Elke Schlote

Learning how to learn

How knowledge programmes can support children's learning

The article presents the results of an IZI reception study that investigated which elements of children's knowledge programmes help fostering metacognitive skills.

Children in the primary school and preteen age group watch "knowledge programmes", because they want to learn something new. 12-year-old Sabrina from Germany, questioned in an IZI study, states: "I keep watching programmes like that because I think they're interesting. I like watching about the body, for example, and nature, water and such." Studies show which elements can increase the learning gains from such programmes (cf. Lee/Huston, 2003; Bickham/Wright/Huston, 2001; Reich/Speck-Hamdan/Götz, 2009; Götz, 2009 and references in vom Orde in this issue).[1]

Well-made children's knowledge programmes can, on the one hand, encourage children to pick up facts and the connections between them. On the other hand, if they additionally present methods of research and learning in engaging ways, children will benefit even more from them (cf. Reich/Speck-Hamdan/Götz, 2009). Knowledge programmes would gain in quality and be more sustainable if they support children in developing their so-called "metacognitive skills". People need these skills in order to acquire knowledge and to direct and monitor their own learning processes ("learning how to learn"). Individuals wishing to acquire knowledge must know how to learn effectively and how to answer questions with the help of a variety of problem-solving strategies. For this, they must plan and monitor their learning processes, but they must also know how to motivate themselves and assess their own success, so that they can change strategy if problems arise (cf. Hasselhorn, 2006; Mähler/Stern, 2006). Metacognitive skills are especially indispensable in view of self-directed lifelong learning which gets more and more important nowadays.[2] Knowledge programmes for children can contribute in fostering these skills in a variety of ways.

This article presents findings from IZI reception studies of "knowledge programmes" which offer specially designed educational content from nature and natural sciences, such as can be observed in everyday phenomena. These programmes were selected for their diverse approaches in presenting information and different ways in how they potentially support the development of metacognitive skills in children.

The study

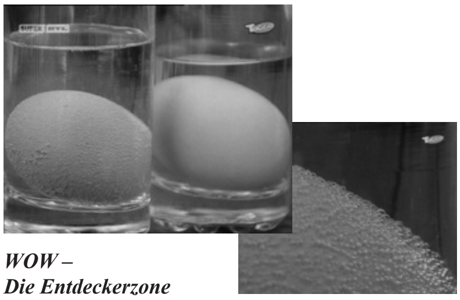
In an IZI study in 2009, we investigated what elements in a show were helpful for the fostering of metacognitive skills, and which ones proved less effective in reception tests (cf. Schlote/Renatus, 2010). We asked 165 9- to 13-year-olds in Germany what they were able to gain in terms of content and problem-solving strategies from items taken from 4 German knowledge programmes. We questioned them about this after viewing and then 14 days later. In 2008 another reception test was carried out on 11- to 12-year-olds regarding the Japanese format *Mathematica* (cf. Schlote/Schreiner, 2008).

Children learn metacognitive strategies by …

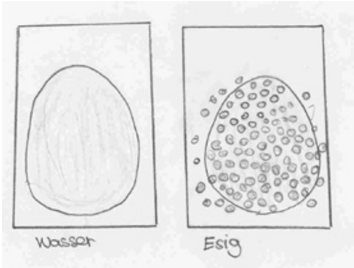
Children like it when knowledge programmes show something being tested. These can be studio experiments performed "live", or a presenter acts as "guinea pig" in an experimental setup. Experiments that can be copied at home are also popular with younger school children. This interest is a good starting point for fostering metacognition, since planning and conducting an experiment is a good problem-solving strategy for many questions in science.

… watching and copying step-by-step instructions

In *WOW – Die Entdeckerzone* ("*WOW – The Explorers' Zone*", Super RTL, Germany), children carry out small experiments and build things (e.g. a water wheel) out of everyday objects. The format focuses on the children doing the activities, and apart from the presenter's parts, who introduce the individual items and give supplementary tips, only children are visible on screen. The step-by-step depiction of the experiments enables viewers to follow what is happening, and encourages them to try it out themselves. Chiara, 10 years old, says of *WOW*: "You can experience some-



WOW – Die Entdeckerzone



Hena, 10 years old

Screenshots from *WOW* © Super RTL

Ill. 1: **Clear images help children understand experiments and processes and imitate the experiment from memory**

thing yourself and you can do your own experiments outside." An item in the reception test:

A boy uses an egg to practise juggling. He gets annoyed when he drops it and it breaks. He takes 2 more eggs, puts one in water, the other in vinegar. The shell of the "vinegar egg" dissolves, and it becomes as elastic as a rubber ball – now the boy can carry on practising without any damage being done.

In the items, great importance is attached to showing all the important elements on the screen, often in close up. Since children generally focus on the visuals when watching television, our respondents were easily able to reconstruct the sequence of the experiments with the egg in their drawings and in the interviews.

One way in which *WOW* fosters metacognition is by giving step-by-step "recipes" that show how children can carry out simple experiments themselves, thus encouraging imitation. In the egg item, however, parts of the problem-solving process are missing. Thus for example the genesis of the idea is not shown: how did the boy find the solution of putting the egg in vinegar? The children in the reception test speculate: "He tried it out, one with water and one with vinegar, but of course he didn't know …" (Steffi, 10 years old).

Thus the item mainly conveys "if-then" knowledge. Metacognitive reflection can play a part later, however, when children implement the "recipe" themselves. 9 children in the IZI study had, without prompting, carried out the experiment at home, and talked about their successes and difficulties. Some had struck the problem that the black balsamic vinegar which they had used could not dissolve the egg shell. Most were unable to solve this problem because they could not derive any alternative strategy from the contents of the programme (i.e. using a more acidic type of vinegar). For them, the experiment simply had not worked.

Here, knowledge programmes for children still have potential, particularly for the older age group, both to diversify their problem-solving strategies, and to provide stimulus for metacognitive reflection, so that children also become aware of how to plan and implement strategies.[3]

… absorbing explanations and developing initiative

Wissen macht Ah! (*"Knowledge Makes You Go Ah"*, WDR, Germany) offers thorough explanations of how things work. The programme's presenters use simplified models to show that everyday phenomena are based on e.g. the laws of science. Thus for example in the item "Megaphone" knowledge about physics is imparted by means of a technical device which appears in an everyday context:

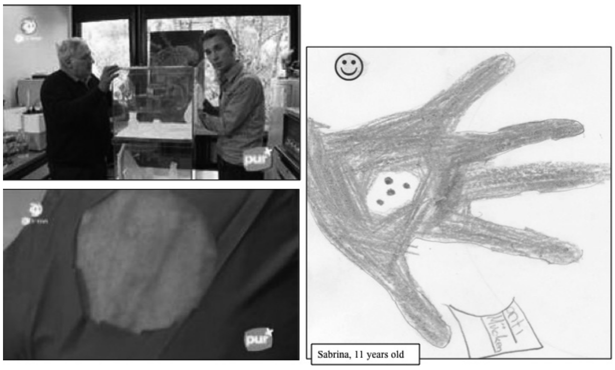
Julika and Moritz are watching television. Julika asks for the remote control, so she can turn up the volume, but Moritz does not hear her. She gets out a megaphone and speaks into it. Moritz jumps because her voice sounds so loud. This is followed by explanations of how the megaphone works: sound waves are visualised, and viewers are shown how the funnel shape keeps them together. Moritz then wants to pass Julika the remote, but Julika has already found another solution: she rolls 2 cardboard cones and holds them up to her ears: the sound waves from the television are "caught" by the funnels and are perceived as louder when they reach her ears.

This item is mainly instructional and the children focused clearly on the explanatory aspects, i.e. how sound waves work. They practise the metacognitive strategy of "mental reconstruction of an explanation", familiar from school, and remembered a certain amount of content from the item when questioned after 2 weeks.

The metacognitive problem-solving strategy "using a model/using analogous devices" is only offered implicitly (in the item, sound waves are compared with water waves, the megaphone with makeshift cardboard cones). The small, casually presented detail "building a megaphone from cardboard" inspired many children. Without prompting, several children had tried to build a megaphone at home, as they told us 14 days later. However, some complained their makeshift megaphone did not work

Screenshots from *Wissen macht Ah!* © WDR/KiKA

Ill. 2: ***Wissen macht Ah!*: a small, but inspiring detail: Julika is making her own megaphone**



Screenshots from *pur+* © ZDF

Ill. 3: **The strategy "self-experiment" is exciting and easy to follow if the course of the experiment is shown step-by-step (here: counting Erik's mosquito bites)**

as anticipated. Although some children grasped the general concept of "making a model" (for example, 11-year-old Christoph explains: "You have to somehow see how it works and then you have to build something like it, like, in a way how it's done correctly"), they failed in finding a solution to the concrete question what constitutes a good model of the megaphone.

In order to stimulate metacognitive reflection about experiments and using models for explanations, the item would have to deal with additional questions such as: "What is a good analogous model for my explanation and why?"

… being able to choose from a variety of strategies

In the programme *pur+* (ZDF, Germany), the presenter, Erik, employs various strategies to find out all about a particular topic. Viewers are "taken along" on his path to knowledge acquisition. In an item about mosquitoes he begins by interviewing an expert. He then gathers further information about these creatures and their bites by conducting a self-experiment (ill. 3) on mosquito repellents, and by undertaking field research in Africa.

Erik visits a scientist at university and asks him about mosquitoes. He learns that only female mosquitoes bite, because they need the blood to lay eggs. He then proposes a self-experiment with mosquito repellents to the professor: "I have a few repellents with me, I'd like to test them." The preparations for and the carrying out of the experiment are shown, we see in close up how Erik puts his hand, sprayed with mosquito repellent, into a box full of mosquitoes. Erik counts his bites and compares his hand with that of the professor, who had tested a different mosquito repellent.

Thus the self-experiment is recorded in an easily comprehensible manner. At every step, viewers have time to follow what is happening, even if there is no concluding discussion to summarise and provide a framework. Aspects of content are intertwined with the concrete problem-solving strategy.

The viewers can check every step as eye witnesses. It was this "self-experiment" as a strategy for knowledge acquisition which children mentioned in individual interviews: "He didn't believe the scientist, but tried out the [mosquito] repellent himself" (Zoran, 11 years old). In some cases this was recognized as a general problem-solving strategy. 14 days later, 12-year-old Lydia states: "First you have to test, you have to try it out, and then you know for sure."

pur+ demonstrates that various kinds of knowledge acquisition can be presented in relation to a topic. Children can develop a more detailed understanding of concepts which are, in some cases, already familiar to them, e.g. regarding experiments.

The programme does not, however, give any support for metacognitive reflection on the questions: "What strategies are suitable for what questions, and when?", "What else could I use this strategy for?", "What alternatives would there have been to the strategy presented?" 11-year-old Elif thus finds that the "self-experiment" strategy is only of limited use for the questions that interest her: "With the mosquitoes you have to put your hand in, and if you want to know how the blue whale sleeps, for example, then you have to search on the Internet or in the encyclopaedia."

... following the solution-finding process

The series *Mathematica* (NHK, Japan) won the Children's Jury Prize at the PRIX JEUNESSE Festival in 2006. A reception test with 11- and 12-year-olds from non-academic families in Germany showed that 2 aspects of metacognitive support are crucial.

Mathematica aims to impart knowledge about arithmetic and geometry; the episode shown is about the mathematical concepts of perimeter and area. No formulae are presented, however; instead the item shows young bakers in a bakery who have to establish whether a round or square cake is bigger (ill. 4). In order to find this out they try various things,

Screenshots from *Mathematica* © NHK

Ill. 4: **A challenging question: which cake is bigger? Bakers apply different strategies before the explanation is offered** weighing the cakes, measuring the perimeter, cutting up the round cake and arranging the pieces on a square surface. Now the explanation begins: an umbrella is used to demonstrate how to get from a square to a circular shape (its round shape is made of triangles, cut out of a square piece of cloth), and another animated sequence follows explaining this.

On the one hand, the children gain certain insights from this representation of the problem-solving process: "I learnt that you can make a circle from lots of triangles" (boy). He goes on to explain, "it doesn't matter how something looks. If you work it out using maths, only then you know how big it is." These are 2 aspects which might perhaps help him to organise his learning and problem-solving strategies in the area of mathematics.
On the other hand, the children acknowledge themselves that they have learnt how satisfying it can be to look for a solution in different ways: "The thing I thought was cool about the apprentice bakers was that they never gave up. They kept on trying out new ways to find out which was bigger" (boy).
Metacognitive skills also include "sticking" with the problem when matters become difficult, and looking for another way to solve it.[4] The children could relate to the everyday setting with the apprentice bakers, and they accepted them as a model to try out another strategy if they run into difficulties. What is important here is that the young respondents from non-academic backgrounds were inspired by this representation of curiosity and persistence, placed in an everyday context.
It is questionable whether this would be equally possible in other representations, e.g. of adult scientists in an academic context. Thus it is of vital importance for television makers to reflect on who exactly is shown engaging in and presenting science on television (cf. Schlote in this issue).

Conclusion

Children closely follow the visuals in knowledge programmes, and can understand and reconstruct processes and sequences if they are engaging and well-presented. Under certain circumstances, these programmes can support them in the development of their metacognitive skills. The knowledge programmes tested in this study offer a wide variety of problem-solving strategies which children actually can utilise to develop their metacognitive skills.
Children differ widely, however, in terms of both prior knowledge and interest in problem-solving processes. Children who have experience of and an interest in experiments are already familiar with many strategies. They are also able to recognise and name implicit strategies in items. Children with little experience benefit from more explicit representations and verbalisations.
It took questions and tasks to discover, in the reception studies, that children learn something from television programmes, which is beneficial to their metacognitive skills. Knowledge programmes for children can therefore improve in 2 areas: they may diversify problem-solving strategies, and they may actively spark metacognitive reflection, so that children become more aware of how to plan and implement strategies (or what to do when something goes wrong). This should occur always by way of concrete questions which interest children and get them actively involved.[5]

NOTES

[1] *The psychology of teaching and learning tells us that we have to abandon the idea of imparting knowledge to the recipients, directly and without interference. Viewers categorize what they see in the context of their knowledge and experiences, and incorporate information into their stores of knowledge actively, individually, and selectively (cf. Reich/Speck-Hamdan/Götz, 2009, Götz in this issue). This is why an analysis of a knowledge programme has to include the children and their reception of the show.*

[2] *Promoting metacognitive skills is also one of the concerns of modern primary education, e.g. in Germany (cf. Hellmich/Wernke, 2009).*

[3] *The person carrying out the experiment should not be very young, however, if he or she gives explanations expanding on the content of the experiment, otherwise the children watching will not believe him or her capable of such explanations (cf. Schlote/Renatus, 2010).*

[4] *Only if children are convinced that it is worth making an effort, and only if they believe themselves capable of achieving something, will they apply thinking, learning, and problem-solving strategies in a spontaneous and self-directed manner ("skill and will", Friedrich/Mandl, 1992, p. 24 f.).*

[5] *Metacognition cannot be fostered in isolation, but should always be related to a field: "Knowledge and skills specific to a particular area (...) are supplemented by broadly applicable knowledge about the use of tools and work techniques." (Mähler/Stern, 2006, p. 791)*

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THE AUTHOR

Elke Schlote, Dr. phil, is Freelance Scientific Editor at IZI, Munich, Germany.