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Findings of the Impact Studies EASI Science and EASI Science-L

What impacts do early childhood education offerings in the science domain have? Up to now, scientists in Germany have hardly been able to answer this question, because virtually no systematic research has been conducted on it for pre-primary level, and no reliable empirical measurement instruments have been available.

The “Haus der kleinen Forscher” (“Little Scientists’ House”) Foundation sees itself as a learning organisation that works continuously to improve the quality of its education offerings. The question of whether science education offerings such as the Foundation’s continuing professional development (CPD) workshops have a measurable impact on the competencies of early childhood professionals and children can be answered only with empirical research. Therefore, together with other partners, the “Haus der kleinen Forscher” Foundation funded two studies of several years duration on the effectiveness of early science education. Independent educational researchers investigated the following questions:

1. What impacts do science education offerings have on *science-related competencies* of children and early childhood professionals? Educational researchers investigated this question in the study **Early Steps Into Science (EASI Science)**.¹
2. What impacts do science education offerings have on children’s *language abilities*? What is the connection between the quality of linguistic stimulation and the science-related process quality of education offerings? These questions were investigated by a group of educational researchers in the study **Early Steps Into Science and Literacy (EASI Science-L)**.²
3. How can the impacts of early science education be empirically measured? The two research groups developed *a set of methodological instruments* for the measurement of the quality of science education and educational impacts.

The researchers investigated educational impacts at the level of the early childhood education and care centres and early childhood professionals as well as at the level of the children. When doing so, three groups were included: early childhood professionals from early childhood education centres with regular CPD in the “Haus der kleinen Forscher” (HdkF) initiative (HdkF Group), those with science CPD provided by other initiatives (Science Group), and those without a science focus (Comparison Group).

¹ The authors of the EASI Science study: Prof. Dr Mirjam Steffensky (Leibniz Institute for Science and Mathematics Education, IPN, Kiel), Prof. Dr Yvonne Anders (Freie Universität Berlin), Prof. Dr Ilonca Hardy (Goethe University Frankfurt), and Prof. Dr Miriam Leuchter (University of Koblenz-Landau). The study was funded by the German Federal Ministry of Education and Research (BMBF) and the “Haus der kleinen Forscher” Foundation.

² The authors of the EASI Science-L study: Prof. Dr Astrid Rank (University of Regensburg), Prof. Dr Anja Wildemann (University of Koblenz-Landau), Prof. Dr Andreas Hartinger (University of Augsburg), and Prof. Dr Sabina Pauen (University of Heidelberg). The study was funded by the Baden-Württemberg Stiftung, the Siemens Stiftung, and the “Haus der kleinen Forscher” Foundation.

1. The EASI Science Study

In all participating early childhood education and care centres, the researchers investigated how firmly science education was institutionally anchored, how strong the pedagogues' content knowledge and pedagogical content and their motivation and interest were, and what science competencies and interests the children demonstrated. To answer these questions empirically, the researchers developed instruments with which the implementation and impacts of science education can be measured:

1. Depth of the anchoring of science education in an institution
2. Content knowledge and pedagogical content knowledge of the early childhood professionals
3. Motivation and interest of the early childhood professionals
4. Professionals' own reports of the quality and quantity of the education offerings that they implement in their institutions
5. At the level of the children: their science competencies, self-confidence, and enjoyment of learning in relation to science

With the help of comparative analyses of the above-mentioned groups in relation to these variables, conclusions could be drawn about the impacts of CPD offerings for early childhood professionals and education offerings for children. Moreover, by means of correlation analyses, relations between these variables were determined. Furthermore, interaction analyses were carried out to examine whether and what conditions must occur at the same time in order to generate specific educational impacts.

Key Findings

1. Professionals from HdkF early childhood education and care centres (i.e., centres certified as a "Little Scientists' House") had attended, on average, more CPD workshops than those from other early childhood education centres with a science focus.
2. Science education was most firmly anchored in HdkF early childhood education and care centres. This can be seen, for example, from the fact that there was greater coordination with early childhood education and care providers and parents and that science topics were addressed in team meetings.
3. CPD has an impact: Professionals (in the HdkF Group and the Science Group) who had attended CPD workshops had somewhat better content knowledge and pedagogical content knowledge than those who had not undergone science-related CPD. Hence, science-related CPD is positively related to the science-related professional competencies of the early childhood professionals.
4. Professionals (in the Science Group and the HdkF Group) who had undergone science-related CPD had more confidence in their own abilities and greater interest in science.
5. Children from early childhood education and care centres with an explicit science focus (HdkF early childhood education and care centres and other early childhood education and care centres with a science focus) showed more enjoyment of learning and had more confidence in their own abilities in relation to science.

6. The deeper the anchoring of science education in the institution was, the greater the science-related motivation of the professionals. The more secure the professionals felt in science and in imparting science content, and the more enjoyment they had in imparting it, the higher the process quality of the learning opportunities was.
7. Children's learning gains were jointly determined by the quantity and quality of education offerings. Science learning opportunities had a positive impact on the children's competencies only when they took place regularly and, at the same time, were of adequate (process) quality.

Conclusion: Continuing professional development in early science education has impacts on early childhood professionals, children, and early childhood education and care centres. In professionals, CPD improves content knowledge and pedagogical content knowledge and enhances self-confidence. In children, it promotes enjoyment of, and interest in, science as well as self-confidence in their own abilities. Science education is anchored more firmly in "Haus der kleinen Forscher" early childhood education and care centres than in the comparison groups. The (self-reported) process quality, which is crucial to promoting science knowledge in children, is significantly better when the professionals have undergone CPD with the "Haus der kleinen Forscher" Foundation.

2. Early Steps Into Science and Literacy (EASI Science-L) Study

Linguistic impacts of continuing professional development (CPD) are described in EASI Science-L with the variable "quality of linguistic stimulation", which is understood as the totality of professionals' language-promoting behaviours. The following questions were investigated:

- Comparing the above-mentioned three groups of institutions, are there differences in terms of the quality of stimulation?
- In which learning phase in the inquiry cycle is the linguistic stimulation most intensive?
- What impact does linguistic stimulation have on the children's language competencies?
- Which factor plays which role: Are the quality of interaction and linguistic stimulation on the part of the individual professional during the inquiry process decisive? Or is the decisive factor whether or not the professionals have undergone CPD?

First, the professionals were asked about the type and frequency of the CPD workshops or courses they attended in the past five years. Then, the researchers filmed the professionals in inquiry situations with children. The quality of the linguistic stimulation observed (i.e., the professionals' language-promoting behaviour and the children's use of educated language) was analysed.

Findings:

1. The highest quality of linguistic stimulation could be shown for professionals from the HdKF Group (i.e., from institutions certified as a "Little Scientists' House").
2. Professionals who had attended science-related CPD workshops or courses demonstrated a higher quality of linguistic stimulation than professionals who had not undergone science-related CPD. On the other hand, no effect of language-related CPD on the quality of linguistic stimulation in an inquiry situation was present in the sample investigated.

3. The effect of science-related CPD was even larger when the focus of the CPD workshop was on the combination of science and language education. Professionals who had attended a combined science and language CPD workshop provided by the “Haus der kleinen Forscher” Foundation,³ demonstrated a higher quality of linguistic stimulation than professionals who had not attended this workshop. The combined CPD module was developed in collaboration with the German Federal Association of Speech Therapists (Deutscher Bundesverband für Logopädie, dbf) and explicitly aims to combine science and language education.
4. The work of the HdKf is based on the inquiry cycle method, which describes six phases of scientific inquiry.⁴ The potential for linguistic stimulation was particularly large in the phases “Observe & Describe”, “Document Results”, and “Discuss Results”. Proportionally, a great deal of linguistic stimulation occurred in the phases “Document Results” and “Discuss Results”. Overall, however, the particularly language-promoting phases in the inquiry process still occurred quite rarely.
5. The amount of educated language that a child used during the inquiry process was related to the specific CPD that the early childhood professional had undergone. If professionals had attended a combined science and language CPD workshop, the children also demonstrated a higher level of educated-language performance.
6. Characteristics of the child, such as intelligence, age, and gender, had the strongest influence on the children’s language abilities.
7. At the same time, the science-related process quality was positively related to the quality of linguistic stimulation of the educational situation. In inquiry situations with the children, professionals with a higher process quality also demonstrated a higher quality of linguistic stimulation.
8. The observed science-related process quality in the inquiry situation was higher in the case of professionals who participated in “Haus der kleinen Forscher” CPD workshops than in professionals who had not undergone science-related CPD.
9. The science-related process quality implemented by the professional was positively related to the scientific competencies of the children.

Conclusion: Science education and language education do not compete with, but rather complement, each other. Of the three groups investigated, the professionals in the HdKf Group demonstrated the highest quality of linguistic stimulation. In inquiry situations with the children, professionals with a higher process quality also demonstrate a higher quality of linguistic stimulation.

³ CPD workshop *Sprudelgas und andere Stoffe - Mit Kita- und Grundschulkindern Chemie entdecken und dabei die sprachliche Entwicklung unterstützen* (Carbon Dioxide and Other Substances – Exploring Chemistry with Children Between the Ages of Three and Ten and Supporting Language Development in the Process), see brochure with the same title published by the “Haus der kleinen Forscher” Foundation (2013). Available (in German only) at: https://www.haus-der-kleinen-forscher.de/fileadmin/Redaktion/1_Forschen/Themen-Broschueren/Broschuere-Sprudelgas_2013.pdf

⁴ See <https://www.haus-der-kleinen-forscher.de/en/practice/inquiry-cycle-method/>.

Findings on Impact Research

Early education is rightly accorded great social importance, and evidence has frequently been provided that early education has positive effects on educational trajectories. To date, however, little research has been conducted on concrete educational impacts of science education offerings at the level of the children. Up to now, such studies were, for the most part, lacking in Germany. With EASI-Science and EASI-Science-L, the research groups entered uncharted scientific territory and developed for the first time valid instruments for the empirical measurement of the impacts of early science education. At the level of the early childhood professionals, it is now possible to systematically measure the impacts of science-related CPD offerings on their scientific competencies, their quality of linguistic stimulation, and the process quality of the science education offerings they design and implement. Moreover, statements can now be made about the impact of professionals' CPD on children's scientific and educated-language competencies. All the correlations described are statistically significant and thus not attributable to purely random effects. Hence, the two impact studies funded by the Foundation and its partners make an important contribution to impact research in the domain of early childhood education.

Outlook

The "Haus der kleinen Forscher" Foundation will use these studies to systematically reflect on its existing education offerings and the impact-oriented development of future CPD workshops. In particular, the now scientifically proven impacts of science-related CPD workshops on the development of the competencies of the early childhood professionals, and the opportunity that scientific inquiry also affords for children's language development, are very encouraging, as they confirm corresponding impact assumptions with which the Foundation works.

Moreover, the findings confirm the approach of the Foundation as a provider of a continuing professional development programme in STEM for education professionals. In future, this person-related approach will be expanded further to include a systemic approach that focuses on the anchoring of CPD workshops in HdKF-certified institutions and, in doing so, also targets management level at the early childhood education and care centres. A great opportunity lies in the stronger linking of the CPD programme (person-related) and the certification programme (institution-related). The "Haus der kleinen Forscher" education initiative offers its workshops and certification throughout Germany and relies on continuing qualification offerings. It is thus well equipped for the task of exerting an even stronger systemic impact at institutional level than is currently the case.

Some of the empirical instruments developed by the research groups can be used for the continuous monitoring of the work of the "Haus der kleinen Forscher" Foundation. The fact that it is now possible to measure the impacts of science education offerings is a decisive step in the direction of quality development in early childhood education and care centres. The Foundation will continue to conduct accompanying research in order to enhance the quality of its offerings. Future studies should be conducted over longer periods and with larger samples in order to achieve representative results.