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"Science4Generation" – An Innovative Event Format for Science Communication

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Abstract

Science is constantly assuming a greater role in our society, a trend resulting in the fact that several new science related jobs are currently vacant and that there is currently a high demand for new workers in this sector of the economy. In order to generate interest, especially among young people, in the generally especially unpopular field of chemistry, several initiatives have emerged in the last few years. One of these initiatives is the University of Osnabrück's project entitled "Science4Generations", a science communication format especially designed for high school students. In the context of the project, students perform exciting scientific experiments for people in retirement homes that have been previously prepared in school covering everyday phenomena. During the preparation process, the students didactically simplify explanations for the senior citizens. On site, the students perform these experiments at different times and discuss the underlying scientific concepts with the senior citizens. In the course of an accompanying study to this science communication format, the students were questioned in a pre, post and follow-up format concerning the theoretical constructs of motivation, interest, self-concept, emotions and a rating of the discipline chemistry in general. In this presentation, the Science4Generations concept and some selected experiments will be outlined initially. Subsequently, the essential findings of the questionnaire-based survey will be presented and discussed.

Keywords: *Science communication, untypical places for teaching and learning, chemistry in public, outreach;*

1. Introduction

In recent years, much has been done, especially in the Federal Republic of Germany, to set science communication - the dialogue between science and society - "in motion". The activities range from science events to various scientific topics on school projects, the opening of student laboratories across all grades, science magazines in the media up to and including public research dialogues and panel discussions [1]. In the city of Osnabrück, Lower Saxony, the science communication project "ChemCity_OS" was launched in 2016. The central feature of this project is that students assume the role of so-called science communicators and convey science to a wide audience at "unusual" learning and teaching venues. To date, in addition to the "Science4Generation" project presented in this article, the event formats "PubScience - the Long Night of Experiments" (with students presenting exciting experiments in dining facilities) as well as "Experimental Lee(h)rstand" (with students teaching science in vacant properties) have been carried out [2].

2. Definition of science communication

In the literature, there are currently many quite different definitions of the concept of science communication; a uniform and thus binding definition does not exist. Burns et al. proposed a first, contemporary definition in 2003 [3]. Their vocal analogy "AIEOU" illustrates the essential goals of a successful science communication. Thus, it is desirable that science communication actions address at least one, but optimally more, of the following:

1) **A**waress: The action creates an awareness and positive attitudes about science.
2) **E**njoyment: Positive affective reactions to the natural sciences are evoked.
3) **I**nterest: The events generate or consolidate interests vis-à-vis the natural sciences
4) **O**pions: The actions give reasons to develop and reflect on one's own opinions about scientific facts
5) **U**nderstanding: The events generate a coherent and complex understanding of and about the natural sciences

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3. The science communication project "ChemCity_OS"

The project "ChemCity_OS" with its various event formats such as "Science4Generation", in which pupils from grade levels 6-10 carry out exciting scientific experiments in facilities for senior citizens, pursues several overarching objectives that enrich and supplement traditional science teaching:

a) Combination of learning and presentation situations

During the preparation as well as the execution of the events by the involved pupils, learning situations, e.g., the development of a scientific phenomenon with different presentation situations, in which the results of the learning situation are presented to a large audience, are combined.

b) Learning value for pupils and students

All event formats are designed to have a high learning value for different groups. Not only did the students, for whom the project "ChemCity_OS" was essentially conceived, benefit from the events, but also the participating teachers, students and visitors of the respective actions can broaden their personal scientific or scientific didactic experiential horizon.

c) The scientific experiment as a "core element"

The scientific experiment forms the central element in all event formats of "ChemCity_OS"; in all events, pupils and other persons involved carry out experiments in a variety of situations and under different conditions.

d) Supplementing science education

All activities within "ChemCity_OS" are understood to be a supplement to science education for the participating students, starting with the physical education for the pupils in the elementary schools, through the middle-level education up to the seminar subjects and advanced courses for the upper secondary school. Participation in the projects offers students the opportunity to learn without grading, to leave the usual teacher-student "dependency" - to seek direct dialogue with scientists and to work together across schools and school formats.

e) Generating interest in the natural sciences

In all events, the expectation is associated with the conception and implementation of generating and promoting interest in the natural sciences among all those involved in the project, as well as strengthening motivation with regard to dealing with natural sciences.

f) A high level of public perception

The events are designed in such a way that they foster a high level of public perception. This has been partly thanks to a high level of media interest; other reasons include the involvement of prominent "patrons" in some events, as well as the "unusual" design of the respective projects from the general public's point of view - for example, scientific experiments in facilities for senior citizens.

4. "Science4Generation" - Pupils experiment with residents in senior citizens' facilities

In the "Science4Generation" concept, lower secondary level students carry out simple scientific experiments in residential facilities for senior citizens. Together with the patrons at the institutions, they discuss the presented and observed phenomena as well as their theoretical background. In 2017 and 2018, a total of 46 students took part in the event format. The content preparation for the event took place in the context of a scientific PLC and proceeded according to the following pattern:

Tab.1: Preparation process for the "Science4Generation" project:

Hour:	Contents:
1	Presentation of the project, formation of working groups (about 3-4 people)
2-3	Literature and Internet research for suitable viewing experiments
4	Definition of the experiment selection within the groups
5-7	Trial of the experiments and conception of general explanations
8	Packing of experiment boxes - preparation of other materials
9-10	Dress rehearsal: The groups present their experiments within the working group and explain them in a professional and generally understandable way

Note: The term "1 hour" refers to 45 minutes of class time

The following list gives a brief insight into the experiments demonstrated in "Science4Gernation":

Tab.2: "Science4generation" experiments

Functioning of diapers and superabsorbents, dry ice and indicators, experiments with household candles, functioning of matches, heating of various fat products in the microwave oven, burning banknotes, experiments with liquid nitrogen, citrus batteries, production of synthetic beer, production and functioning of red cabbage indicator

The event was held in two different residential facilities for senior citizens for a total of four afternoons. It started with an official welcome by the project manager and took place in large common rooms. The groups of students were then distributed among the residents and carried out the respective experiments in a rotation procedure, so that as many persons as possible could carry out several experiments.

5. Accompanying research on the "Science4Generation" project

In addition to the theoretical foundations for science communication [3], the Science4Generation project is based on the motivational and interest theory of Deci & Ryan [4]. In their concept of the self-determination theory of motivation, the authors deal with three basic inborn psychological needs. These are the need for expertise or effectiveness, the need for autonomy or self-determination, as well as the need for social inclusion or social affiliation. This means, among other things, that every person has a need from birth to participate actively and with a lasting effect in society and to act independently. Intrinsically motivated behaviors are usually associated with the need for competence experience and self-determination, while extrinsically motivated behavior has references to all three basic needs [4]. In addition to the aforementioned aspects of motivation, the creation of a meaningful learning environment is very important for the development of medium-term and long-term interest in relation to certain content, such as natural sciences. In particular, an informational learning and development environment (informational conditions), positive feedback and the support of self-determined learning have a positive effect on learning environments [5]. This may ideally lead to interest-oriented learning, which is supported by intrinsic motivation and/or integrated self-regulation [4]. This self-regulated, interest-oriented learning can also lead to a comparatively comprehensive, differentiated and deeply anchored learning content [6].
Based on these theoretical considerations, an empirical study on Science4generation is currently being conducted. The participating 46 pupils are interviewed in a pre, post and follow-up format in a questionnaire study. The focus here is on the following research questions:

1) How do the students rate "Science4Generation" as an event format for science communication?
2) To what extent are motivation and interests influenced by natural sciences and chemistry?
3) To what extent does the self-concept change, especially with regard to independent experimentation through the PubScience format?

6. First results of the accompanying research

The first evaluation of the surveys indicate that the science communication format "Science4Generation" can be regarded as successful in terms of its conceptual, methodological and content orientation. The general procedure and the organization of the project were rated very positively by all surveyed persons. It can also be said that the students rate the opportunity to convey scientific experiments and their theoretical background in front of a foreign audience as "experts" positively. There is also a significant increase in one's self-concept in relation to one's own experiments. The confidence to prepare and carry out experiments independently increases to a significant extent in the short and medium term through the Science4Generation format. With regard to the motivation and interest constructs, no significant effects can be identified in the evaluations to date. This finding may be due to the fact that all students participating in Science4Generation are participants in a scientific working group and, therefore, one can assume, naturally have a high scientific interest.
With regard to the AEIOU model presented in Chapter 2, it can be stated that the pupils primarily give priority to the dimensions "interest" and "enjoyment". The students also focused on the goal of "Understanding". The "Opinion" aspect partly reflects unexpected reactions from the senior residents. Thus, the students emphasized that they did not expect in advance that the senior citizens would be

so interested in the event. Furthermore, the residents were impressed by the extraordinary commitment and enthusiasm of the students.

7. Conclusion

The "ChemCity_OS" project offers students the opportunity to present their scientific-experimental competences to a large audience beyond the chemistry class. On the one hand, this public presentation offers the opportunity to reduce prejudices such as "nobody cares about chemistry anyway" or "we can't do that". Likewise, such formats contribute to positively influencing students' natural scientific self-concept in a positive way.

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