Informatics and Media Education -
Designing a Curriculum for Media Education in Teacher Training with Regard to Basic Areas of Informatics

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Abstract: The Didactics of Informatics research group at the University of Paderborn is involved in efforts to design, implement and evaluate a curriculum for Media education for prospective teachers at the secondary school level. One major issue is the question of whether it is necessary for future teachers to learn the basic concepts of informatics, and if so, which topics within informatics are relevant, and which main objectives should be achieved. After two years of seminars on basic informatics for students of education at the University of Paderborn, it is now possible to submit the preliminary results. The presented paper discusses the rationale behind introducing informatics into media education for teachers, and describes elements of the curriculum, as well as the main teaching objectives for a better understanding of computer-based media.

The Role of Computer-Based Media in School

From the Perspective of the Student

Students today should have many different abilities in using computers and computer-based media. First of all, they must have the ability to use hardware and software (i.e. to turn on a computer, use a word processor, work cooperatively over a network, etc.) Because of the ongoing revolution of products and ideas, training for specific software products will not sufficiently prepare students for future demands. Today's students should be able to analyse and evaluate the social impact of using computer systems and computer-based media (CBM). Therefore, it is not sufficient to teach only the basics of computer operation. Students should learn about concepts of computer-based media, digital coding of data, and computer networks (especially the Internet), as well as the relationship between traditional and computer-based media. They should acquire basic skills and understand the functionality of new media such that they can evaluate its future impact on society. These are the elements of competency in media that should be taught to students.

From the Perspective of the Instructor

Educators have tasks which range from planning and instructing courses to administration of schools or counselling of students, and they can incorporate CBM into these areas. But if students should learn more than simple computer operations, then teachers must as well. They should not only have media competency so that they can work with computers, but also didactical media competency in order to integrate computers into the learning and teaching processes. Finally, teachers need media *educational* competency to teach computer-based media. It is essential that teachers learn to use CBM in different classroom settings (scenarios), in order to enhance the learning process. These scenarios are helpful in designing a curriculum for media education in teacher training (Magenheim & Schubert, 2000).

Organisational Aspects

Administration can also benefit from the use of computer-based media. Although its needs differ from those of the classroom, administration is concerned with the improvement of the school system, and this can be done with CBM. It can be used to create a more customized learning environment, design curricula for media education or create new ways of teaching and learning, make the school more responsive to community needs and vice versa, administrate school equipment and networks, and make the school dynamic and open to change.
The role of computer-based media in school involves learning by the students, instruction by the teachers, and organisation and improvement by the administration. Teachers need not only a specific tool, but knowledge about how it works in order to adapt the tool to their specific needs. This means that the curriculum must be generic, and must include the basics of informatics. If future instructors do not obtain grounding in informatics in their media classes, they will not be able to use the full potential of computer-based media.

To gain an understanding of the possibilities of computer based-media that cover the above perspectives and allow prospective teachers to keep their understanding up to date, a curriculum for media education must supply the learners with a solid foundation. This foundation is built by incorporating the specific qualities of CBM into the curriculum.
One of these qualities is digitalization. CBM uses digitally-represented data, regardless of form (text, video, sound, etc). This quality allows certain features such as transforming, copying, etc. To understand this aspect, one must consider the technical and informatics background of digitalization.
Another important aspect is to understand how the processing of digitally-coded data and its representation is interwoven with the human processing of information in media use. CBM are tools for constructing, transforming, and copying digital data, and simultaneously, they convey information. One must comprehend this duality of CBM in order to fully grasp the effect on our daily lives.
To understand and use CBM effectively, its construction process must be considered; software development is not only a technical process, but must take into account cognitive processes and needs of the users (Magenheim, 2001). This is especially important in an educational context where prospective teachers should learn to apply pedagogical software tools, to evaluate and (hopefully) to improve them in cooperation with software developers.
It is clear that these goals are only reachable by a curriculum that includes basic elements of informatics. These will be discussed later, but first, we consider other elements necessary for the development of a curriculum.

Elements of a Curriculum for Media Education in Teacher Training

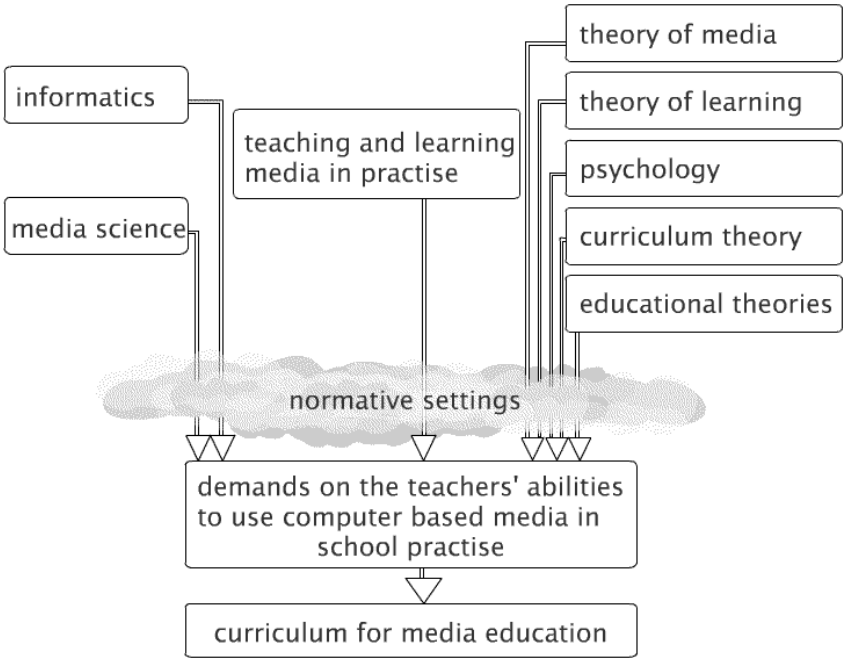

Figure 1: Influencing Factors on a Curriculum for Media Education

Many factors influence a curriculum for media education. Arts and sciences (not a topic of this paper) contribute to its concepts, content, and teaching methods. However, these cannot entirely dictate the curriculum, as they are filtered through normative settings (society, educational conventions and politics). They do assist in forming the requirements, which are necessary in the use of computer-based media. From these requirements, tasks and scenarios can be generated and worked into the construction of the curriculum. Specific contents can be taken from the general curriculum to cover different tasks.
The curriculum for media education in teacher training developed by the research group at the University of Paderborn does not claim to be complete; rather, it is focused on those aspects of a curriculum which require fundamentals of informatics.

Basic Areas of Informatics in Media Education for Teachers

As we have seen, instructors must have different skills and knowledge areas to be successful. There must be a way to distinguish the use of specific software tools from the use of computer-based media. Useful here is Basic Areas of Informatics (BAI), which describes the fundamentals of informatics for general media education (Schulte & Scheel, 2001). BAI serves as a theoretical foundation for forming basic skills and knowledge. BAI was developed in the context of didactics of informatics to specify the role of informatics in secondary education for a general media education. Thus, didactical concepts, common media education concepts, and corresponding work in informatics were analyzed, with a resulting abstract consisting of four tasks for building the informatical foundations of a general media education. These areas are:

1. Concepts of formalism and problem solving strategies in informatics
In informatics, modelling languages and tools are developed for the representation of information. We call them representation techniques. Modelling tools such as UML are usable outside of the software development process. The aim here is to supply students with the background knowledge necessary to competently use these tools. On the one hand, students should be able to express representations of things

(structures and processes in different subject areas) formally with the aid of representation techniques. On the other hand, they should learn skills for using software products (i.e. word processors, spreadsheets) to represent things. The aim is not to teach a specific user interface, but rather to teach understanding for the typical media functions of these computer-based tools – for example, the proper use of style sheets. These functions are 1) to represent things, 2) to (re)arrange representations, 3) to save representations in data files, and 4) to provide others with information about these products (see Hubwieser, 1997). This Area does not cover questions concerning the content or aesthetics of representations.

2. Technical basics
This Area describes the technical and informatics skills necessary for using computer-based media. It covers skills such as choosing the appropriate data format and software-tool, building suitable directory trees to manage data, and querying databases and search engines. Students should gain an overview of the technical infrastructure in which they use computer-based media: For instance, the global networks, protocols and software tools that build the World Wide Web.

3. Semiotics
In computer-based media, symbols have a dual purpose: They form programs to control machines, but they also serve as media in a broader sense; for example, source code for a program is executed by a machine but understood by a human. The learning goal of this Area is to reflect on these specific semiotic implications of computer-based media. The user communicates with other users, but interacts with the machine (human-computer interaction). There lies an area between which is a combination between human-computer interaction and communication between humans. This can be seen in automated email systems, in which a message is generated by computer as a result of statistical information, but it is possible for a human to add a personal note (i.e. a user might receive a note thanking him or her for contributions) (Maurer,1999).
Students should also be able to understand the possibilities and the role of technology in automated and partially-automated communication processes. Therefore they should learn to differentiate between the ways in which humans and computers process data. Media functions can be addressed to further this understanding.

4. Social impacts of computer-based media
The goal here is to become aware that software-tools and description techniques – in short, the technical infrastructure – a) is purposely created to meet specific aims, b) is changeable, and c) embodies implicit values and regulates individual behaviour (Lessig, 1999).
It is important here to contextualise the current computer, software, or internet generation within its development history. In many cases, the functionality of a current version is only clear with knowledge of its evolution.

All in all, the BAI describes essential basic skills for prospective teachers, but does not cover an important aspect which was previously mentioned: The specific function of computer-based media in school and typical scenarios of its use in teaching and learning.

Scaffolding a curriculum of basic informatics within media education
The professional future of an educator is determined by activities within the scope of the classroom, administration, or other didactic area, as well as communications with students, parents, and community administrators. These are termed *action scenarios*. Often, it is useful or even necessary to integrate computer-based media into teachers' professional lives.
These situations can be incorporated into seminars for future teachers, on the topic of media education and fundamentals of informatics. First, we analyse professional scenarios of teachers and identify typical situations of computer-based media use. Then, we cover the fundamentals of informatics which teachers should know, in order to foster:

- a fundamental understanding of CBM
- elementary skills in handling a sample of computer-based software tools
- an effective use of computer-based media in school-related action scenarios
- the ability to organise learning and teaching processes with CBM in different subjects
- the ability to organise media education in the classroom, with CBM itself an educational topic

Finally we must structure these situations based on fundamentals of informatics with regard to the tasks previously described. This will generate a generic curriculum enabling us to create a selection of contents and objectives for university courses on the BAI of CBM. The table below describes how to assign each action scenario to a Basic Area of Informatics, as well as describing outlines for problem-centred seminars.
The contents listed in the table below should not all be covered in a single seminar, but represent possible options describing how to teach the basics of informatics in a problem-centred seminar. In some cases, it will be possible to re-assign contents to different Areas. For example, xml is assigned to Area 1 (as a formalism) but can also demonstrate how documents are divided into content, structure, and layout, thereby allowing specific semiotic functions and automated processing (see Area 3).
Nevertheless, the curriculum will be helpful in organising student seminars. These seminars should focus on practical problems and issues regarding the use of CBM in teachers' professional lives. University seminars and related materials with the topic of BAI should be organised around a certain action scenario. The project should contain an assignment to produce specific computer-based media to be used later in a real pedagogic action scenario. While finding solutions for this relatively complex problem, students shall not only learn about different functions of CBM and how to use them in a pedagogic context but also gain a fundamental understanding of basic areas of informatics. The university seminars should not be organised simply as lectures, but should offer students different action scenarios in which they can exercise the use of CBM and develop media products of their own as a contribution to the complex problem-solving process. The concept also includes aspects of constructivist learning, because students should have access to a hypertext learning environment, with relevant materials such as supplement texts, pictures, animations, videos, interactive forms and so on. By navigating this web-based learning environment, they will be able to organise learning processes of their own and gain the knowledge they need to solve the problem presented in a seminar.
This will give them the ability to use their newly acquired knowledge and skills on CBM in a variety of similar scenarios. At minimum, after attending another one or two such courses, they will finally have the media competency described in the objectives above, and be able to independently manage complex assignments using Information and Communication Technologies (ICT).

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Combination of Scenario Types and Basic Areas	Scenario Type A: using CBM in classroom practise	Scenario Type B: producing CBM	Scenario Type C: using CBM in organisational context
Specific Example of Scenario Type	Co-operative networking project	Building an interactive website	Administration of a school library
Basic Areas of Informatics	Optional content	Optional content	Optional content
Area 1: Concepts of formalism and problem solving strategies in informatics	? Structuring knowledge with mind mapping software, ? Structuring co-operation with project planning software ? Formal description of scheduling processes ? Divide and conquer method ? Knowledge in distributed systems	? Elements of documents (layout, structure, content) ? Structure of documents ? Document type definition ? Document description language (HTML) ? Basics of Metadata, aspects of XML ? Hypertext, knowledge management and organisation of working processes	? Modelling techniques as UML, CRC Graphical representation of information ? Object diagrams, storyboards ? Entity relationship diagrams ? Interaction diagrams ? Concepts of knowledge management
Area 2: Technical basics of CBM	? Communication protocols (OSI, TCP/IP) ? DNS and internet addresses ? Network structure and technical components of networks ? Virus, worm, logic bomb, denial of service attack ? Firewalls and security ? Digital coding of data ? Transformation of information into data	? Internet services; searching engines ? Client server concept ? Data encryption ? Parameter concept ? Interactive elements of a window ? Concept of event-driven programming ? Basics of an object oriented programming language (applets; script language)	? Basic aspects of software development process ? Basic algorithms (e.g. sorting algorithms) ? Basic data structures ? Database development software
Area 3: Semiotic function of CBM	? Knowledge and skills concerning basic functions of cognitive tools (text processing, spread sheets, database presentation, graphical design software) ? Basic concepts of CSCW, CSCL ? Computer as an external storage and mind tool ? Media functions of information systems	? Layout concepts (style sheets, master slides) ? Basic concepts of screen design ? Concept of visual communication ? Perception of semiotic types (text, diagrams, pictures, icons, animated graphics, videos)	? Development of graphical user interfaces for the database ? Human-computer interaction ? Models of human communication vs. models of technical data exchange
Area 4: Social impacts of CBM	? Impact of ICT on workflow and learning processes ? Changes in roles, personal relationships, communication styles between people involved in CSCW ? Concept of socio-technical information systems	? Web presentation of institutions and merchandising effects ? Web performance and influence on public opinion ? Economic and social impact of e-learning and e-commerce	? Security of data ? Protection of personal data of customers ? Software techniques of data protection ? Legal aspects of data processing in school ? Structure of a knowledge- or information-based society ? Software development and interest groups

Table 1: Combination of Scenario Types and Basic Areas