EDUCATION-LINE

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Scholarly research on mind maps in learning by mentally retarded children

Paper presented at the European Conference on Educational Research, University of Goteborg, 10-12 September 2008

Abstract

Mind maps (or similar concepts) have been used for centuries, for learning, brainstorming, visual thinking and problem solving by educators, psychologists and people in general. People have been using image-centered radial graphic organization techniques referred to variably as mental or generic mind maps for some areas. The claim of the origin of the mind maps has been made by a British popular psychology author, Tony Buzon. He argues that "traditional" outlines rely on the reader to scan left to right and top to bottom, whilst what actually happens is that the brain will scan the entire page in a non-linear fashion. He also used popular assumptions about the cerebral hemispheres in order to promote the exclusive use of mind mapping over other forms of note taking.
In our studies we examined the learning behaviour of mentally retarded children at the age from 12 to 16 at special schools. In all age groups there were a test group and a control group. The teachers taught the subject of instruction to the pupils of the test group using mind maps. These mind maps were presented in different colours, using symbols,images and keywords, the latter for the pupils to realize the hierachy of the subjects taught.
The pupils of the control group worked on ‘normal‘ texts.
Ater three, six and nine weeks tests were carried out. The pupils had to fill in gaps in the mind maps and the ‘normal‘ texts respectively.
We found that the mind mapping technique had an impact on the ability to recall. This improvement was robust after some weeks for those in the mind map group.
As a result of our studies the students - on the one hand - said it was both more pleasure and motivation to learn at school when using this method and - on the other one - the teachers confirmed that there were no emotional problems and behaviour deviation in the student's learning process.
The results showed the differences between the two groups concerning the number of facts that could be remembered

Introduction

In Germany, pupils who permanently and in several subjects do not meet the requirements of school are called pupils with learning impairments. On the one hand these children and youths are not well equipped for information processing and on the other hand their learning activity is limited.
From numerous studies it is clear that pupils with learning impairments show deficits on all levels of information processing. It was particularly stated that pupils with learning

impairments have difficulties acting strategically on a superordinated level while learning. The reasons are diverse and individually very different, as learning generally is only to be understood as a *complex active action*. This is based on the idea that learning and thinking are to be understood dominantly as mental self-activity and are to be seen in the related psychosocial context of the learner. Therefore the learning processes and the learning results should provide answers to the question, where connections can be made for interventions in school.
Depending on the manner, how these pupils deal with and solve learning assignments, Lauth distinguishes between *good* and *bad* learners.

On the basis of numerous empirical studies he concludes that the difference is the greatest in superordinated, strategic actions. Almost all studies showed that *slow learners*

- spend less time processing the tasks
- call up existing knowledge to a lesser extent
- exercise lesser control over their learning processes while learning
- are less likely to access superordinate, rule-based procedures
- are less likely to actively project a task and to express the learning problem in their own words
- rarely formulate a binding target for their learning process which later allows them to check their own learning
- are less likely to monitor their learning and correct their way of learning, if it does not lead to success (Lauth 2000, 24f.).

This has a lasting effect on the ability to achieve accomplishments in school and demands changes in the arrangement of lessons.

In numerous cognitive psychology based theoretical approaches deficits in memory performance are considered as an important reason for under-average cognitive capability (Büttner 1998, 46).
Accordingly the support of memory performance, often called knowledge, is focused in the considerations.
In how far the learning process succeeded can be determined on the basis of knowledge acquisition.
The basic modules for this are taking in, processing, understanding, keeping and using, respectively the transferring of information.
Results of previous studies reveal that children and youths with impairments learning at school have deficits on all levels of information processing, whereas the requirement profile of a task is of particular importance. As soon as they have to draw on strategies and the complexity of the task increases, the possibilities of processing of the task decrease. It can therefore be assumed that pupils with learning impairments draw far less on strategies for the extraction and processing of information, the organization of actions, self-management, self-regulation and self-review.
Regarding the use of metacognitive strategies Schröder (2000) realizes that these pupils do not generally lack such strategies. It was demonstrated that the discrepancies to control groups without learning complications were lesser when learning tasks were structured simply (Schröder 2000, S. 648; Büttner 1998, 47).
Forness, Kavale, Blum and Lloyd evaluated in a mega-study 18 meta-analyses on the basis of 700 primary studies. The several meta-analyses showed the effectiveness of certain intervention methods by estimating the medium effectiveness strengths on the basis of many primary studies.

The highest effectiveness strengths were registered in the intervention classes Mnenomonic Strategies (1,62), Enhancing reading comprehension (1,13) and Direct instruction (0,84) (Masendorf & Grünke 2000, 990).

Mind Mapping Method

Against this background of theoretical findings the mind mapping method became one of our central objects of research.
Friedrich (1995, 120ff.) counts this method as one of the information processing strategies, with which information is permanently stored in memory by sophisticated processing.
The method was developed by Tony Buzan and published for the first time in the book *"Use Your Head"* already in 1974 (Buzan & North 1997; Buzan & Buzan 1997).
By means of graphic techniques, symbolic representations and the keyword method

- texts can be edited, organized and structured,
- (knowledge) contents can be compressed and structured,
- notes of lectures and the like made more effective
- possibilities for the creative generation of ideas can be provided,
- the basics to speak freely can be created and
- abilities for problem solving can be initiated

(vgl. Salzberg-Ludwig 1998; Salzberg-Ludwig 2003; Svantesson 1993).

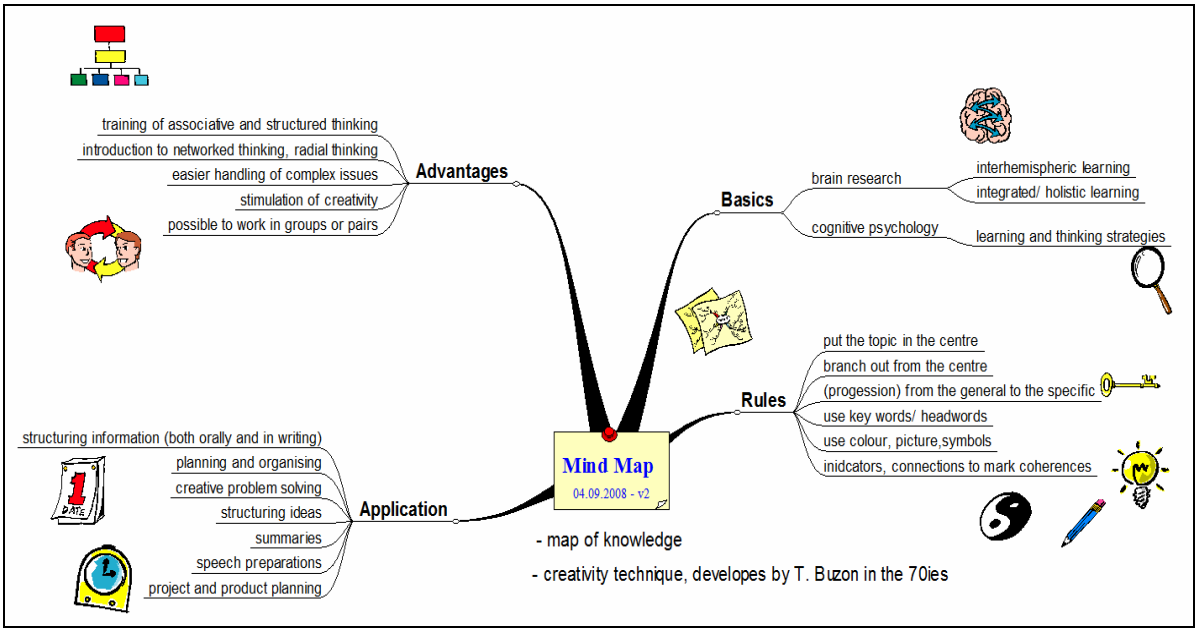

Figure 1: Graphic representation of the mind map method

In applying this method it is assumed on the one hand that the brain does not work in a linear way. This means that the thoughts of a person regarding a certain topic are disordered first. A prematurely fixed structure might hinder the generation of ideas and creativity. Furthermore findings of neurobiological and neuromedicinal research in interhemispheric cooperation of the right and the left hemisphere of the brain are used. A working and presentation method was developed that joins linguistic-logical and intuitive-pictorial thinking and thus addresses both hemispheres of the brain.
Furthermore, the mind mapping method can be characterised as an organisation and structuring strategy. Pieces of information will be structured netlike, corresponding to the way

the memory stores information. From the perspective of developmental psychology the quality of order formation; assigning features and relations to concepts and events depends on the cognitive stage of development of each child. This leads in the highest phase to categorial groupings, in which abstract superordinate concepts will be applied (Grünke & Stemmler 2004, 259f.).

Study

These findings provide the basis for the school interventions in the study presented here. By the teaching of mapping techniques an action regulation can be initiated in children with learning impairments which makes it possible on the one hand to structure and categorise information and on the other hand to memorise information in long-term memory.
Students of the special education branch of study „Education of children with learning difficulties“, who studied in tandem with work, carried out empirical studies on the teaching and learning effectiveness of the mind mapping method. Directed by hypotheses they examined the effectiveness of mind map presentations as against text presentations in lessons of special schools in various class levels on the basis of memory performances of their pupils (Engelmann 2004; Freund 2003; Schmidt 2001).
At the centre of their studies was the development respectively the specification of learning strategies for the development of declarative and procedural knowledge of pupils with learning impairments in special schools in the federal state of Brandenburg. Pupils of different class levels developed fields of knowledge with the help of mind maps (experimental groups) and respectively with the help of traditional texts (control groups). It was analysed which of these presentation formats led to better memory performances. These performances were identified by tests.

The following questions were focused in the scientific work:

- Does the development of a mind map - as a conceptual web – support memory performances better than the development of a respective text?
- Are there differences in memory performances in the different class levels?

As a result the following **hypotheses** were derived:

- The development of a mind map - as a conceptual web - leads to better memory performances than conventional presentation forms (continuous text).
- With increasing age the use of the mind mapping method results in better memory performances.

All studies were based on the same design.

The pupils of the experimental groups were first made familiar with the mind mapping method to summarise knowledge in this way in the following lessons. Figure 2 shows such a map that was developed in physics for the topic „Light“ by a grade 7 of a special school. This map was then the basis for the following series of tests in experimental group.
Words in italics should have been added in the test; as support the icon of a pen was added.
Pupils in the control group should present their results in conventional text form (figure 3).
The underlined words in italics should have been added in the cloze text in the respective tests.
This examination (map vs. text) is reasonable because learners are used to tests in text form.

First knowledge in a certain subject area was asked in the experimental and the control groups whereas the pupils were free to present this knowledge in whichever form they chose. Following the topic was elaborated in several lessons.
The pupils in the control groups summarised the results in text form.
The experimental groups presented the worked out knowledge in mind maps. The pupils were given much freedom for the illustration so that they could work with colours, shapes, pictures and each could create his or her individual map.

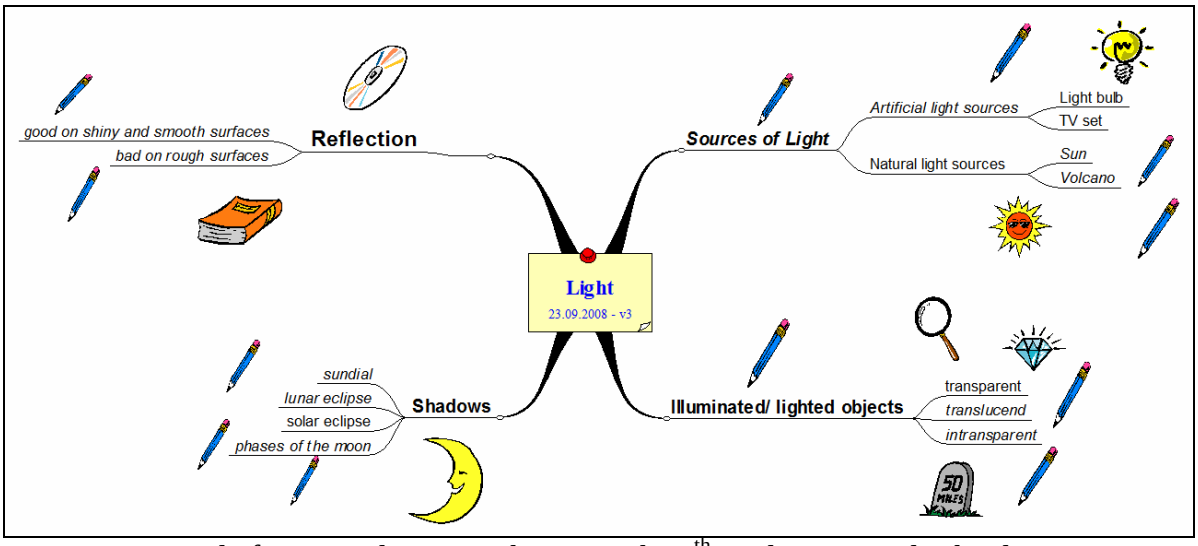

Figure 2: Example for a Mind Map in physics in the 7th grade in special schools

Light
Light is emitted by *light sources*.
There are *artificial light sources* (lamp, snap lights/snap light sticks) and natural light sources (*sun, volcano*).
Objects that are no light sources, are called *illuminated* objects.
There are *transparent, translucent* and opaque objects.
Opaque objects cast a *shadow*.
In this way the time of the day can be determined by a *sundial*.
Earth and moon cast huge *shadows* in space.
Therefore the *solar eclipse*, the lunar eclipse and the *moon phases* ooccur.
Light is reflected (mirrored).
Smooth and shiny surfaces reflect light well.
Rough surfaces *scatter* the light.

Figure 3: Example for a continuous text in physics in the 7th grade in special schools

To check the memory of the pupils, four tests were conducted in all groups.

Table 1: experimental design

Test/ experimental groups (Mind Map)				**Control groups (Text)**			
Main test	Post 1 (after one week)	Post 2 (after 3 weeks)	Post 3 (after six weeks)	Main test	Post 1 (after one week	Post 2 (after three weeks)	Post 3 (after six weeks

The main test, which was conducted with cloze texts and cloze maps respectively, was followed by three post tests at intervals of one, three and six weeks. The performances were

evaluated on the basis of the right entries given, whereas in the mind maps very often much more terms were mentioned than requested.
To compare the individual experimental and control groups, the given points were converted into percent. This is also usual in grading.

In the study presented here 19 groups took part (figure 3). Since the test persons could not be chosen by random (merely the choice of experimental or control groups was accidental), the study becomes a quasi-experiment (Rosemann & Bielski 2001, 16).
To answer the initial question regarding the memory performances in the individual class levels, first the average (A) and the standard variance (SV) for the individual groups and tests (figure 4) were calculated with the points reached (which had been converted into percent). To make clear, in which group the average calculated was higher, these data were highlighted in bold print.

With this comparison several tendencies become visible:

- In the overwhelming number of the tests (22 of 31) the average of the pupils of the experimental groups is higher than in the control groups.
- The standard variance is in some groups markedly high so that it can be assumed that the test results of the pupils are very widely spread. This means the difference of performances of individual pupils is very great.

The mind mapping method made it possible for the pupils of the experimental groups 1a and 1b to write down far more facts in the cloze maps than requested, because there was no limitation by a given text structure. This explains why the average was above 100 percent in some of the tests.

Table2: Comparison – average and standard variance of test results of the individual groups (data in percent)

	Main test		**1. Posttest**		**2. Posttest**		**3. Posttest**	
	A	**SV**	**A**	**SV**	**A**	**SV**	**A**	**SV**
EG 1a (6. Klasse)	**115,6**	24,7	**128,1**	56,5	**104,2**	49,1	**87**	50,9
CG 1a	79,1	32,1	74	32,5	80,3	20,7	83,9	25,3
EG 1b (6. Klasse)	**105**	23,5	**90,8**	35,5	**91,7**	37,1	74,4	33,6
CG 1b	85,6	29,2	87,2	22	82,8	31,8	**84,4**	33
EG 2 (7. Klasse)	43,6	26,7	42,7	24,1	**63,3**	31	45,3	31,1
CG 2	**63,5**	37,4	**46,2**	42,1	57,7	43	**55,8**	37,2
EG 3 (10. Klasse)	**58,2**	24,4	**65,5**	29,3	**63,5**	23,9		
CG 3	57,6	19	51,9	20,2	44,4	19,4		
EG 4 (7. Klasse)	**39,8**	36,4	**53,4**	52,8	36,7	42,6	**23,9**	26,9
CG 4	17,9	29,2	19,6	39,9	12,1	15,4	13,8	14,6
EG 5-1 + 5-2	41,3	22,5	41,5	24,6	41,3	22,5	30,4	32,8
CG 5 (8. Klasse)	**64,8**	25,4	**84,5**	38,7	**64,8**	25,4	**55,3**	29,1
EG 6-1 + 6-2	**45,2**	21,4	**41,4**	22,5	**37,7**	21,1	**33**	20,9
CG 6 (9. Klasse)	34,3	27,5	20,8	16,7	19,4	12,8	16,7	16,3
EG 7-1 + 7-2	**92,5**	52,8	**98,1**	47,9	**64,8**	36,3	**68,1**	38,2
CG 7 (10. Klasse)	57,3	22,8	56,3	28	45,1	23,3	46,5	21

To answer the initially formulated hypotheses the raw data of the individual experimental and control groups were checked with the U-test (Mann-Whitney)[1] regarding the statistical significance, whereas the probability value lies at 5 percent. The calculations are seen in figure 5.
Starting from the null hypothesis, which states that the groups do not differ from each other, the P-value specifies the probability of correctness of this hypothesis (double sided question).

Table 3: Comparison Experimental Group – Control Group – U-Test (Mann-Whitney)

EG - CG	Main test		1. Posttest		2. Posttest		2. Posttest	
	P-value	Sign.	P-value	Sign.	P-value	Sign.	P-value	Sign.
1 a	0,06	ns	0,02	*	0,14	ns	0,29	ns
1 b	0,02	*	0,48	ns	0,03	*	0,44	ns
2	0,29°	ns	1	ns	1	ns	0,38°	ns
3	0,79	ns	0,31	ns	0,10	ns	-	-
4	0,05	*	0,09	ns	0,12	ns	0,52	ns
5	0,02°	*	0,00°	*	0,02°	*	0,02°	*
6	0,26	ns	0,03	*	0,14	ns	0,08	ns
7	0,04	*	0,01	*	0,29	ns	0,16	ns

Anm.: ° CG better
* /ns = sigificant/ not significant

According to this calculation in the groups 1a, 1b, 4, 6 and 7 there are in seven tests significant differences in favour of the experimental group. In group 5 the results of the control group are in all tests significantly better.

Final Remarks

The test supervisors summarised that the pupils of the experimental groups worked more motivated and more persistently and there were lesser behaviour problems during work.

Summarising the subject matter with the help of key words in a hierarchically ordered structure made it possible for the pupils of the experimental groups to memorise more knowledge for a longer period of time.

With this kind of account it was accomplished to increase the awareness of what is essential and to take away the frustration toward long, complex texts. Weak reading performance(s), which are by all means part of the daily life of pupils with learning difficulties, were therefore no stumbling block, since the choice of words in the work with maps is short and concise. Joy and creativitiy were stimulated. This could be seen in the presentation of the maps in the lessons but also during the tests. Because only the pupils of the experimental groups reached more than 100 points, since their maps were open for new ideas. The pupils did not have a given pattern which restricted their train of thoughts.
Especially to be empasized is the creative layout of the maps with colours, shapes and pictures. In this way associations are possible which support the memorising process in the long-term memory.

[1] The calculations were done with WINSTAT Excel.

Starting from the posed hypotheses it can established

- The pupils of the experimental groups achieved better results in 22 of 32 tests than the ones in the control groups. In seven tests significant differences in favour of the experimental groups and in four tests in favour of the control groups were calculated. This means that the knowledge memorised in the declarative memory has been higher in the respective tests.
- The bigggest increase of declarative knowledge is to be noted with pupils of higher grades.

Clear, well structured knowledge, worked out on the basis of positive emotional conditions, leads to motivated and focussed work which in turn brings about better memory performances.
The simple and logical structure of the subject matters to be worked out enabled the pupils to memorise the presented knowledge more effective and for a longer period of time.

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