EVALUATION OF CARTOGRAPHIC EDUCATIONAL SOFTWARE FOR CHILDREN

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Abstract

The use of printed maps or rather printed atlases is standard at school, especially in lessons of geography and history. However, to read and interpret the abstract cartographic signs is very difficult for younger and sometimes also for older children. It is necessary to acquire a minimum of cartographic knowledge. In the era of electronic media it is possible to advantage the specific of new media to improve the achievements at using maps.
The Commission on School Cartography of the German Cartographic Society (DGfK) developed criterions of assessment for such media and evaluated cartographic educational software made for children. The research gave the learning theoretical angle priority treatment.

1 Introduction

„Working with maps" is part of know-how in many spheres of life. Already in the geography and history lessons in school spatial subjects can be imparted by the usage of map only. However, the user of maps (child, student) first have to learn to handle with this abstract representation. That is why the aim should be to impart a cartographic competence to students from childhood on.

There are two complexes you need for cartographic competence:

1. Appropriation of minimal cartographic knowledge, for instance about the characteristic of map, as:
- selection represented objects
- generalization,
- reduction to scale
- transformation from three-dimensional to two-dimensional objects or
- cartographic sign language.

2. Learning methods to use the map as resource of new knowledge. Such methods are (e.g., *Breetz 1983*):
- elementary map reading (what objects are where?)
- map exploitation [complex map reading] (for instance spatial functionalities)
- map interpretation (mental links to information out of map)

- creation (draw, sketch) of maps.

Classical lines of actions to appropriate cartographic knowledge and methods were realized with printed atlases, wall maps, textbook maps combined with among of other things, as original objects (excursions) or sandtables (e.g., *Hüttermann, A.* 1998). Over the years a lot of electronical products which are meant for mentioned aims were published. What are this products able to achieve within a learning process? Are they better than classical teaching media?

The Commission on School Cartography of the German Cartographic Society (DGfK) investigated cartographic educational software for children which was published on CD-ROM. The aim of this investigation was to advance criterions of assessment and to realize a first evaluation.

2 The term „Cartographic Educational Software"

Cartographic educational software are computer programs including maps which have an essential importance to a learning process. Here it must be distinguished between three learning sectors at school:

1. Geographic, historic and other specialized knowledge which will be acquired on the basis of map information and/or
2. Cartographic (medial) knowledge about the characteristics of the medium map and/or
3. Cartographic ability to read, exploit, interpret and design maps.

The learning sectors 1., 2. and 3. have close relations to each other and are integrated in the software in different combinations. According to target one of the three sectors is still most dominant.

To judge the quality of a cartographic educational software for children relating to the three mentioned learning sectors in the following are:
- determined the functions of cartographic educational software within the learning process as well as partial depend on it
- advanced of evaluation criterions.

3 Functions of Cartographic Educational Software for Children

Figure 1 shows relations between teaching, learning and media (e.g., *Fischer, P.M./Mandl, H.* 1990). Accordingly the cartographic educational software is:
- integrated in a personal (teacher, pupil) - medial connection
- effective in a specific using situation
- useful under special formulation of a problem
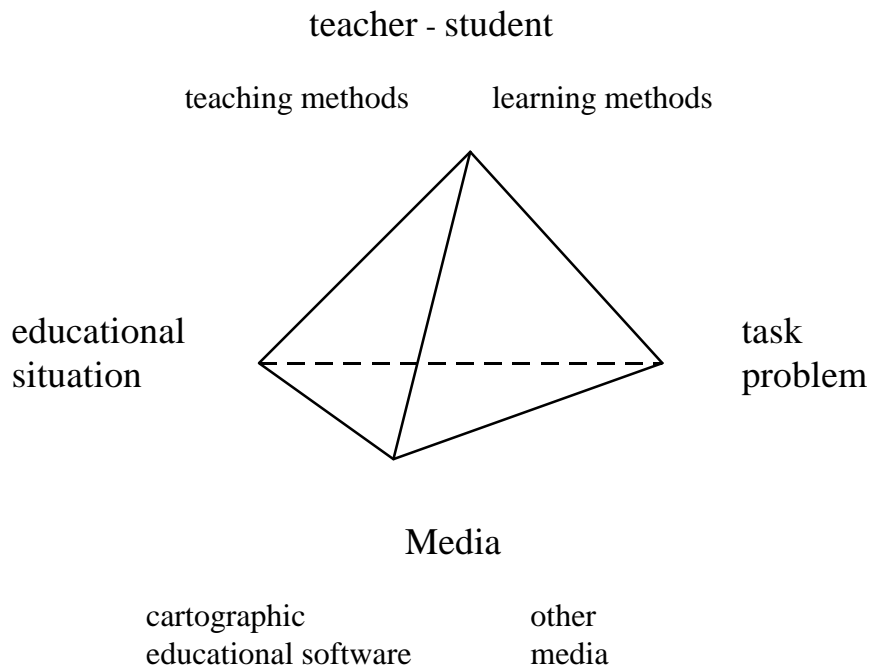- only one medium of a few others.

teacher - student

teaching methods   learning methods

educational
situation

task
problem

Media

cartographic   other
educational software   media

Figure 1: Cartographic educational software within the model of media use (source, modified: *Fischer, P.M./Mandl, H.* 1990)

It is known from literature that software can not substitute the teacher and traditional media. It can adopt only restrictive functions within the learning process and can not be multifunctional.

One of the biggest problems is to integrate a software into a learning process usefully. In lessons occur near technical-organizational often mediadidactical problems. The more the software is designed multimedial the more the teaching concept is determined by the software and not by the teacher. This pushes the teacher back who normally reacts to recent individual situation of the students and the social structure in class appropriate his own teaching concept and recent teaching aims. Only the teacher can modify quickly his line of action adequate to different and changed learning situations (e.g., *Peschke, R./Schulz-Zander, R.* 1996).

The question is where is the place for an effective and efficient employment within the learning process. Therefore a didactical reasoned use considers the specific functions of this medium. Figure 2 shows some special qualities of cartographic teaching software (especially multimedia maps) by comparison with other cartographic media.

Qualities	*Atlas*	*Wall Map*	*Textbook Map*	*Multimedia Map*
technical condition	no	map stand (or the like)	no	capability of hardware
flexibility of operation place (class-room, home/in	mobile	fixed	mobile	fixed on place of computer; mobile by help of laptop

the open air ...)				
map information	fixed	fixed	fixed	fixed or changeable
design of map	cartographic design rules and methods	cartographic design rules and methods	cartographic design rules and methods	cartographic design rules and methods
dynamic maps	no	no	no	practicable
media combination	external (internal)	external	internal (external)	internal
map explains itself	no	no	possible	typical
map opens up subject matters	external process	external process	internal process	internal process typical
medium visualizes structures and relations	fixed	fixed	fixed, illustrative possible	illustrative typical
medium gives feedbacks	no	no	no	typical
user intervention, action	no	no	no	typical
structure of medium adaptable to learning process	no	no	yes, prescribed	yes, prescribed or several variations
motivation	external	external	internal (external)	internal

Figure 2: Table of some qualities of chosen publication forms of maps

You can recognize that cartographic educational software (especially multimedia) has characteristics that are true for all shapes of maps, too. But to emphasize the exceptional peferences, the following functions can advance:
a) Motivational function
The medium is in a position to stimulate children's interest and curiosity about the new learning matter. Because the abstract map produces just a bit learning motivation some illustrations, animations, comic figures, virtual assistants etc. that have a relation to cartographic learning motivates especially younger children.
b) Function of variability
The programming of software allowes to go different ways of learning and gives several feedbacks. The learning is variable arrangable within certain limits.
c) Guidance and navigate function
Within the software elements to guide and navigate the user are inherent.
d) Selfexplanation function
Electronic (multimadial) maps can explaine themselves (for instance by animation) or by interaction between child and cartographic program.
e) Opening function
Software can be programmed in a way that subject matters can be opened up as a whole; important elements of the subject can be devided from unimportant and can pay attention to critical marks of facts.
f) Modelling function

Cartographic educational software can support the creation of complex mental models by explaining elements, its structures and its relations and combinations. Especially the acquisition of cartographic knowledge requires to think about an abstract model.

These specific functions are realized by media specific possibilities of communication:
- Interaction (extent/chronological order of information are individual determinable, alternate permanently between different data, reaction of system to action of user)
- Navigation (possibilities to move through the program)
- Opening instruments (assistance to help and guide the user on the right way).

4 Evaluation criterions

Under consideration of the mentioned functions the following criterions of evaluation are formulated. Before that, we:
- studied the curriculum
- evaluated learning theoretical and didactic publications related to use computer and maps at school
- analysed cartographic educational software
- realized some laboratory experiments with children.

Therefor the criterions can be seen from four angles:

I Geographic (historic ...) subject aspect (cartographic educational software as support of expert information about geography, history a.s.o.)
II Learning theoretical and didactic aspects (position of cartographic educational software within the learning process)
III Cartographic aspect (design of maps under cartographic design rules/methods)
IV Technical aspect (standards of hardware)

In the following only the criterions I and II are focus of interest.

I Geographic (historic ...) subject criterions

In order to judge a cartographic educational software it has to be clear what kind of pertinent reference is intended mainly:
- map as indirect learning expedient (for topographic, geographic and other knowledge)
- map as subject matter itself (knowledge about characteristics of map, abilities and proficiencies in „working with maps"). Parts of it are: explanations and illustrations of signes, symbols, scales, kinds of maps, projections, grids and so on, practice for elememtary map reading, training of map interpretation, design own maps and so on.

Another criterion is the connection of map information to other information. General there are three kinds of programs:
- Independent cartographic programs; map is in the centre of view with links to information about contents of map, links to other maps, links to algorithms for map interpretation and so on. Such relativly independent cartographic programs are for example electronic atlases, topographic training programs or special programs which are good for development in order to understand the map better.
- Accompanied and additional cartographic segments within a subject matter of overriding importance; it could be geoecological, hydrological, population and other subject matters, that

absolutely needs maps to visualize spatial facts. Such cartographic segments could be maps to orientation or fixing location or to get partial information about subject matter.
- Open cartographic programs; the user can supplement his own designed cartographic elements or prefabricated modules. Those open cartographic programs are for example GIS-programs.
This criterion of information connection gets particularly clear within multimedia software. The mutual support of maps, text, pictures, graphics, speech and so on cause on condition that the medium is designed good for learning process (e.g., *Heidmann, F.* 1999):
- increase of important information by combination different media,
- relief of visual sense by shifting the information to different audiovisual media,
- encouragement of process of memory by combination abstract with pictorial media to improve the memory capability and later the reproduction of knowledge,
- encouragement of mental modelling by force of adequate media and combinations of media, for example animations to visualize dynamics.

II Learning theoretical and didactic criterions

Cartographic educational software has to focus on the age of user (child) especially to the level of his stage of intellectual development. The following things have to be checked:
- way of introduction and entry into the program,
- kind of motivation to deal with the contents of program,
- level of contents (e.g. didactic simplification),
- level of presentation (e.g. kind of cartographic transformation of contents),
- guidance through the program,
- instructions for use the program actions,
- different kind of assistance.

Cartographic educational software lives on possibilities of interactions. Volume and way of interactions could influence the learning result. Formally you can distinguish (e.g. *Ormeling, F.* 1994):
- view-only-maps which integrate only a few chances of interaction, like to shift the map or to choose between different maps,
- interaction maps with focus on graphic interaction (zooming, change the contents of map, call a information about map objects, find complex facts, animations, simulations),
- interaction maps with focus on data analysis (use, supplementation of data bank in the background of map, free design of an own map under use of a data bank).

All interactions include a dialog between child and software program. You have to check if the dialog is (e.g., *Heidmann* 1999)
- suitabled to tasks and exercises (dialog assists the user to carry out all orders effective and efficient)
- described by itselfe (every step within the dialog is clear by feedback or is explaint by inquiry)
- controllable (the user can influence the speed, volume and sequenz of input and output)
- conform with the expectancy of user
- tolerant of errors (dialog tolerates faulty inputs of user within limits, an error report informs the user about mistakes)
- individualizable (adaptation of the dialog system to requirement of instructions, the individual abilities and interests of the user)
- good for learning structure (relevant learning strategies should be supported e.g. learning-by-doing or intellectual-rational-learning).

Learning theoretical aspects in a narrow sense among others are: creation of mental abstract concepts, inductive and deductive (combined too) learning ways, measures to consolidate knowledge and abilities with aim of transfer to other learning situations, last but not least motivation and continuous maintenance of motivation (e.g., *Kirchberg* 1997):

- creation of mental abstract concepts (here cartographic concepts) that describe the characters of the map
- inductive and deductive learning ways consider
    - the relation of individual/concrete to general/abstract Information, its structures and order
    - choice of media elements relating to vivid illustration or abstract graphic, relating to its adaptation to meaningfull learning ways by a logical sequence of media elements, by logical comparisons etc. and relating to geographic, historic and other subject matters (phenomenons and spatial structures, functionalities, processes, systems and models)
- transfer of knowledge and abilities to other learning situation (supported by repetitions, exercises, controls, valuations and assistances)
- motivation (supported by child adequate design of program, personal appeal to the child, auditive commendations, virtual rewards, games, competitions, elements of surprise etc.).

5 Results of evaluation

It is not possible to show all details of the results of evaluation. The by us evaluated cartographic educational software had very different targets and with it very different potentials of shapings and utilization. That is why a comparable statement is hardly possible. Still the following chosen results can admit some conclusions of shaping and use of cartographic educational software.

As already proved in other investigations in computer operation:
- harmonically integration of educational software into a teaching general conception is not unproblematically,
- if just a few of the chosen sequences of the program for realisation of specific didactic functions are needed the action is very difficult,
- software programs are following a specific logic and permits often just a „mediadetermined use" in school; that means the teaching sequence follows decisive the computerprogram,
- usage of cartographic educational software is most productive in very small student groups. In fact the intervention by the teacher is restricted, but the advantage for students who have fear to fail is immense. Mistakes made by students have no direct social consequences. The student is not forced to take the responsibility in front of teacher and classmates.

- Still educational software is dominating which gives just one possible way of learning. Every strengthening, exercise for repetition is borring and not effective.
- In very few programs it was possible to choose the way of learning and the level of difficulty by the user himself. However every software program can just respond to the learning situation (level of intelligence) of the student in it's very limited way of programmed frame.

- In older and newer schoolatlases (printmedia) for younger and older students you can find integrational parts which tell about the features of the map. Mostly there is compared a terrestric photo, an incline perspective aerial view and a vertical shooting of a landscape and

maps by becoming smaler scales. However such introductional parts in printed atlases are not very effective. They are just receivable in a receptional way. But the younger student has to deal with his well known environment in his home. A good way for this are excursions, to model in the sandtable, sketches a.s.o. Just after it a usage of educational software for support, repetition etc. is usefull.

- It exist a whole serie of training programs for support of map introduction and elementary reading of maps; for example for map-signatures, star direction, tail direction, scale, altitude.

- To train the interpretation of maps there exist just a few programs or they show a very primitive promise. In one evaluated software the students can use the new knowledge about maps in a second part of the program. In different games and contests the students have to look for towns, objects etc. The student has to make solution decisions in dialogue with the educational software, which he can only manage by working with maps. The most interesting point at this software is that printed maps for the whole class belong to this computer program. With their help the students have to solve the tasks. In interaction with the program the student has to give the solutions into the computer and now for confirmation a solution card is shown on the sreen, where he can compare with his result.

- Direct or indirect aids according to the methods of map utilization we only found within special computer programs of type „maps for cartographic education". We did not find it in programs of type „maps for geographic, historic ... education" although it could be a typical part of this specific medium.

- A lot of programs allow to create parts of maps or whole maps. Within such programs are found little moduls with prefabricated symbols and other elements but none of the programs had comments on cartographic methods or rules to compose an esthetical map. This could be a typical specific of the medium to lead the child in a dialog to draw a simple esthetical map.

- Within some multimedia software learning theoretical ingenious connections of maps with other media to form precise ideas of abstract map signs are found. Examples are interactive change between topographic map and vertical aerial view or change between map, scenery view and profile.

- But a multimedial extension of the direct cartographic information could cause complications in unfavorable case. Especially by frametechnologies including high information density results a visual overload by too much or too complex optical structures on the screen. The search of top information on the screen and to make a mental note of it are impeded. The child's visual system must react to the change of frames and its new grafic structures. It is a tightrope walk; on the one hand between a adequate learning process combination of several media elements which are all on one screen and on the other hand of a visual-cognitive overtax. Unfortunately, there exists not enough empirical investigation with children to solve this problem clearly.

- In all tested programs it could be noticed an insufficient guidance of the child to solve the tasks consequently step by step. Most of the programs offer a complete solution and the child can only compare it with it's own result. Very rarely the child is asked by the program to reconsider it's result or to repeat some parts of the educational program, if necessary several times with the help of different navigation paths till the correct result is achieved. This is significant for learning psychological reasons because the child believes it finds the correct result absolutely by itself.

- A lot of parts of researched cartographic teaching software programs are exercises to learn the topographic matter. For better motivation these parts are games or competitions. Dubious are such types that first place the assess of speed in solving the exercise. We could find out that the students who played the same game several times could give answers very quickly but not seize the sense of it clearly. The knowledge is superficial and not transferable.

6 Conclusion

The evaluation of cartographic educational software shows that there are a serie of good products to help to acquire knowledge about maps and map use. But there is showmanship, too. Design and use of cartographic educational software have to consider the learning process, more than in past. The evaluation criterions, compiled by the Commission on School Cartography of DGfK could help to create better software for children. Because it was only a first test, the research about this subject will be continued.

Evaluated Media

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