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SUPPORTING SCIENCE CAPITAL TEACHING THROUGH A PARTICIPATORY ACTION RESEARCH COOPERATION BETWEEN SCHOOLS AND OUT-OF-SCHOOL SETTINGS

APOIO AO ENSINO DO CAPITAL CIENTÍFICO ATRAVÉS DE UMA INVESTIGAÇÃO-AÇÃO PARTICIPATIVA E DE COOPERAÇÃO ENTRE ESCOLAS E AMBIENTES EXTRA-ESCOLARES

APOYAR LA ENSEÑANZA DEL CAPITAL CIENTÍFICO MEDIANTE UNA COOPERACIÓN DE INVESTIGACIÓN-ACCIÓN PARTICIPATIVA ENTRE ESCUELAS Y ENTORNOS EXTRAESCOLARES

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ABSTRACT | According to the concept of science capital, science-related knowledge, attitudes, experiences, and resources are crucial for a person's ability to succeed in a science-driven world. Essential aspects of science capital teaching are the personalisation and localisation of learning processes. Extracurricular offers can support schools by providing real-life and individualised offers. In a cooperation between primary schools and a non-formal institution, an action research process has been used to improve an out-of-school learning opportunity to support students´ science capital. Therefore, an inquiry-based teaching setting with narrative framing was developed. The format is currently still a process in progress. After completion of the first of the three planned Action Research cycles, positive results are evident regarding the effects of narrative framing as well as the differentiation of learning processes. However, the connection to classroom activities and the consideration of heterogeneity of learners still require further adaptation.

KEYWORDS: Science capital, Educational cooperation, Individualized instruction, Science adventure, Primary science.

RESUMO | De acordo com o conceito de capital científico, os conhecimentos, atitudes, experiências e recursos relacionados com a ciência são cruciais para a capacidade de uma pessoa ser bem sucedida num mundo orientado para a ciência. Os aspetos essenciais do ensino do capital científico são a personalização e a localização dos processos de aprendizagem. As ofertas extracurriculares podem apoiar as escolas, fornecendo ofertas da vida real e individualizadas. Numa cooperação entre escolas primárias e uma instituição não formal, foi utilizado um processo de investigação-ação para melhorar uma oportunidade de aprendizagem extraescolar e para apoiar o capital científico dos estudantes. Por conseguinte, foi desenvolvido um ambiente de ensino baseado na investigação com enquadramento narrativo. O formato ainda é atualmente um processo em curso. Após a conclusão do primeiro dos três ciclos de investigação-ação planeados, os resultados positivos são evidentes no que diz respeito aos efeitos do enquadramento narrativo, bem como à diferenciação dos processos de aprendizagem. Contudo, a ligação a atividades de sala de aula e a consideração da heterogeneidade dos aprendentes ainda requer uma adaptação adicional.

PALAVRAS-CHAVE: Capital científico, Cooperação educativa, Ensino individualizado, Aventura científica, Ciência Primária

RESUMEN | Conforme al concepto científico capital, el conocimiento, actitudes, experiencias y recursos son cruciales para la habilidad científica. Aspectos esenciales de la enseñanza del capital científico son la individualidad y la localización del aprendizaje. Ofertas extracurriculares pueden apoyar las escuelas ofreciendo programas individuales y de la vida real. En cooperación con escuelas primarias y una institución informal, una investigación, llamada action research process, ha sido utilizada para mejorar las oportunidades de adquirir un conocimiento científico. Por este motivo, se ha desarrollado un ambiente con el fin de enseñar, basándose en la experimentación y una formulación narrativa. El formato aún está en proceso. Después de la realización del primer círculo del action research se han manifestado efectos positivos, tanto en los efectos de la formulación narrativa como en la diferenciación en los procesos del aprendizaje. No obstante, la conexión entre el aula y la heterogeneidad de los alumnos necesita más adaptación.

PALABRAS CLAVE: Capital de la ciencia, Cooperación educativa, Enseñanza individualizada, Aventura científica, Ciencia primaria.

1. INTRODUCTION

NaturErlebnisPark Science Education Center is a non-formal institution that has been working for almost 30 years to support science education in schools for students of all ages by developing teaching materials and methods, engaging in professional development activities for teachers and offering educational activities in outdoor learning environments and student´s laboratories. An important target group of the activities developed at the Science Education Center are preschools and primary schools, grades 1-4. They visit the center as a class and take part in a research adventure in a prepared learning environment both in- and outdoors. After their visit, they reflect and work on their experiences and findings back at school. The reference subject is the multiperspective "Sachunterricht", included in the Austrian curriculum, which aims at an integrative interdisciplinary development of the students' abilities to understand and handle the various challenges in their everyday living environment and prepares them for the later subject teaching at secondary level. The natural sciences are represented in this approach to teaching through the perspectives of nature and technology as well as through universal teaching principles like sustainability and environmental education.

For several years, at NaturErlebnisPark Science Education Center an experiential teaching format has been used for the primary level, which has been continuously adapted to respectively current teaching requirements within the framework of repeated action research cycles.

In 2022, a further revision of the teaching setting was initiated. Decisive for the current development process were on the one hand trends that have been observed in the educational landscape for some time and on the other hand new requirements due to a reform of the curriculum for primary schools:

- More than ever, familiarity with scientific ways of thinking, sources of information and the ability to make connections to one's own everyday life are necessary for participation in a society shaped by scientific discourse. According to the findings of Archer et al. (2015) this disposition, known as science capital, is insufficiently developed in a considerable proportion of pupils. Targeted science capital teaching- the concept is explained in more detail in section 2.2- can help children to see science as relevant to their personal lives and to experience themselves as competent in science-based problem solving.

- A strong increase in the heterogeneity of students can be observed in school classrooms. This relates to different dimensions such as developmental level, prior experience, language proficiency or socio-cultural backgrounds. In order to contribute to educational equity and to support individual educational biographies in the best possible way, differentiated teaching offers are needed to enable different approaches to the development of curricular contents.

- In autumn of 2023, a new curriculum will be implemented in Austria, which will place a stronger focus on cross-curricular, interconnected aspects, competence development in research and discovery methods and cross-cutting topics such as sustainability education. The individualisation of learning processes and the targeted support of each individual child will be central principles in all teaching subjects.

The objective was therefore to provide primary schools with an event format that ties in with regular classroom activities and curricular requirements, enables experiences that contributes to the development of science capital and addresses heterogeneity among pupils.

An iterative path of repeated loops consisting of sequential phases of development, testing in cooperating schools, evaluation, and revision, was chosen for the design process of the format. This report represents the state of development at the end of the first of three developmental loops.

At the centre of the design process is "Fridolin's Research Adventure", a teaching approach that is continuously adapted to the current needs of all participants during the cycles of revision, practical application, and evaluation. The approach is characterized by an experiential scenario for inquiry-based learning, during which problems, provided in a narrative and immersive setting, are solved through various methods of inquiry. The basic format can be adapted to several curricular contents and focused on the promotion of different scientific competences.

In the ongoing evaluation of the format, a triangulative mixed-methods approach is used. The perspectives of the students, the class teachers, and the experiences of the educators from the Science Education Center were considered.

2. RATIONAL AND CONTEXT

The objectives and methodological guidelines for the revised teaching format result equally from the legal and didactic requirements of the new curriculum, the findings from the evaluation of previous formats and from up-to-date concepts of educational research.

2.1 Extracurricular learning venues as a support for Austrian "Sachunterricht"[1] teaching

The demands on teaching associated with the 2023 curriculum reform pose new challenges for schools. To a much greater extent than before, the promotion of competences relevant to research, the connection to the students' lifeworld, the opportunity for discourse and argumentation as well as the creation of individualised learning opportunities are considered mandatory desiderata in teaching. In order to increase the learning opportunities of the pupils, the new curriculum explicitly calls for the use of extracurricular places of learning and cooperation in the students' living environment. (BMBWF 2023).

With their specific staff conditions, infrastructural and professional scientific resources, out-of-school educational institutions can create conditions for learning processes that would be difficult to implement in this form in everyday school life. In recent years, the number of institutions such as museums, science centres and school laboratories that offer educational programmes specifically for schools, has increased significantly. The extent to which such activities have a sustainable educational impact depends on the extent to which they are connected to regular classroom teaching.

2.2 Fundamental educational theory

Essential impulses for the development of the teaching format "Fridolin´s Research Adventure" come from the concepts and findings on Science Capital Teaching as well as from the ideas of 21st century competencies education.

[11]The term "Sachunterricht" describes a school subject that aims at general knowledge and includes science and humanities.

- The term science capital encompasses all those resources, knowledge, experiences, social relations, attitudes, and dispositions that enable a person to act autonomously in a world shaped by science and to participate in society. In the empirical studies underlying the concept of science capital (Archer et al. 2015), eight dimensions of science-related experiences, knowledge, interests, behaviours, and attitudes emerged as particularly decisive for the science capital available to a person. According to this, the following are the crucial components for building science capital:

  -Scientific literacy

  - Science-related attitudes, values and dispositions

  - Knowledge about the transferability of science (skills, knowledge)

  - Consumption of science-related media

  - Participation in out-of-school learning activities

  - Family science skills, knowledge, and qualifications

  - Knowing people in science-related roles and jobs

  - Talking to others about science in everyday life

  In society, science capital is quite unequally distributed. A British study claims that 27% of young people have low levels of science capital (Archer et a. 2016). Targeted science capital teaching is therefore also considered an important contribution to social justice (Archer et al. 2015).

  A person's science capital is not a fixed quantity but can be influenced by experiences and knowledge. Positive in- and out-of-school experiences can have a beneficial effect on the interest and attitude towards science (Jones et al. 2022). The Science capital teaching approach (Godec et al. 2017) does not refer to a concrete set of materials and methods, but rather a focus on three pillars of attitudes and principles that underlie everyday teaching: (1) Personalising and localising (2) Eliciting, valuing, and linking student's ideas and experiences (3) Building the science capital dimensions.

  There is significant evidence that in primary education, science capital can achieve positive developments in children in dimensions such as interest and sense of meaningfulness, engagement in the classroom or participation in extracurricular science opportunities. (Primary Science Teaching Project 2021).

- The Austrian primary school curricula define a set of guiding principles by which the cognitive, emotional, and social aspects of the statutory educational mandate are characterised. The 4-K model of 21st century competencies (Fadel et al.2015) serves as the central reference model for this. This characterises communication, collaboration, creativity, and critical thinking as essential areas of competence for learners in the 21st century.

In a synopsis of these principles, a framework concept for supplementary educational activities for primary schools was developed.

3. DESCRIPTION OF THE EDUCATIONAL PRACTICE AND ITS IMPLEMENTATION

3.1 The Basic Concept of Fridolin's 'Research Adventures

The fundamental idea of the format is to offer a structured science adventure for classes, that aims to connect to the curriculum and support the acquisition of several competences related to scientific literacy. A narrative, puppet-based format staged around the puppet "Fridolin" is used in which problems are embedded that are to be solved with the use of scientific methods. The format can be applied to different topics and focus on different areas of competence. Moreover, some key concepts of knowing and understanding are included, which aim at gaining scientific knowledge and support informed decision making. These are: Observing; collecting, comparing, sorting; exploring; science talks and fact-based argumentation, hypothesis-driven experiments using variable control strategies, as well as scanning for information in diagrams, images, and text material.

The central structure of the format is maintained regardless of the teaching topic. This includes the following science-related pathways, which are used to gain information and experience to solve the challenge:

- *Collecting, comparing, sorting:* This activity serves the explorative grasping of the respective topic and the relevant elements and organisms.
- *Exploring with all senses:* The students are motivated to get in contact with the object of investigation and to use different modes of perception such as feeling, smelling, hearing...to do the exploration.
- *Observing and describing observations:* This activity guides the children to focus on details and on changes and to verbalise their observations.
- *Science Talk:* The children articulate their observations, findings and ideas and justify their positions with the facts they have gathered. They learn to distinguish observable and measurable facts from opinions.
- *Experiment:* The students gain initial experience in using a variable control strategy to test assumptions and hypotheses

3.2 Aspects to be regarded in the actual adaptation

Based on the evaluation of former Action Research cycles and on the needs resulting of educational theories and legal conditions mentioned above special attention was paid to the following aspects:

- Increasing the quality of the narrative setting and the immersive character of the activity

Elaborated staging, decorations and targeted use of the puppets were supposed to be a crucial factor for gaining children´s interest and motivation to engage in the program.

- Offering opportunities to get in contact with people working in scientific contexts

The staff members supporting the program are all young scientists with experience in the respective field of science.

- Offering various options to deal with the topic and enable individual learning paths

Several activities vary in their level of academic achievement and ways of gaining information, thus aiming to provide individual access to the topics.

- Laying a strong focus on adequate use of language for the respective target group

Not only the targeted age group but also the fact that the classes consist of students with different first languages, requires special attentiveness concerning the use of language and non-verbal scaffolding, such as images or props.

- Navigating the necessity of taking matters further with follow-up classroom lessons and conceptualizing individualized approaches that take the heterogeneity of the learners into account.

We decided to deal with this juxtaposition by keeping the main thematic points the same for all students, while providing opportunities for individualization within the methodological approaches.

- Offering helpful scaffolds

Especially in open tasks, some students might need more support in approaching problem solving and activity management.

3.3 Teaching Example: "Spiderman´s Superpower"

One result of the ongoing development process is a 90-minute-long programme for children aged 8 to 10. Based on the topic "Spiders and their abilities", the following teaching objectives listed in the curriculum of the 3rd and 4th grade are dealt with:

- To extend, consolidate and consciously apply working techniques such as examining, and observing in direct contact with nature.
- Observe and understand certain animal behaviours.
- Plan, carry out and evaluate simple experiments.

The programme is structured in an outdoor and indoor part. A fear or disgust of spiders to a certain extent was expected and was therefore implemented in the narrative of the storyline, leading to a more detailed understanding of a spider's world.

An analogy to Spider Man's superhero abilities is the underlying backbone of the narrative setting, thereby catching the participants interest and motivation throughout the duration of the programme. Spider-Man's superpowers, such as his strength, speed and reflexes, ability to climb and stick on walls, and his webbing, are mirrored in the families of the Araneae. For each of Spider-Man's superpowers and abilities, the programme makes use of one family representative and centres each indoor programme point around one of these spiders.

Participants are first introduced to the puppet Fridolin, who is immensely scared of spiders and does not have courage to come near the forest grounds. The group makes acquaintance with Fridolin's best friend Mira, a spider enthusiast and huge Spiderman fan, who simply cannot accept Fridolin's irrational phobia of spiders. She offers to show Fridolin how fascinating spiders are. She wants to take this opportunity to find out where the spiders' superpowers come from and whether she too can succeed in acquiring them. Research works best when done by a team and so Mira proposes for the participants to help her in this endeavour. Both puppets are an integral

part of the narrative situation and accompany the participants throughout the course of the programme as impulse givers, instructors, motivators, and reflection figures. With the goal or mission in mind, participants are led to the outskirts of the nearby forest, where the first activity starts:

Collecting, comparing, sorting: What makes a spider a spider?

Assisted by various scaffolds like pictures and identification guides the children search for spiders and other small animals in the forest. They are free to choose between different tasks such as observing them in terrariums, solving challenges like trying to find the biggest spider or putting the insects they found and other animals they might find into the correct terrarium, assorted by the number of legs the species in question has.

Science Talk: What does the perfect web look like?

The activity's goal is to draw the ideal spider web. Students can look up webs in the resource material provided. The drawings and their inspiration for their webs are then discussed with Fridolin, the puppet.

Clever Books: What can we find out about spiders that helps to solve our questions?

Students gather information they deem know-worthy or interesting from provided literature and self-produced material. The materials cover a wide range from simple pictures to demanding texts. Each student can choose the materials they want to work with. In pairs they alternately play Mira and Fridolin. In these talks Mira is telling interesting facts about spiders to Fridolin, so that he can conquer his fear and Fridolin questions Mira's ability to be like a spider.

Observing and describing observations: Meet Sissi, the Venezuelan tarantula.

Participants are observing the tarantula and other exotic spiders with flashlights and magnifying glasses, while also learning about interesting facts from spider expert Mira. One of the staff members talks about his profession as a biologist and talks about research on spiders. The children are collectively observing a feeding session and talk about their impressions.

Exploring with all senses: Which senses might spiders use to hunt their prey?

Students are assuming the role of the spider inside a tube-net, while other group members simulate the prey. They are touching the tube with soft toy insects and the "spider" has to react as quickly as possible. In a reflecting talk, the children consider which senses the spider could have used to detect the prey.

Experiment: How can some spiders stay on walls?

With a tinkering activity the children search for hypotheses on how some spiders stay on walls without falling down. For this purpose, they create spider models with different constructions of legs and try to stick them on various surfaces. Different materials such as hooks, tape, Velcro, pins and sticky notes are provided. The testing surfaces are felt, cork, bricks, and different foils. The crucial step is the testing of the hypotheses using a variable

control strategy. The children find out which structures succeed best to stick on most materials.

By examining specimen of spider legs under the microscope they search for further arguments that support or contradict their assumptions.

During all these activities the students document their experiences and findings in a protocol. In a final *Science Talk*, based upon their findings, they draw their conclusions on the underlaying research questions, which are whether Mira with her human body could ever become like a spider and whether Fridolin has verifiable reasons to fear spiders.

3.4 Design and methods of the Action Research Process

In our action research process, we follow the methodological concept of Altrichter et al. (2018). This provides a structured approach to professionalise pedagogical practice through an iterative process combining knowledge acquisition and educational development.

The evaluation assessed the extent to which the targeted developmental dimensions were successfully realised. Furthermore, we aimed to gain general insights about successful cooperations between schools and extracurricular places of learning considering current challenges.

Therefore, we used a mixed-methods research design, triangulating the perspectives of children, teachers, and our educational staff.

An essential part of the multi-stage action research process for the further development of the format is the cooperation with primary school classes. Five third grade classes with a total number of 115 students were selected to take part in this research process. In selecting the classes, the criterion of the greatest possible heterogeneity within the class was decisive, i.e. those classes were included that are composed of children from the most diverse cultural and linguistic backgrounds. We chose this selection criteria since 55% of primary school students in the local schools speak a mother tongue other than German. Primary school teachers consider the linguistic heterogeneity within their classroom as one of the most difficult challenges while teaching.

They so called “cooperation classes” participate for free in all educational activities developed during the process and are involved in the planning and evaluation of the formats.

Given the children's varying levels of writing ability, we used non-written survey methods to capture the pupils' perspectives. For this purpose, puppet talks were conducted with the children after the event, in which they reflected on the event in dialogue with the hand puppets. Additionally, they were instructed to evaluate different aspects of the activities by using sticky dot charts.

The teachers filled out a feedback sheet at the end of the event and were interviewed in focus groups a few weeks later about their experience with the process and their wish for further cooperation.

The team members of the Science Education Center documented their experiences with the individual groups in a logbook and summarized them in final feedback.

4. EVALUATION OF THE IMPLEMENTATION OF THE PRACTICE AND MAIN RESULTS

4.1 Results of the students' feedback

Examples for statements of the students:

"Wow, you can really find tiny animals out here! I didn't expect to be so successful"

"Boah, that's super cool how Sissi catches the cricket. I've never seen anything like it!"

"At first I was just as scared as Fridolin, but then it got better and better."

"I liked everything very much. The animal search was the best part!"

Fridolin, you don't have to be afraid at all. Spiders are great. ~

I didn't know that. Look what it is written there.

"Is that a tick? That's a centipede. The white worms are called earthworms. "

"Hey, this is so exciting"

The students' feedback can be summarised in the following key statements:

- *The narrative setting and the staging have been met with great enthusiasm.*

Students were raving about Spider-Man, especially about Mira's costume and research nook. They were unified in their mission to support Fridolin in conquering his fear.

- *The living specimen have aroused great interest.*

Throughout the groups, participants were engulfed with the tarantula, making remarks about the fur colors, and feeding speed.

- *They proudly used the newly acquired words and terms.*

It was astonishing seeing them make use of the puppets to convey information, especially coming from students who are foreign-language learners or are speaking German as a second language. In one group participants were shouting new words like "Terrarium" (terrarium) "Becherlupe" (magnifying glass) or "Vogelspinne" (tarantula) in unison. Some were incorporating newly acquired words and termina during the puppet play station.

- *They enjoyed the exploring and felt confident to succeed in research activities.*

Overall, they were happily exploring and commenting on different aspects, such as the make-up of spiders, or managing the difficulty of making "small things big", meaning magnifying.

4.2 Results from questionnaires and focus group interviews with class teachers

Examples for statements of the teachers:

"I liked it very much, the material was top, the support was optimal, it was something very present, which is also very important when working with children...thank you, especially this aspect with the structure.

"and of course the excitement, yes, for children it was really exciting".

"they simply cooperated very well"

"Many facts were pleasantly packaged and conveyed to the children in an understandable way, so that the children were able to learn an incredible amount without really learning."

"I was surprised that some of the pupils were really committed to the subject, which I didn't expect at all, the child would have classified the children as quieter and that they didn't contribute much, and suddenly the children were ready with questions for us all the time".

"Fun, innovative, and original set up."

"Great balance of outdoor and indoor activities."

"The material was top-notch and wonderfully differentiated. It was something to take hold of, to look at. I really liked the material."

"I remember very well when we went to the library a week later and everyone was hanging over the spider book."

"The children were able to connect and complement their findings from the programme with a laying circle about spiders in the school. They discussed among themselves and tried to remember certain things they had seen and heard."

The central statements of the teachers can be summarised as follows:

- *The teachers considered the narrative setting to be motivating and appropriate for the age group*

There was a right amount of spooky excitement, especially around Halloween, yet familiar and motivating enough for the students to show interest in participating. The program provided enough mystery to have them intrigued and was yet clear enough to have the students know the task at hand. For the teachers it was quite surprising that even older students really liked and interacted with the puppets. The puppets were relatable and funny. Students wanted to take them home and were talking about them at school.

- *The activity linked well to children's everyday experiences*

The tasks were relevant to everyday life; students were familiar with the topic, yet a lot of the students have not been exploring in woods or in nature. The students were able to relate to the problems and interests of the puppets since they could make use of their prior experiences and knowledge.

- *The offered scaffolds supported students 'learning of complex issues*

Teachers cherished that complex issues were broken down into precise activities. The programme offered an interesting angle to the content, which would take a lot of effort and time to organise in school for one class only. Team-guided yet student-led workflow was very

appreciated. Students were able to derive their own conclusions or even test their own assumptions.

- *Individual needs of the individual children were well addressed*

There was a wide array of methodological input that caters to different learning skills. The Spider-Man analogy and comparisons are seen as a great approach for visually motivated students or second language learners who best work with pictures and visual input. Reading material and research station were a great addition for those needing revision or more time to dive into the topic. Teachers mention the great use of space; there was room for both individual work and group activities. Children with individual learning needs were not excluded from the group during the activities, but rather included in the exploration of the topics. Individual students exceeded teacher's expectation concerning engagement. Some remarked they were positively surprised by students who are usually more of the quiet and shy type in classroom settings. Throughout the programme, the educational team was accessible for questions from the students. They were engaging actively with the crowd and taking necessary time and measures to ensure that each child understands the activities and the overall goal.

- *The activity had an impact on the children's language acquisition*

Some students learned new technical terms pertaining to biology and nature. Some students retained certain language fragments, which they reproduced on site and in later contexts. The topics dealt with in the programme were a topic of conversation among the children for a long time. Especially in classes with a high proportion of children who do not have the language of instruction as their first language, a sensitive approach to the linguistic circumstances plays a decisive role in the extent to which extracurricular offers can be used effectively.

- *Concerning the cooperation between schools and non-formal educational institutions further aspects should be regarded*

It would be desirable to link different extracurricular activities, e.g., research adventures and related literature from the city library. It would also be beneficial to plan enough time for the extracurricular programmes. For comprehensive topics, 90 minutes is short. There is an increased need to argue with legal guardians and school administrators when extracurricular programmes are taken up. A precise curriculum orientation and presentation of the targeted competences should be aimed for already in the programme announcement send out to schools and legal guardians.

4.3 Results of the diary and the feedback rounds with the Science Education Center staff

Examples for statements of the Science Education Center staff:

"The programme was designed in a very accessible way so that the children could easily get into the game story".

"In the next implementation, however, I would design the stations in a more self-explanatory way, so that a programme leader does not always have to supervise them."

"I particularly liked the logical sequence of events in this programme, which was also reflected in the actions and feedback of the students during the programme."

- *Puppet play and narrative setting had the desired effects on the motivation of the children.*

Setting up the narration for participation made a noticeable change in student activity and statements. Clear and structured puppet personas with instruction for desired learner impact and learning outcome are necessary in conveying and nourishing the narrative situation, task flow, arrangements, technical input, language input, social cues, scaffolding, and reflexion. There was immense interaction with the puppets, especially during the research activity. Students were enthusiastic about finding the best facts about spiders so to help poor and scared Fridolin.

- *The individual needs of the children and the heterogeneity of the classes must be considered even more strongly*

The program should provide even greater variety in learner settings that cater to different needs, such as reading books, or simply more time for some sequences that require higher-level competences and skills. The reading material needs a higher differentiation with regards to the reading skills of the learner, e.g., through making use of various text approaches, such as matching, memory, flash cards. For some topics more in-depth material is needed. Regarding prior experiences and attitudes of the learners is crucial to future programme planning and needs to be considered carefully. (For example some students were afraid of stepping onto grass or getting their shoes dirty. They were not used to exploring or have never been in the woods before. Some were afraid to look for spiders and were even disgusted by insects they found in the ground.)

- *The scaffolding materials can be improved to offer better access to children with reading difficulties*

There is a need for updated material with highlighted or marked passages, keynotes, sketches, drawings, and pictures. New modes of visual aids, such as self-produced stop-motion film, or real-life clips of spiders in their natural habitat should be developed and tested.

5. DISCUSSION

The process of revising the teaching format for primary schools was based on concrete objectives, which primarily related to enabling individually tailored learning processes for the individual children and making the learning content more attractive through narrative framing. In view of the data available so far, initial trends can be identified. However, further starting points for further adaptations are also emerging, which should be tackled in the following development circles of the action research process.

The statements from children, teachers and Science Education Centre staff all agree that the narrative framing, the staging, and the puppet show achieved the desired effect of making the learning content attractive and creating a stringent structure of meaning.

The offer of choices in the elaboration of the topic and the range of materials provided are positively evaluated, especially by the teachers. This, but also the team's attention to the concerns of individual children, is seen as conducive to individual learning processes in the heterogeneous classes. Even weaker children could thus be actively involved in explorative learning.

From the point of view of the team conducting the programme, this aspect is evaluated less euphorically. Here, more aspects are mentioned where there is still room for improvement in order to achieve the desired individualisation. This concerns above all the offer for better-performing children and children with above-average interest, for whom there is a need for more demanding materials to deepen the topic.

The situation is similar about the use of scaffolds: The teachers appreciate the provision of aids and structures that enable the children to gain knowledge independently.

The team on the other hand mainly shares suggestions on how the scaffolds can be better adapted to the different performance levels of the children. Above all, the different reading skills should be taken more into account in the development of the materials.

Regarding the adequate use of language, only indirect conclusions can be drawn from the available data. The teachers observed the children's participation in the puppet discussions and registered the use of new technical terms and phrases.

Little information on this point comes directly from the children. In general, the findings from direct questioning of the children are not very strong. This suggests that the survey methods for the children need to be further elaborated in order to obtain more differentiated feedback.

In summary, the findings from the first action research circle show that the development of the format is on the right track. However, it also becomes apparent in which areas weaknesses still need to be remedied or qualitative improvements are possible.

6. CONCLUSIONS AND IMPLICATIONS

The first results indicate that the format succeeds well in awakening interests for science in heterogeneous groups of pupils, in promoting the children's confidence in their own problem-solving skills and in encouraging sustained engagement with the topics dealt with. The range of differentiated activities is also rated positively by the participants. There is still a need for further development in linking the events more intensively to classroom activities by providing materials for preparing and following up the workshops that supplement the lessons.

This first development and evaluation cycle in a three-stage action research process led to findings in several respects that can be helpful for further development in the institution concerned, but also for cooperation between schools and extracurricular educational institutions in general:

- The concept of Science Capital goes far beyond the acquisition of knowledge and skills. Especially for those dimensions that aim at linking with the children's lifeworld, establishing relationships, experiencing authentic application contexts, or experiencing one's own action competence and problem-solving ability, extracurricular learning places can effectively complement school lessons.
- Extracurricular places of learning can score points because of their special experiential character.
- However, to make a lasting contribution to the learning process, but also to gain acceptance from parents and school administrators, it is necessary to dovetail extracurricular activities with classroom activities and curricular conditions.

- The resources at the out-of-school place of learning can support individualised approaches to learning processes. Offering different methodological approaches within a uniform subject area was very positively received by the test classes.
- The heterogeneity of the children within a school class comes into play in many aspects. In the present context, the very different levels of language comprehension have turned out to be particularly significant. Further developmental steps are necessary here to create optimal conditions for all children.

Based on the findings of this first evaluation phase the aims of the following action research cycles are to focus on intensifying differentiated activities that take various aspects of heterogeneity into account and to align the offers with curricular goals and classroom needs even more precisely.

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