CURRICULUM DEVELOPMENT AND PROJECTS

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How the Project “Kolumbus-Youth” Nurtures the Interest of Scientifically Talented Students

Abstract

The project “Kolumbus-Youth” was founded in 2009 by the Department for Didactics of Biology at Bielefeld University as the older equivalent for the formerly introduced project “Kolumbus-Kids”, which is an enrichment programme for students aged 8-12. “Kolumbus-Youth” aims at promoting students of year ten in the area of natural sciences. Students from regional schools are invited to participate in this project, where they have the chance to carry out research in their special field of interest and convert it into a research project with professional help and equipment. The students work together in small groups and are constantly accompanied by a group instructor, who is a student at Bielefeld University and is planning to become a future teacher for natural science. Consequently, the project is beneficial for both the participating students and the university students, who plan and accompany the sessions.

THE PROJECT

In 2009, the Department for Didactics of Biology at Bielefeld University founded the project “Kolumbus-Youth”, whose objective is to promote talented students of year ten in the area of natural sciences. It is called “Kolumbus-Youth” because it was developed as an equivalent to the enrichment programme “Kolumbus-Kids”, which enables students aged 8-12 to participate in interesting extracurricular teaching units. While the thematic focus of the project primarily lies in the field of biology, it also over-

laps with other scientific disciplines like chemistry or physics and further fields close to biology, such as nutritional or health science. Selected students from regional schools are invited to participate in interesting sessions, dealing with biological problems and phenomena at university. The sessions are accompanied by university students who plan to become future teachers for secondary schools. These students need to have finished at least four semesters at university and participated in a preparatory theoretical seminar training the university students in detecting different student personalities such as gifted students or underachievers and to deal with them accordingly. The project gives them the chance to lead a group of students on their own, simulating school reality; however they are constantly in contact with the project's founder, who supervises the university students. If they complete the project and the preparatory seminar successfully, they get nine credit points plus a certificate stating the additional qualification in the area of individual support with the main emphasis on particularly gifted pupils, issued by the district government. Approximately 25 year ten students apply for the project after having been recommended by their natural science teacher. Part of the application is a letter of motivation, followed by a diagnostic test of the students' talent. One course consists of twelve to fifteen students, who are subdivided into research groups with three to four students each (Fig. 1). With the aid of the group instructor, the group members' ideas and interests are converted into a research project.

Figure 1. Students working on their projects in small groups.

The project extends over fourteen sessions à 90 minutes. Once a week, the students come to university in order to elaborate their projects and to conduct research in their specific field of biology. “Kolumbus-Youth” is divided into three sequences – an introduction, an experimental phase and finally a presentation of the research results. During the introductory phase, the students get to know the project's course and each other since the research groups are formed. The structure of the experimental phase contains the process of idea generation and the collaborative development of a research project, and also the project's interpretation and presentation. In order to help the students to structure their working process better, they are given an overview of the four general phases of research with further single steps for each phase (Fig. 2). The first phase of research deals with the choice of a

project. For that purpose, the students have to select one of the fundamental specialist fields (biochemistry, genetics, microbiology, neuro- or behavioural biology or ecology), which they work on in small groups.

In research step 1.1, the fields of interest, an introductory experiment of about 40 minutes is conducted by the group instructor, which enables the students to settle in and gives the group instructor the opportunity to judge the students' experimental skills. During this step, it is the group instructor's task to detect the interests of the group members which are then categorised and visualised via a mind map.

In the case of students having chosen biochemistry as their field of interest, the group instructor might notice heightened curiosity in the areas of enzymology, metabolism and health. All those areas are tried to be combined in research idea suggestions by the instructor, which are then discussed and modified by the group members in the next step, the choice of the research idea. With the example of biochemistry, the proposed research ideas are further specified and could result in a project examining the relation of the mechanism of action of enzymes and toxins. The instructor might narrow down the project's experiments to be carried out with the alga model organism *Chlorella*73 and herbicides inhibiting photosynthesis, as experiments with a human biological focus would endanger the students' safety. The final research question would be “Which implications does the use of the herbicide Diuron have on algae of the genus *Chlorella*?”

The second phase of research consists of collecting information; previously to that, however, the group instructor has to develop a list of comprehensive questions. This intends to monitor and guide the process of question formation. For the sake of highlighting greater factual connections, single questions are subsumed under different categories; questions regarding chemical processes in the alga therefore might be separated from the issue of the herbicide's structure. Once the essential subject matter has been acquired on the basis of an extensive set of questions (2.1), it is important to pick an appropriate research method (2.2). After having chosen a research method, the group members test the method with the help of the group instructor so that they become confident in working independently on the experiments of their projects (Fig. 3). The phase of collecting information

Phase of Research	Research Steps
1. Choice of Project	1.1 Fields of Interest 1.2 Choice of Research Idea
2. Collecting Information	2.1 Theoretical Background 2.2 Research Methods 2.3 Formation of Hypotheses
3. Planning and Execution	3.1 Planning Process 3.2 Test Execution 3.3 Results and Discussion
4. Presentation	4.1 Reflection 4.2 Presentation of Project

Figure 2. Detailed overview of the research steps in the experimental phase.

Figure 3. Scientific techniques can be applied by the students independently.

is completed by research step 2.3, the formation of hypotheses, as this requires a broad theoretical background of subject knowledge already.

The third phase, planning and execution, comprises the scheduling of the research project, its implementation, documentation and evaluation. To support the planning process (3.1), the students are given a table containing issues to be kept in mind for the planning. This table contains the aspects of describing individual working steps, the time set for these steps as well as the name of the group member held responsible. After having finished the planning process successfully, the group members should be able to experiment on their own during a phase called “test execution” (3.2). At the end of this phase, the results have to be compiled and presented in an appealing way, for instance in a diagram or a table. The challenge in step 3.3, called results and discussion, is to verify or falsify the posed hypotheses, to adapt them if necessary and to conduct an error discussion. Finally, in the presentation, the completed research process is to be reflected (4.1) and presented appropriately. The reflection on the process concerns both subject-specific and social issues. Depending on the remaining time and interest, group members may conduct follow-up experiments or new research projects.

MOTIVATION IN THE PROJECT “KOLUMBUS-YOUTH”

By the means of close collaboration between university students and participants, the latter’s motivation is kept on a high level for the whole term. Since motivation is only an assumptive parameter which is not measurable, viewable or locatable (cf. Bovet, 2008, p. 301), the reasons for the pupils’ drive as well as which of them are motivated at all cannot be detected easily. Motivation is generated by a motive and stimulation. In regard to the project, the pupils’ motive might be the promotion of individual abilities plus finding satisfaction in dealing with biological topics. Stimulation is provided by the project’s form, the learning group’s small size and the ongoing support by teacher trainees.

The only thing measurable in Didactics is the behaviour which triggers motivation (cf. Bovet, 2008, p. 300). Pupils are especially prone to work on a certain topic if their needs for competence, autonomy and social integration are met (cf. Ruppert, 2004, p. 112). People strive after feeling efficient in their environment, for which being able to cope with a given task is a main prerequisite. This is why the project’s lessons are specifically designed to meet the students’ needs and competence levels. Motivation is further triggered by the free choice of an individual research topic. The third need is fulfilled by the work in groups of four pupils at most, as they experience a feeling of togetherness due to the fact that assignments are completed in an authentic learning environment as well as the close contact to the university student supervising the project (social integration, cf. Ruppert, 2004). Additionally, the project’s form boosts the pupils’ motivation as it does not limit the teaching students to a rather static and narrow lesson design like normal schooling environments often do. Apart from this, the teacher trainee is not presented as a person grading the participating pupils, which makes for a very natural and relaxed atmosphere in the project’s classrooms (cf. Ruppert, 2004, p. 119). This special relationship between the university students and their pupils is further improved by the fact that classes take place in small groups in a confined space, resulting in an intimate and familiar learning atmosphere. This also gives the teacher the opportunity to take good care of every learner, thus giving the latter a feeling of being taken seriously, which is one of the main advantages of open learning. In such forms of learning, teachers rather support and accompany the development of the learners’ learning pathways.

CONCLUSION

After having at least twelve students attending the project annually, one can draw the conclusion that it is a very successful project. Ten Bachelor’s and six Master’s theses on topics such as the effects of activity-oriented learning, epistemological beliefs and emotional constructs as well as the development of a scientific aptitude test have been used to evaluate the project (for references visit the homepage www.kolumbus-kids.de and click on the link “Referenzen” at the top). A recent study

concerning the motivation of participating students found that motivation increases during the project as the basic needs autonomy, competence and social integration are addressed (Ruppert 2004). As the university students’ assessment was also surveyed, it could be found that they were able to estimate the participants’ interests quite fittingly and arranged work in a pleasant atmosphere so that the students showed high results in the category of “joy”. This positive mentality of working in groups with the aid of university students surely contributed to winning the “Jugend Software Preis” in 2010, which is an award for outstandingly designed multi-media presentations with the aim of passing on natural scientific knowledge. The students created a website regarding the topic of “Non-indigenous Species”. Besides, research projects like “Microbiology: How Antibiotics Act on Different Bacteria”, “Biochemistry: Can Plants be Stressed?” or “How Can Pond Water be Cleaned Most Efficiently?” have been realised with great interest and fun. In order to estimate the benefits of “Kolumbus-Youth”, also with regard to generic competences acquired through this project, an evaluation project is planned to be carried out in 2013/2014. For further information please visit www.kolumbus-kids.de and navigate to the menu item “Kolumbus-Youth” on the right.

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