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Mathematics Courses at Preparatory Colleges as an Exceptionally Promising Field of Didactics Research

Introduction, Aims, & Structure

Studienkollegs (preparatory colleges) are educational institutions in which applicants with a foreign university entrance qualification, that is not recognized as an equivalent to the German *Abitur*, are prepared for academic studies at a German *Universität* (traditional university) or *Fachhochschule* (university of applied science). This final exam, called *Feststellungsprüfung*, is – as is the *Abitur* – located in level 3 of the International Standard Classification of Education (cf. OECD & al. 2015). Most students are foreigners with a foreign educational background and the learning groups are mostly highly heterogeneous. *Studienkollegs* are underestimated as a data source and as a field of research. They not only harbour great potential for research connected with teaching and learning the German language (for a brief introduction, cf. eg. Kupetz 2022), but also for mathematics didactics research.

The main aim of this article is to give a first overview of the little-explored area ‘*Studienkolleg*’ from the point of mathematics didactics. This aim should be met, by giving a multifaceted synopsis of exemplary possible aspects which can be focused on connecting *Studienkollegs* with educational and didactical research especially in mathematics.

Preparatory Colleges in Germany

A *Studienkolleg* in Germany can be public or private and prepare for studying at an *Universität* or a *Fachhochschule*. It operates under the supervision of the state ministry of education, like *Studienkolleg München*, or under the supervision of the state ministry of science, like *Studienkolleg Sachsen*. On the one hand, *Studienkollegs* prepare to study certain subjects throughout Germany, on the other hand the legal framework is more state- than federal-based (cf. KMK & eg. FSPVO). This diversity itself would be interesting for a comparative meta-study on educational institutions.

All *Studienkollegs* have in common that the training language is German and students are prepared in a two-semester course which is subject-specific. For traditional university *Studienkollegs*, eg., the following *Schwerpunktkurse* are offered: G- or S-course for the humanities or philology, W-course for social and especially economical sciences, M-Course for medical studies, and T-Course for mathematical, scientific or technical studies.

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Mathematics at Preparatory Colleges

According to the course, the students are trained in mathematics: especially in T-, W-, and M-course. Depending on the subject specificity of the course, the taught mathematical competences, contents, and lessons are different:

Course	Mathematical Topics	Lessons per Week
T	elementary arithmetic, algebra, and geometry; basic set theory and logic; theory and application of calculus, elementary linear algebra and group theory; vector geometry; basic prove theory; applications in informatics, science, and engineering	6–10
W	elementary arithmetic, algebra, and geometry, applied calculus; elementary linear algebra and applied elements of statistics and stochastics; applications in economical and political science	6–8
M	elementary arithmetic, algebra, and geometry; applied calculus; applied elements of statistics and stochastics; applications in medical and life science	4–8

Even though mathematics and computer science are getting more important in humanities, these subjects are not taught obligatorily in G- and S-course.

Since 2018 and 2021, the curricula of the public *Studienkollegs* started a decentral process towards competence orientation that is not finished and the new local curricula are not completely established or even developed in every institution yet.

Data, Questions, & Fields of Research

To enter a *Studienkolleg*, future students usually have to pass an entrance exam where their written skills are tested to determine the general German language proficiency, e.g. in a *C-Test* (cf. Grotjahn 2019), and to assess basic knowledge and competences in mathematics, if they want to take a T-, W- or M-course. To pass this German (!) mathematics' entrance exam usually just very basic arithmetic, term transformation, equation theory, geometry, and 2nd degree function's skills are needed.

Most of the mathematical entrance tests are not designed to use the results for future diagnostics. Considering that some *Studienkollegs* are testing more than one thousand candidates a year, it would be a great benefit for didactical research in general and for the development of individual learning environments in particular, to evolve these entrance exams like eg. the

Mathematik-Oberstufen-Diagnostetest (MOD) or the MINTFIT Mathematiktest (cf. Rolfes & al. 2022; Barbas & Schramm 2018).

Also a closer look at the entrance and the exit level in mathematics of the students in a *Studienkolleg* would be very interesting, especially, because of their very heterogenous education biography. By experience, the mathematics teachers of a *Studienkolleg* knows, how the mathematical education of the individuals of a group can vary: It mostly correlates with the mathematical training of the education system in their homelands. But it has not been studied, what the specific influence of the mathematical training at a *Studienkolleg* on the mathematical education of the students is: Do the students just know how to deal with the German written mathematical problems, eg. by training German mathematical lexica, or do they really develop their genuine mathematical skills? Maybe it is something in between, but if the second hypothesis is more suited to a certain group of students, the mathematical training at *Studienkollegs* harbours a great potential of optimisation, like developing higher mathematics courses to give this group a tailored training for their future academic subject, so they use their resources more profitable towards a successful study in Germany.

The connection between language skills and academic success has recently been comprehensively demonstrated empirically by Katrin Wisniewski & al. (2022). Her study is mainly located in Leipzig and is based on students in chemistry, economics, and German studies. Surely, the language dimension can and should not be decoupled from the subject 'mathematics'. It is more a matter of focussing.

Another interesting research field, the students of a *Studienkolleg* may help to cultivate, has an ethnomathematical dimension and may be linked with teaching methodological aspects (cf. Mora 1997): It is no surprise that it is very profitable if students with different educational background, from countries with different mathematical traditions can learn a lot from each other, if they work as a pair on the solution of the same mathematical problem. Eg., students from Latin America mostly use the general formula for finding the roots of a 2nd degree polynomial equation. Most students from Arabic countries prefer a simple scheme based on Vieta's formula. On the one hand, this scheme is very efficient to find integer roots, on the other it is not, if the roots are no integers.

The analysis these different mathematical ways of solving, related to the different mathematical schools or traditions, harbours potential for differentiation and didactic research related to connectivity, but also to answer questions related to the history of mathematics (cf. Wußing 2008, p. 16 sqq.).

Conclusion & Plea

Many other questions could be asked and properly answered by using data one can find, generate, and evaluate on *Studienkollegs*. Didactics in general and mathematics didactics in specific, should have open eyes and should take a closer look at these unique educational institutions. Collaborations between mathematics didactics research and *Studienkollegs* may help to find solutions to face problems connected with educational migration and therefore to open our social and democratic society to people, the German economy needs. It may also help to develop and test specific learning materials, as well as the teaching and instruction practice in mathematical courses at *Studienkollegs* could gain benefits for the teachers and students.

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