

- Motor skills (what we do physically)
- Affective skills (what we feel or what attitudes we have)

These taxonomies still influence the design of instruction [15][63][65][66].

However, the model probably most commonly used for creating instructional material is the ADDIE Model introduced by Molenda [67]. The acronym symbolises the 5 phases of the model:

- **A**nalyze - analysis of the learner characteristics, the knowledge that has to be transferred and so on
- **D**esign - design of the educational material and the selection of the pedagogical approach
- **D**evelop - the actual development of the educational material
- **I**mplement - delivery of the created educational material
- **E**valuate - assessment of the learning success

Strickland argues that most of the current instructional design models are variations of the ADDIE model [68].

Instructional theories also play an important role in the design of instructional material, for example the Instructional Transaction Theory as introduced by Merrill [69]. The instructional strategies can be described as methods of manipulating the elements of knowledge objects. They allow the specification of executable knowledge.

Furthermore, the pedagogical perspectives introduced in 2.4.3 also have a major influence on the outcome of the educational material.

2.4.2 Constructivism

The formalisation of the theory of constructivism is generally attributed to Jean Piaget, who articulated mechanisms by which knowledge is internalized by learners. He suggested that through processes of accommodation and assimilation,

individuals construct new knowledge from their experiences [70]. Constructivism is a theory of learning based on the idea that knowledge is constructed by the learner by mental activity. Learners are considered to be active organisms seeking meaning. Constructions of meaning may initially bear little relationship to reality (as in the naive theories of children), but will become increasingly more complex, differentiated and realistic as time goes on.

Jonassen defines constructivism as follows:

Constructivism claims that reality is constructed by the learner based upon mental activity. Humans are perceivers and interpreters who construct their own reality through engaging in those mental activities. Thinking is grounded in perception of physical and social experiences which can only be comprehended by the mind. [71][17].

Bednar et al. go on further:

The learner is building an internal representation of knowledge, a personal interpretation of experience. Learning is an active process in which meaning is developed on the basis of experience. Conceptual growth comes from the sharing of multiple perspectives and simultaneous changing of our internal representations in response to those perspectives as well as through cumulative experience [72].

Tenenbaum et al. show that there is a wide gap between how teaching processes should foster and encourage learning processes according to constructivist pedagogy and how far the theory is actually practised [73]. Furthermore, they conclude that this gap might be the result of a lack of knowledge of these principles by instructional designers and educators, and call for the stakeholders to try to bridge the gap between theory and practice. This makes it clear that very little of what is normally preached is really practised. The finding does not come as a big surprise to anyone who is actively involved in teaching, and is constantly trying to make the best of available time and resources.

2.4.3 Pedagogical perspectives

While examining the pedagogical attributes of e-learning, the pedagogical perspectives, i.e. the different viewpoints from which pedagogy can be regarded, must be taken into consideration. The outcome of any learning process is influenced not only by the learning material, but also by other factors or perspectives that have an impact on the learner.

The following pedagogical perspectives are important, but for this project left out of scope, due to the fact that this project is focusing on the separation of technical and educational content. Additionally, the application of the different pedagogical perspectives lies within the responsibility of the author of the educational material.

Cognitive perspective

Bloom and Krathwohl state that cognitive perspective focuses on the cognitive processes involved in learning as well as the way the brain works [74].

Emotional perspective

Baath argues that the emotional perspective focuses on the emotional aspects of learning, like the motivation of the student [75].

Behavioural perspective

The behavioural perspective focuses on the skills and behavioural outcomes of the learning process, for example role-playing and learning on-the-job scenarios as described by Areskog [76].

Contextual perspective

Black and McClintock point out that the contextual perspective focuses on the environmental and social aspects of the student that can influence the learning.

This can cover the communication and interaction with other people, the tutoring of the student as well as other factors, such as pressure [77].

2.5 Educational research

2.5.1 Education and educational research

Berliner points out that since 2002, within United States policy circles and elsewhere, there has been a growing call for enhanced evidence that educational innovations are working. Doing science and implementing scientific findings are so difficult in education because humans in schools are embedded in complex and changing networks of social interaction [78]. Berliner's conclusions are extremely relevant for the e-learning community. If we as e-learning developers accept the fact that there are unique complexities to be taken into account when learners use our tools, then a single-minded approach to researching the impact of e-learning on the learner is faulty.

The fact that a lot of research has been undertaken in the different areas of e-learning shows the general interest in the research area [79][80][81] [82][83][84].

Macpherson et al. state that most of the literature on corporate e-learning concentrates on the benefits, such as cost advantages and flexibility in delivery of learning [85]. However, it is argued that the issue of flexibility is only addressed in an organisational or financial dimension but not in a pedagogic dimension addressing the variety in individual learning styles. Several drawbacks of current implementation policies which are characterised by an enthusiasm for technology are addressed: bias in the balance of quality versus cost, lack of a supportive and interactive context of learning, and low learner and trainer acceptance.

Furthermore, Young introduces a survey involving more than 2300 professors in the US on the impact of the Internet and the Web on education [86].

The study ends by noting that at institutions of higher education, there is still much uncertainty about the efficient and effective use of information and communication technologies for education. It is recommended that further education for professors should focus less on the use of the technologies in general, but rather on the teaching strategies for their particular subjects.

Harley suggests that the future e-learning landscape will depend on how institutions respond to a number of variables [87]:

- Costs and sustainability
- Technology
- Students
- Public expectations and needs
- The realities versus perceptions of new competitive markets

Furthermore, it is assumed that there will always be a market for residential higher education and that new markets will emerge.

Ward and Newlands undertook an experiment on web based lectures replacing traditional lectures which took place in 1997 at Aberdeen University [88]. Nine lectures of a course on Economics of Public Policy were conducted as web lectures. 53 students had access to the lecture notes on the web.

Of the six potential advantages that students were asked to rate, the most important perceived advantages were richer learning resources and greater freedom of when to study and of the pace of study. Of the eight potential disadvantages that students were asked to rate, the most important perceived disadvantages were loss of contact with staff and other students, and lack of access to computers.

This experiment shows that students may not always use the web as imagined by course developers, even though too much generalisation of these results should of course not be attempted. Additionally, it was argued that students approached the web lectures conservatively and with a reluctance to explore and experiment [88].

2.6 Teaching and learning strategies

Over the last few years, there has been increasing growth of hypermedia information bases available over services such as the WWW [1]. Senac et al. argue that the contribution in terms of openness, accessibility, extensibility and portability of the WWW make it a good choice for the design of global hypermedia applications [89]. However, global hypermedia applications are difficult to build and it is important to create tools that allow them to be constructed efficiently. Koruska points out that although generic authoring tools have allowed people without extensive technical training to create software, they have not provided much help with creating educationally effective software [90]. Furthermore, Walker and Hess state that if someone can teach, it is not necessarily the case that this person can become a competent developer or, perhaps even more importantly, will want to become a competent developer [2].

Therefore, we suggest the separation of the knowledge based content, e.g. teaching strategy and expertise of the teacher, from the technical one, e.g. programming languages and distribution medium. The result should be an improvement in the authoring field of educational hypermedia over the WWW (cf. section 3.1). A part of this improvement should be provided by the semi-automated production of educational hypermedia as described by Bultermann and Hardmann [91].

Four different TLSs have been selected as an initial basis for this PhD project: Question and Answer (cf. section 2.6.4), Lecturing (cf. section 2.6.5), Case Study (cf. section 2.6.6) and Problem-Solving (cf. section 2.6.7).

2.6.1 Problems

As Elliott states, most teaching staff can use word processing packages and, perhaps, a drawing package, but would stall at the challenge of progressing to more complex software packages [28]. He argues that there is a lack of adequate Hypermedia Authoring Tools especially designed for teachers. This raises the question of how to create such a tool to simplify the task of authoring for the teachers. To answer this question, we will try to separate the knowledge based content provided by the teacher from the technical content. Ideally, the technical content or