. And this tool is "E-BOOK".

A device, that if used properly, can "look friendly" and most of all *familiar* to all "traditional educators". Easy to use and manipulate to most of the students and extremely useful to people that will decide to work with it.

More and more companies are publishing e-books today, while manufacturers, with the aid of technology seem to favor TABLET PCs as a form of a vastly improved E-BOOK device. Actually, a compromise among a PDA device, an E-BOOK device and a LAPTOP PC.
Even Microsoft developed a special version of its operational system –Windows– specifically for Tablet PCs.

With an initial cost of 3-4.000 EUROS, certain Tablet PC models have now reached a –retail– cost of 500 EUROS, within only two years in the market. This practically means that in another couple of years, the "wholesale' (factory) price of Tablet PCs (for example orders placed by a ministry of education) will be well under 200 EUROS per device.

On the same time, it is inevitable to compare this cost, with the cost of traditional paper schoolbooks.
In our research, we took as an example a 10 million people country (Greece).
The situation (Source: Ministry of Education of Greece, year 2002) is as follows:

	No of Schools	**No of Students**	**Books/student**	**Total books**
Elementary	5.474	636.463	10	6.364.630
High School	1.960	350.493	12	4.205.916
Upper H. School	1.341	243.848	15	3.657.720
Technical School	538	140.734	15	2.111.010
	Total Students:	1.371.538		16.339.276
		Average cost per book:		3 €
		Total cost of books:		49.017.828 €

Average cost for the books of one student: 30 - 45 €
Cost for books per student, for 12 years: 360 - 540 €
Total cost of books for 12 years of school: ≈ 600.000.000 €

There is no hope that the cost of books will change in the close future. Quite the opposite, it is expected to rise. Books have many advantages but their disadvantages are exactly where e-books excel!

- They contain limited information while e-books contain practically unlimited amount of information.
- They luck interactivity
- They luck multimedia capabilities
- After the end of the school year they are useless to the students and they need to be replaced
- It is practically impossible to change their content, even if a mistake will be found or the contained information and data will change as time passes
- A significant weight must be carried by student every day
- They cannot be adapted to different curricula or different schools or different needs
- There is a huge problem in publishing and distributing them to students

For all the above-mentioned reasons, we decided to emphasize in the supplementary usage of e-books in education and research the best way to develop really useful, interactive and innovative e-book lessons. Our proposal was approved and is partially funded by the European Union "Socrates" program. The project was named METABOOK (after-book, the future book).

OUR PEDAGOGICAL APPROACH

Introduction of information and telecommunication technology, and specifically computers, into the educative process has been heralded as a panacea for the woes of education. The technology does offer teachers the opportunity to individualize instruction, place children in open ended student centered investigations, and to shift from their traditional instructor role to mentor and co-learner but the panacea, like past revolutions in education, will go the way of previous technologies unless changes to our schools and the tools provided with computers occur. These changes need to be part of a shift in teachers becoming more disposed to view learning as an active, creative, and socially interactive process and to view knowledge as something children must construct and less like something that can be transferred. Additionally software tools need to be available in order to support the learner in construction of this knowledge.

> *In order to understand how to achieve these goals, the development of an extensive research base of empirical evidence to support the changes that we instigate in learning environments needs to be developed (Bork, 1995)[4]*

One of the most extensive longitudinal studies on the effect of the introduction of information technology in classrooms has been carried out under the Apple Classroom of Tomorrow (ACOT) program (Dwyer, 1995).[6] The ten year research and development collaborative program focused on how teaching and learning change when teachers and students have routine access to technologies. One of the key elements of this program was a belief that technology should be used as a tool for learning and a medium for thinking, collaborating, and communicating. The research showed teaching in ACOT classrooms compared with traditional classrooms involved more project work, more extensive projects, more motivation for the writing process, more group work and cooperative learning, more interdisciplinary activities, more opportunity for students to make choices and a different philosophy of teaching. It also involved less structure, less teacher presentation and the elimination of worksheets.
In support of these findings, Schofield & Verban (1988)[18] have found that:

> *"The introduction of computers into the classroom changes the teachers' role... leading to decreases in teacher-directed activities and a shift from didactic approaches to a constructivist approach"*
>
> *The role of software in this process has also been examined and Norman (1993)[14] has proposed that the software used in such environments should support the change in teachers' views.*
>
> *"The trick to teaching is to entice and motivate the students' excitement and interest in the topic, and then to give them the proper tools to reflect, to explore, compare, and contrast, to form the proper conceptual structures"*

Don Norman's view of software for classrooms has formed the basis of the design goals for Media Fusion, (Bellamy, et al, 1995)[2] the designers of the program "Media Fusion" use video to motivate users and then provide data and data analysis tools to allow them the opportunity for deeper reflection on the issues presented in the video.
The overall outcomes of the ACOT program have been summarized by David Dwyer (1995)[6]

> *.... technology plays a catalytic role in opening the minds of teachers to new ideas about children, learning, and their own role in the education process.*

Dwyer also claims that without this form of reflection and subsequent changes in professional practice, the promise of technology will never be realized. This premise supports the criticisms of Bork (1995)[4] and Schank and Cleary (1995)[19] of our current modes of education.

The pedagogical approach we used in METABOOK, adopted tenets from both the cognitivist and constructivist paradigms. Norman' Schemata Theory (1976)[15], and the Generative Learning Theory (Wittrock, 1979)[22] posit that learning is a matter of acquiring new structures by constructing new nodes and interrelating them with each other and existing nodes. Like hypertext nodes, schemata can be combined and linked to form larger structures. (Fig.3.)

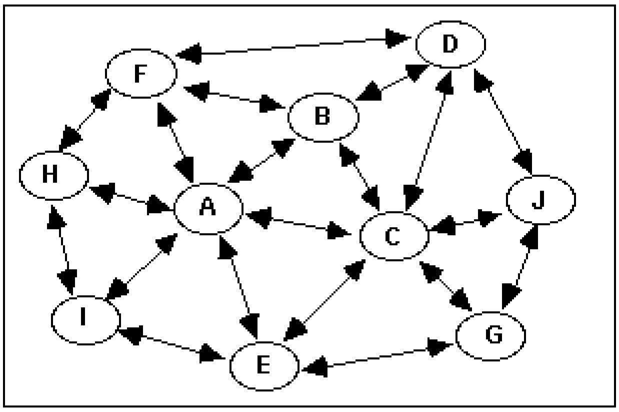

Figure 3. Schemata of inter-related nodes

There is a therefore a relationship between the Schemata theory and interactive multimedia design and development, as both are based on the concept of assembly and construction. The class instruction was built like the nodes in Norman's Schemata. Once the students had acquired this expanded schemata, they were then able to assemble and construct their own learning in their own idiosyncratic way.

In addition, the pedagogy allowed for a high level of constructivistic activity in class. Jonassen (1993)[11], said that constructivists claim that reality is in the mind of the knower. Constructivism is concerned with how we construct knowledge from our experiences, mental structures and beliefs and use this constructed knowledge to interpret objects and events. Thus this theory also applies to students, learning how to build their own knowledge of subjects. In our case, although the instructor demonstrated equipment operation and highlighted useful features of the METABOOK application, the multimedia novices did not fully comprehend until they had hands-on practice. To them, the reality of learning occurred when they themselves were pushing buttons, pressing keys and finding their own solutions. A constructivistic environment therefore naturally promotes self-directed learning. This constructivist approach alters, but *does not diminish the teacher's role* as the teacher now functions as a mentor or coach who guides students in their construction of knowledge.

Research shows that experts and high achievers do very well in a constructivist environment as they are self-motivated and are capable of high individual performance. However, multimedia novices and lower ability students require more structured and guided instruction and often faired poorly when asked to construct their own knowledge. Glaser and Chi (1989)[9] suggest that while experts are able to quickly access a solution strategy because that strategy is closely linked (in memory) to the problem node, solution times are slower and less fluid for novices as they must engage in one search to identify the problem and another to solve it. In a multimedia scenario, novice students will face many intellectual and technical problems, but given ample planning and usage time, determined and motivated multimedia novices can devise appropriate solutions to their learning and comprehending problems.

FEATURES OF METABOOK

The final product is expected to have following features:

1. Low cost, ease of use, and an intuitive, point and click GUI,
2. Suitability for use without elaborate training by academic staff and students at primary, secondary or even tertiary educational and training institutions, which are equipped with inexpensive multimedia computers, tablet PCs or even PDAs.
3. Presentation in a constructivist problem-based learning format,
4. Incorporation of physicist and philosopher David Bohm's (1980)[3] approach to the study of complex phenomena as an "unbroken whole" system, rather than attempting to acquire expertise in a discipline in a serial and isolated mastery of its component parts
5. Recognition of the indispensability of the learner-mentor interactions as a fundamental element in the optimal learning process, which may be supplemented, but not replaced, by computer-based multimedia presentations.
6. Open source code for easy amendments, corrections and localization, even at real time
7. Portability to many platforms and to the Internet
8. Easy navigation. Know where you are at any moment, go everywhere with maximum of two clicks
9. No scrolling in main pages. The information you will need is 100% visible once you will enter the page.
10. Minimum of text. Step by step progress at user's pace
11. Self evaluation capabilities in every lesson and in every chapter
12. Additional tools (editor, unit converter, lab book, teacher's book e.t.c.)

The rationale for the cost and functionality specifications, in points 1., 2. and 6. above, is the premise that multimedia authoring software for educational purposes should be demystified and accessible to the broadest number of teachers and their students who wish to create their own multimedia learning materials.

A further premise of this project is that educational use of multimedia does not require broadcast quality standards or the creation of expensive graphic effects in order to be effective. It is submitted that, for educational purposes, the trade-off between production values and ease of production should fall heavily on the side of simplicity and low cost.

WHAT WE DID

We decided to build a software that will use the above mentioned theories, learning techniques and pedagogical approaches in the best possible way. On the same time we wanted the software to be universal and able to run on most of the available platforms and operational systems.
The basic platform of choice was TABLET PC, but we also wanted it to be able to run on PDAs, laptops, and naturally, ordinary home computers.

We basically designed everything to be able to run on Windows OS, however, we chose technologies that will permit the user to use the application in Macintosh and Linux environments, even on-line, through the Internet, by using any device and any OS that has a Web browser.

Therefor, the tools that we could use were very specific: tools to develop Internet applications.
This fact, posed certain restrictions, and so, we either had to find the best solution to overcome problems or to compromise.

The most difficult to overcome problem was the interactive, virtual laboratories. Java applets, which are so widely used for this kind of applications, do not allow large flexibility, cannot have appealing 3D graphics and thus are not so friendly to students or cannot look so "close" to the "real world." Therefore, we basically decided to use Flash interactive animations for the virtual experiments of the basic application.

Java however, has without any doubt, some not easy to find elsewhere advantages. Small size is the most important of them, even if we compare Java applets with the vector graphics of Flash animations. Thus, we decided to offer a two versions METABOOK at the final stage of the project. A “heavy one” with 3D interactive experiments, close to the real world, for off line usage or for fast (broadband) Internet or local network connections, and a “light” one, for low storage capacity devices (f.e. PDAs), direct on line usage and slow Internet connections.

As for the rest of the application (besides virtual experiments), the choices were almost “one way”. We used HTML (sometimes in a very complex way, with frames, pop up windows e.t.c.), together with Java applets, Javascript and DHTML.

This meant that we had to develop special applets or certain routines to do specific jobs. As an example I can refer to the most basic ones:
1. *Pop up information windows.* These are certain small windows that pop up either on click or on pass over, to show a certain kind of information to the user. For example they can show the explanation of a certain term (without having to refer to the dictionary), or they give feedback upon choosing a reply between the possible ones in questions or exercises. These windows have adjustable colors, fonts, sizes, line thickness and they can even show pictures.
2. *Editor.* At certain stages, the user might want to keep notes or reply to an exercise in written form. A special Java text editor was developed for this purpose.

The above technologies, brought to us a very welcomed advantage. The application was “open sourced” at least to its greatest extent. This means that teachers with small programming experience, could easily perform three tasks:
A. Localize the application into another language
B. Adapt the application to their curriculum
C. Add their own content or make corrections to the current one

It will be quite easy to develop further tools, which will permit teachers to change the content of METABOOK, without having any programming knowledge, as simple as it is to use a text editor. However, the development of such applications is beyond the scope of this project.

POINTS OF ATTENTION IN DEVELOPING THE APPLICATION

Criticisms of Educational Multimedia

A major ongoing complaint about computer assisted learning and interactive multimedia is that it is more suited to teaching simple recall of facts (rote or surface learning) than it is for promoting understanding of complex processes (meaningful or deep learning). This shortcoming is linked to the limited range of interactions that are available within the current technology. Other critics have stated that the design of so-called educational multimedia is driven more by the technology than by sound educational principles. We will now describe how we attempted to address these issues by applying the findings from current research into the use of multimedia in teaching and learning, to the design of METABOOK. Some of the educational principles identified by the research which we attempted to apply to the instructional design included:
- the pedagogical approach to be followed (instructivist vs constructivist);
- the context in which the program will be used (to replace or supplement lectures);
- the degree of learner control (student control versus program control);
- the degree of interactivity (page turning through to virtual reality);
- individual differences between users (how does the program cater for these?).

Pedagogical Approach

In a recently published guide for developing interactive multimedia, Phillips (1996, p.17)[17] states that multimedia educational process is best taught from a "constructivist viewpoint" and that "constructivism provides the guiding philosophy behind design of effective educational materials". This view is supported by a report from the University of Queensland, Tertiary Education Institute on "The Effectiveness of Multimedia as an Instructional Tool Within Higher Education (Andrew and Isaacs, 1995)[1]. In a section on the "constructivist philosophy", it states that, "multimedia provides an ideal learning environment for this sort of learner activity and it is this view of learning which is the foundation upon which many of the claims for the effectiveness of multimedia are based".

Phillips (1996, p.17) [17] also links the constructivist approach with the use of an n-dimensional network of information where the student can navigate almost at will, instead of a quasi-linear flow through the program. This is sometimes called "Hypermedia" (Cotton, 1993)[5]. He goes on to warn us, however, of the danger of the student becoming "lost in hyperspace" (Smith, 1989)[20]. To prevent this, we fully covered the need for navigation aids, which allow the students to find their way, back to a specific reference point or to jump between sections.

Context of Use

Although the context in which the program would be used was specified in the original application for funding by the European Union, it was still subject to change if it was not consistent with sound educational practice. It was decided, however, not to change this original decision when research showed that, "studies employing multimedia to supplement instruction produced significantly higher achievement effects than when multimedia replaced traditional forms of instruction." (McNeil and Nelson, 1991)[13].

Learner Control

There has been extensive research on this aspect of multimedia design. The findings so far show that any benefits are "dependent upon the degree of control and the extent of prior knowledge in the particular subject area." (Andrew and Isaacs, 1995)[1]. The most effective forms of control are described as "guided control" or "learner control with advisement" (McNeil and Nelson[13], 1991; Steinberg[21], 1989). The studies also show that students who have little prior knowledge about a subject are likely to perform poorly when they are given total control over the program, (Steinberg, 1989) [21]. According to this, it was decided to allow students in METABOOK to select a "browse mode" or "tutorial mode" in which they would be given a suggested sequence for working through the materials rather than being locked into a set linear path.

Interactivity

The research shows that "the higher the level of interactivity, the more effective the program in terms of learning outcomes (Fletcher, 1990)[7]". One form of interactivity is the feedback that a user is given when they answer questions as part of a test or quiz. Studies show that the more elaborate the feedback, the more learning is increased (Hannafin et al., 1986)[10]. Laurillard (1993)[12] believes that any action without feedback is completely unproductive for a learner. In order to achieve high levels of interactivity in this program, it is intended to design a range of activities in which the user clicks and drags items in a virtual laboratory, which simulates a full lab in a "safe" environment. It is also intended to provide comprehensive feedback to questions that go far beyond the usual "correct" or "incorrect".

Individual Differences

The report by Andrew and Isaacs (1995)[1] describes two "major characteristics which have been studied" as "learning style and information-seeking behavior". The findings on learning style are inconclusive while those on information-seeking behavior (Gill and Wright, 1994)[8] identified three distinct groups as described below:

> *The 'book reader' makes a steady linear progression...making little use of the available resources, but nonetheless gains a reasonably good understanding of the text being studied. The 'studier' also exhibits a fairly linear progression but with a tendency to flick backwards and forwards, referencing earlier texts, and making sensible use of resources... the 'studier' exhibits the best understanding....The third group, the 'resource*

junkies' often generate the most number of events but do so in a rapid manner... They usually gain little understanding from the material, but usually enjoy the package. (p.143)

The authors concluded that the 'book readers' and the 'resource junkies' need to be presented with interaction cues to provide more guidance as to the optimum course to take through the material. As described earlier under "learner control" it is intended to provide such an "optimum course" within the "tutorial mode". The only problem that remains is to find some way to identify the 'book readers' and 'resource junkies' and encourage them to follow this path.

CONCLUSION

Education is the pursuit of knowledge and the exploration of the known and unknown. It is a constantly evolving and changing journey through a wild and untamed landscape. It is fraught with anxiety and filled with victories. It is the place where we build relationships, friendships, partnerships, and where we can examine ourselves. Education is a noble and pure pursuit, in an imperfect world. The discoveries of yesterday combine with the explorations of today to bring us the education of tomorrow. How best can we be a part of this exciting equation?

The development of innovative interactive multimedia packages that support student driven exploration and investigation has not been a priority for the multimedia industry. Exploring Physics in a “METABOOK” way is an example of a product that provides a range of cognitive tools in an information landscape to support student investigation. Simulations and support tools that allow multimedia reporting are embedded in the package and are supported by several metacognitive tools for the writing process or shelf evaluation. These tools not only include details about genre but also scaffolding templates to support the learners. The extent to which problem solving and student centered learning goals are achieved will be further investigated and reported upon when the METABOOK product will pass in the second evaluation phase in schools.

Education must be more than a body of knowledge and skills to be used in the future. Society is transforming from industrial into information mode. (OTA, 1995; COMMITT, 1996)[16]. Many pupils entering school nowadays will have jobs that don’t even exist today (Roblyer, 1997). This asks for the ability of pupils to change. People have to be enabled to connect knowledge and information from different sources, check it, and restructure it, until it is usable for the present circumstances. Skills are needed to identify and acquire new knowledge and solve new problems or create new solutions for old problems (Commission of the European Communities, 1995, Panel on Educational Technology, 1997). Creativity and critical thinking are needed. And not only this, but also participation and production. The moral value of education is strongly bonded with participation in the production of knowledge and responsibility. Learning and working will be connected with the generation of information. Skills such as identifying, searching for, handling and presenting information will be paramount.

Connected with this, there is a shift in educational focus from teaching to learning. Education industry shifts from simple delivery of knowledge to assisting people in carving their own learning process. We see a general predominance of constructivist ideas. Learning is a continuous process during which the learner tries to connect new information with prior experiences, individual ideas, insights and conceptual notions. So, learning is an active process and maybe passive learning doesn’t even exist. (Panel on Educational Technology, 1997, Rubin, 1996). Learning is the result of interaction between learner, teacher, peer learners, counselor, aims, content, materials and infrastructure.

All these trends reflect themselves in new curriculum plans in the fields in primary, secondary and higher education. Little by little, schools try to implement ICT in their education, address pedagogical questions -especially in relation to the challenge of inclusive education and a multicultural society- and e.g. in upper secondary education try to organize education in such a way that the learning process of the pupil is the starting point for class activities.

Still there are many questions: How can education offer enough of a challenge in today's society? How can we combine pedagogical freedom for schools and teachers with guaranteed quality and accessibility? What kinds of investments are needed in order to better equip the education system with the ability to innovate? How do we provide for equal opportunities in education?

Our initial evaluation of using METABOOK within real classroom environment showed an improvement of 1.5 to 2.8 times in comprehending the fundamentals of physics and in solving simple problems by using this new knowledge (gain by the use of METABOOK). Even though research, evaluation and further development is still in progress, and will continue for at least one more year, it seems that the final results will not be far from the current.

Students show absolutely no problems to adapt to these –modern but not at all new– learning methods. Technology is readily available and will be more available in the close future with even more capabilities and even lower cost. One of the most urgent questions is whether teachers are equipped and competent to take part in these trends. As in all history of human kind, the luck of technology was always a less important problem, compared to the wrong application of available technologies by few.

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