The importance of learning strategies and how the project 'Kolumbus-Kids' promotes them successfully

Dr. Claas Wegner[1], Lea Minnaert[2] and Friederike Strehlke[3]

[1] Department for Didactics of Biology, Bielefeld University, Bielefeld, Germany
[2] Department for Didactics of Biology, Bielefeld University, Bielefeld, Germany
[3] Department for Didactics of Biology, Bielefeld University, Bielefeld, Germany
For correspondence: Friederike.Strehlke@Universität-Bielefeld.de

Abstract :
In education systems learners are expected to possess an increased degree of autonomy and show initiative in learning processes, inspecting learning materials and understanding contents. An efficient growth of knowledge inside and outside of school is only possible if students have skills which initiate, guide and control the search for information and later on its processing and storage. In learning and teaching research these techniques are called learning strategies. They are necessary for students to use in order to foster their application of results in education. Since 2006, the Bielefeld University project "Kolumbus-Kids" has been promoting scientifically gifted learners by inviting selected students of regional schools to participate in interesting sessions dealing with biological problems and phenomena at university. The sessions are designed and held by university students. So far, this project is a unique concept in Germany in terms of Biology Didactics aiming at an adequate support of students gifted in natural sciences. During the sessions, we noticed that many students are not able to use learning strategies successfully as they had not learned them in school. The paper at hand intends to provide the reader with a brief overview of the project and the six different types of learning strategies defined by Mandl and Friedrich (cf. Mandl & Friedrich 2006). It shows how our project supports the students' learning strategies and also presents some inspiration for applications in day-to-day science teaching. Fostering and improving your students' learning strategies is important for them in order to learn successfully.

Keywords: Learning Strategies, 'Kolumbus-Kids' project, teaching technique, efficient learning, tips for regular school teaching

Introduction

In modern education systems learners are expected to possess an increased degree of autonomy and show initiative in learning processes, inspecting learning materials and understanding contents. An efficient growth of knowledge inside and outside of school is only possible if students have skills which initiate, guide and control the search for information and later on its processing and storage. In learning and teaching research those techniques are called learning strategies. Since 2006, the Bielefeld University project 'Kolumbus-Kids' has been promoting gifted children between ages nine to twelve, whereas learners aged fifteen to nineteen are tutored in the program 'Kolumbus-Youth'. Selected students of regional schools are invited to participate in interesting sessions dealing with biological problems and phenomena at university. The projects' sessions are mainly designed and held by university students planning to become teachers. They are also supported by academic staff of the Department for Didactics of Biology. This means that the students get the opportunity to improve competences important for their future career as a teacher, for example designing and realizing teaching units or identifying and dealing with different student personalities. So far, this project is a unique concept in Germany in terms of Biology Didactics aiming at an adequate support of the gifted regarding natural sciences. In the sessions we noticed most of the children do not have any efficient learning strategies since they have not learned them in school. This is why the project uses certain teaching methods in order to offer the participants aid and guidance on learning those

strategies, promote the individuals' already established learning strategies and their creation of new knowledge. For further information please visit the project's homepage *www.Kolumbus-Kids.de* (cf. Borgmann & Wegner 2011, 80-81; Wegner & Minnaert 2012, 20).

Current psychological and pedagogical research focuses on students' learning processes in general and also on which learning strategies students should be introduced to enable effective and autonomous learning. The term learning strategies does not describe one uniform, scientific concept. It rather summarizes various concepts of different research groups. Whereas Mandl and Friedrich see learning strategies as sequences of action to reach a learning goal, Lompscher describes them as the following: learning strategies are procedures which are more or less complex, differently advanced, intentionally or unconsciously used to realize learning goals and to cope with learning requirements (cf. Mandl & Friedrich 1992, 6; Lompscher 1996, 2). Weinstein and Mayer understand learning strategies as internal and external actions influencing the learner's motivation, attention as well as selection and processing of information (cf. Weinstein & Mayer 1986, 1).

This article will use Mandl's and Friedrich's definition that learning strategies are targeted processes which are first applied intentionally and then gradually automated. This is the basis for the article's presentation of learning strategies which will be structured into the following six types, also defined by Mandl and Friedrich (cf. Mandl & Friedrich 2006):

- Cooperation strategies
- Elaboration strategies
- Motivational and emotional strategies
- Revision strategies
- Organizational strategies
- Control strategies

This article intends to provide the reader with a brief overview of the project and six different types of learning strategies. It shows how our project supports the students' learning strategies and also presents some inspiration for applications in day-to-day science teaching. Generally, the concept of learning strategies is very important. More teachers need to be aware of it and should improve their students' learning strategies as well as to help them learn learning strategies in the first place.

Cooperation Strategies

In today's society, learning is a cooperative process which includes social interaction. Already in 1977, Tough carried out first examinations to prove the positive effect of cooperative working on small children's learning success to show that children can learn and increase their knowledge without teachers (cf. Tough 1977, 35). Cooperative learning means that students support each other in working to reach a common result. This happens in pair or group work. As a basic requirement for successful learning in such environments, certain conditions have to be fulfilled. One of them is to create a pleasant learning environment. Therefore, the teaching organization should ensure that spatial and temporal conditions support the students' cooperation. The task assignments have to fit pair or group work so that children are enabled to use cooperative skills, such as conversational skills, decision-making, communication and conflict management. The teacher should not leave the students alone, but rather function as a learning aid by creating a tutorial learning environment. The working groups' size is also essential for cooperative learning since they should not have more than three to four members. A heterogeneous group composition is useful since strong and weak students can support each other cooperatively. Active participation in group work has a positive effect on the amount of remembered items. Nevertheless, group work does not necessarily imply that all group members have to cooperate with each other (cf. Huber 2006, 261-263). There is always the risk of very

good or rather silent and weak students being exploited by others, which should be monitored by the teacher surveying the group work.

Cooperative learning is useful for all kinds of students. For example, silent students who often take the outsider position in class and children with attention deficit or hyperactivity disorders can be integrated into the learning group more easily. Through this method, they are enabled to join conversations and discussions with their class members. The teacher can make use of popular or gifted students by putting them into a group with weaker students. For teachers such learning situations are ideal because they can hand over the responsibility for learning to their students. In this way, the students can also be trained concerning their social skills and their team spirit. Students participating in the 'Kolumbus-Kids' project have the chance to meet and exchange experiences with peers having the same stage of cognitive development and the same interest in natural sciences.

Within the project Kolumbus-Kids, the students have to work on experiments in small groups of around four people every session. For example, the students have to find out how ants are able to follow the trails laid down by other individuals from their nest to a food source. For doing so, however, the students do not get a complete description of an experiment, but a mere list of material they can use. The students now have to develop a design for an experiment within their group in order to solve their questions, discussing flaws and problems that might come with certain ideas. This triggers the development of the learner's social skills, as they learn that achieving a goal as a group is much easier and can also be more fun than working individually. Besides, the children's degree of autonomy from the teacher is increased when they work collaboratively on tasks. While the teacher only interferes if needed, the children are very active in the sessions and responsible for their results. The Kolumbus-Kids teachers noticed that through group work the children understand new information better and are able to keep it in mind longer than through teacher-centered instruction. There are various teaching methods for cooperative learning, such as the jigsaw puzzle. Generally, students have to be trained on collaborative activities in class and initial failures are normal. Also, a learning group has to have certain social abilities to practice such learning forms, otherwise preliminary exercises have to be done. In the long run, the classroom climate will be improved by social cooperation and excessive demands can be prevented.

Elaboration Strategies

What is problematic about all learning and knowledge-gaining processes is integrating new knowledge into an existing, cognitive structure (cf. Friedrich & Mandl 2006, 2). Elaborative techniques encourage both the understanding and remembering of new knowledge since they create links between new information and the already existing stock of knowledge. Generally, they are used when students invent analogies and mnemonics for facts that have to be learned, link new ideas to their previous knowledge or express new information in their own words (cf. Schräder-Naef 2002, 44). Those techniques support learning through understanding. Mnemonic devices help memorizing and remembering unstructured material, such as vocabulary or word lists as well as complex correlations, which is of special importance for gifted learners and underachievers. In 'Kolumbus-Kids' sessions, the course members are allowed and encouraged to invent and use individual mnemonic aids and sentences of remembrance from their own perspectives. We experienced that learning via rhymes and images is both fun for many of the students and useful for remembering information. We also promote training these strategies by exposing our students to synthesis exercises and to those which require using already stored knowledge. These are, for example, procedures activating previous knowledge such as brainstorming, finding analogies, utilizing notes and mnemonic devices. From such starting points, the lessons then lead over to new information, such as unknown features of processes the students have already known before. The teachers also instruct the students on how to organize their exercise books in a structured way. Besides, teachers can explain

complex facts, activate previous knowledge and draw analogies by creating vivid images from the students' environment. Another possibility is to introduce memory training techniques as mnemonic sentences into your lessons.

Motivational and Emotional Strategies

The learner's motivation is mostly regarded as a central condition for successful learning. However, other factors like intelligence, previous knowledge and interest play an important role as well. Rheinberg describes motivation as an activating orientation to a target status which is regarded as positive. He states that the strength of this orientation influences the action's duration and intensity. In a school context this means that the extents of learning motivation affects whether a student learns at all and if so, for how long (cf. Rheinberg 2000, 15). Furthermore, there is a distinction between intrinsic and extrinsic motivation. Actions which are intrinsically motivated are especially interesting, exciting or challenging for learners and show positive aspects of experience. In contrast, extrinsically motivated actions have an instrumental function as they are used to reach positive consequences, for instance praise of the parents or good grades (cf. Rheinberg 2000, 60).

The promotion of learners' individual and thematic interests has become an important matter in current research. Students like gifted learners or underachievers as well as students with autism or borderline disorders profit from motivational and emotional learning strategies. In contrast to other learning strategies mentioned in this text, particular examples of application cannot be presented but rather approaches which should be considered in certain situations. A declared objective of school teaching is to raise the students' interest for subject matters. One way of raising interest is to implement these subject matters into lessons as appealing, varied and entertaining as possible and to present unexpected questions and contents (cf. Schiefele & Streblow 2006, 238/239). As main prerequisites the need for competence, self-determination and social integration are mentioned frequently. The goal of promoting intrinsic motivation and subject related interest is to create positive experience during learning and to increase the learners' personal significance of learning objectives (cf. Schiefele & Streblow 2006, 239). As children need to be motivated in order to work on challenging tasks and phenomena successfully, the 'Kolumbus-Kids' sessions are designed so that they motivate our participants and give them a high level of autonomy. The activity- and problem-oriented lessons offer them space to live out their interests and talents regarding natural sciences. Also the choice of methods is to support the children's motivation, such as watching short film clips, conducting biological experiments and working practically in the laboratory or outside in nature on every day life problems and phenomena. We learned from experience that handling animals during the project is highly motivating for children. The participants benefit from observing living objects, such as the project's sea water facility which enables children to explore the marine habitat and its residential animals. During the course of the project, the students elaborate hypotheses on the animals' food ingestions, movements and behavioural characteristics. These are then verified via rule-based observations and small marine biological experiments. It has to be acknowledged that regular schools are not able to possess as great a diversity of animals, but study groups can also be motivated by working with tadpoles, tortoises and pond mussels. Also teachers can invite students to bring their own domestic animals to school in order to function as observation subjects in biology lessons and increase the learners' motivation. In addition to that, the learners' motivation is raised by the selection of topics that meet their levels of knowledge and abilities, as this fulfils their need to feel competent. In order to do so, our teachers conduct knowledge tests at the start of each teaching unit that give them an overview of about how much they have to explain and how much they can leave for the students to discover themselves. Also, it gives them the possibility to check which topics might be too hard to deal with for their students, thus keeping them from the frustration of being over-challenged. Furthermore, the above mentioned activity orientation and the fact that teachers take a background seat during practical phases make the students feel self-determined, thus boosting their motivation once more. It starts with developing and conducting experiments on their own and ends with

analyzing and interpreting the collected data which is well possible in regular classes, too. The most important bit is that teachers design the lesson in a well-wrought way and that they have a backup plan up their sleeves in case things do not work out.

In order to strengthen a learner's confidence, teachers can make use of extrinsic motivation tools like praise or reprimand, the promotion of active participation and applications close to everyday life, a clearly structured learning content as well as social support by setting appropriate tasks (cf. Schiefele & Streblow 2006, 240). By providing students with autonomy, their self-determination is automatically fostered. Using team work and a good teacher-student relationship can increase the feeling of social integration. If possible, the curricula substance should be of emotional importance to the students and practical applications need to be presented. Students should be able to have an influence on lessons, as for instance through market place learning which the project uses as well. Use cooperative learning forms like the jigsaw puzzle to support social structures and to avoid students working in the same groups every time.

Revision Strategies

Students are confronted with a large amount of information each day at school, however, only a small amount of this subject matter is anchored in the long-term memory by a single impulse. The more detailed the subject matter, the more important is the revision of what has been learned as a pre-condition for remembering (cf. Konrad 1999, 85). The significance of revision was first investigated by Atkinson and Shiffrin in the 1960s and has been focused on ever since in the academic world (cf. Friedrich & Mandl 1992, 11; Atkinson & Shiffrin 1968). Active repetition and reciting helps to store particular facts in the long-term memory. Besides the classical repetitive learning of word or vocabulary lists, any other content like rules and tables can be learned through memorizing techniques. This strategy is particularly useful for weaker students or students with dyslexia or autism spectrum disorder because they often need more time and repetition phases to grasp new subject matter. As our course participants are gifted students, our project rather focuses on the other learning strategies and not on this one in particular. However, we also support active repetition and reciting if individuals need it. At the end of most lessons, a short summary of what was done and found that day is given by a student, with others helping out in case something is missing.

A useful revising technique has proven to be learning with index cards which can be applied to every subject by noting special terms on one side and their meaning on the other. With a card index each student can work on individual weaknesses at home. There are also numerous other possibilities to make revision interesting and motivating for students. A learning poster can be designed by students to depict new subject matter for everybody in the classroom. As a teacher you should include regular revision phases in your lessons, such as monitoring the afore-mentioned homework and explain to your students how important systematic revision is.

Organizational Strategies

Those learning strategies aim at organizing new knowledge by making connections between the different knowledge elements (cf. Friedrich & Mandl 2006, 4). Miller was the first to discover these and describe them in 1956. By using organizational strategies important information is identified or depicted visually, details are combined and clustered and thus a deeper understanding of the new subject matter is achieved. As the human working memory's capacity is limited, complex information is easier to process when transformed into a structured form (cf. Schräder-Naef 2002, 44). Utilizing organizational strategies is generally beneficial for students of different personalities, skills and needs. For one, this strategy is important for every student as it helps organizing large amounts of subject matter by dividing the learning content into suitable sequences. The depiction of facts in a mind map or a poster helps visually oriented learners to store the connections between learning content in their

long-term memory. Subject matter can be made clearer and put into context of meaning with forms of external visualization. Underachievers often have difficulties with structuring the knowledge they already possess and activating it in learning situations. Mind maps and posters are frequently created regarding the results of experiments during the project's classes. They are then uploaded to the project's electronic platform, thus giving the students a possibility to have a look at their newly gained knowledge in a structured form afterwards. In addition to that, the platform gives short and structured summaries of the lessons' topics and presents the main information that has been taught. Furthermore, work sheets proposing further organizational tasks that ideally transfer the new knowledge to already existing knowledge and everyday phenomena are made available for download.

Students with problems in reading and spelling may improve their skills by using reading and highlighting techniques. Material that has been systematized by highlighting, for example, is easier for students to understand and to retrieve later. All these weaknesses can be improved by acquiring organizational strategies. When students are offered and taught about such methods, they are provided with material assisting them to confront their learning difficulties autonomously. The project supports these strategies by teaching the children how to categorize research processes in experiments, observations or other research projects. It is much easier and beneficial for them to know that these processes can be subdivided into an initial problem, formulating a hypothesis, conducting some experiments and finally formulating a conclusion. By dividing the subject matter into these categories, they can organize it better and put it into context which makes it easier to understand and remember it.

Control Strategies

Effective learning needs strategies controlling one's own learning and thinking. Control strategies were first introduced by Borkowski, Pressley and O'Sullivan in the 1980s (cf. Borkowski, Pressley & O'Sullivan 1985). Competent learners are able to plan, monitor, check and reflect the results of their leaning and thinking processes. These strategies are called metacognitive strategies as they operate above and perform the function of regulating one's own information processing (cf. Mandl 2006, 5). Setting educational goals as well as wording control questions have to be included when planning a learning sequence. Control strategies help to check the learning progress, for instance whether a text was understood in detail. Regulation strategies are useful to adapt one's learning to the demands of the task, such as reading a difficult section of text once more. These learning strategies rather address experienced learners with a distinctive ability to reflect. Younger and inexperienced learners have to be prepared for such techniques first. Within the project, the students have to take more responsibility for their own learning outcomes the older they are: the older ones are given more freedom regarding their experimental designs and their tasks are less explicit about what parts of information provided by texts or teacher presentations are important when forming their hypotheses or when planning their experiments. By gradually letting them take care of their own learning processes more and more, most students automatically develop control strategies that fit their character. Working in small, ever changing groups further improves this process as the students learn from each other and take bits and pieces of others' strategies that seem reasonable to them.

Different student personalities can benefit from control strategies, as for example the class clown can focus on the task and hence minimizes the risk of being distracted from learning contents. In addition to that, such students within the project Kolumbus-Kids are often given an additional task in monitoring his fellow students' progresses once he is finished. Thus, he does not only oversee his own work, but also helps out others, by this getting the chance to see how others employ control strategies. He can benefit hugely from this, as he might implement features he found helpful into his own future learning processes. Students with reading and writing difficulties can be supported as well as gifted students can be enabled to work in a structured and organized way when making use

of such strategies. In the project, the students use these techniques when working on their own small research projects and writing a learning diary in order to control and reflect on their individual learning processes and results. Another important aspect is to reflect critically how an experiment was conducted and to analyze the mistakes in plenum. Independently working on tasks without the teacher's help supports the children's self-confidence and also enables them to reflect their learning process. This competence is promoted as it is especially important for the children's future life and life-long learning. Once they leave school, the students have to be able to monitor their learning processes by themselves. Only if they are capable of doing so will they be able to also learn and improve at university or at their workplace for their whole life. As a teacher you should promote and accompany your students developing their individual control strategies and hence help them to improve learning.

Conclusion

Often school is called the primary place of learning. Necessarily, school also has to be the place where students learn how to learn and thus successfully acquire learning strategies. Nevertheless, acquiring these has so far been a by-product of school teaching and still needs to be optimized and developed further. In the conflict between imparting knowledge and developing the students' learning competence school education puts the focus on the former. If learning strategies and methods have the importance of key qualifications, they should also be developed systematically so that learners have developed a repertoire of strategies by the time they leave school (cf. Friedrich & Mandl, 2006, 17). To reach this objective, teaching learning strategies must be organized systematically by school as well as supported by teachers and their choice of teaching methods. The Bielefeld University's 'Kolumbus-Kids' project supports the course members in their acquirement of learning strategies by the above-mentioned examples of teaching techniques and methods. We hope that they can also serve as inspiration for day-to-day teaching in regular schools, since they are extremely important for efficient learning. The fact that school education takes place over a long period of time and that various subjects are taught makes schools an ideal place for acquiring learning strategies. Therefore, it is important for teachers to examine this topic and to teach their students about it as early as possible. Only repeated practice of these techniques enables students to develop into good strategy users, who can select the strategy they want to use according to their objectives and the situation they are in.

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