Secondary School Mathematics Teacher Training in Austria

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Abstract
After a brief overview of the Austrian education system, the teacher education system is reviewed in sections. The differences before and after 2015, when significant changes were enacted, is highlighted. Central to the pedagogical changes was the influence of Hans Werner Heymann.
Keywords: secondary school and mathematics

Introduction

Austria is a middle-European country which borders on eight other countries: to the north are Germany and the Czech Republic; to the east are Hungary and Slovakia; to the south are Italy and Slovenia; to the west are Switzerland and Lichtenstein. Austria is a parliamentary federal republic with German as its official language. Slovenian is also an officially recognized language in the federal state of Carinthia as is Burgenland-Croatian in the federal state of Burgenland. The chancellor-led federal government exerts influence over all law-making matters. Certainly, however, the nine federal states of Burgenland, Carinthia, Lower Austria, Salzburg, Styria, Tyrol, Upper Austria, Vorarlberg, and the Austrian federal capital Vienna also exercise law-making functions and in certain areas have administrative primacy.

Figure 1. Austria: Borders and federal states (Source: https://de.wikipedia.org/wiki/Österreich)

The Austrian School System

The Austrian school system is in essence composed of three parts. A primary level, the Austrian "Volksschule" after "Kindergarten" (or preschool with children from 3 to 5 years old), followed by the secondary levels I and II. While the primary level instructs pupils from ages six to ten years old, the secondary I level is attended by pupils between ten and fourteen years old. With the completion of the ninth schoolyear, compulsory education ends in Austria. In cases where students finish this ninth schoolyear in a polytechnical school, they often choose to begin a trade apprenticeship. For those pupils who complete their secondary I level in a higher-level general education school ("AHS", "Gymnasium"), they can remain at this type of school. Other types of secondary-II-level schools which continue are, for example, those which focus on commercial fields, such as business or technical schools (e.g., "HTL", "HAK", "HLW"). Many of these secondary-level-II schools ("Gymnasien", technical schools, etc.) end after the twelfth or thirteenth year of schooling with finishing exams ("Reifeprüfung" or "Matura" in Austria, "Abitur" in Germany). This gives graduates the right to attend a university or technical university ("Fachhochschule"). However, many university programs, e.g., medicine but also teacher preparation, will still require an entrance exam.

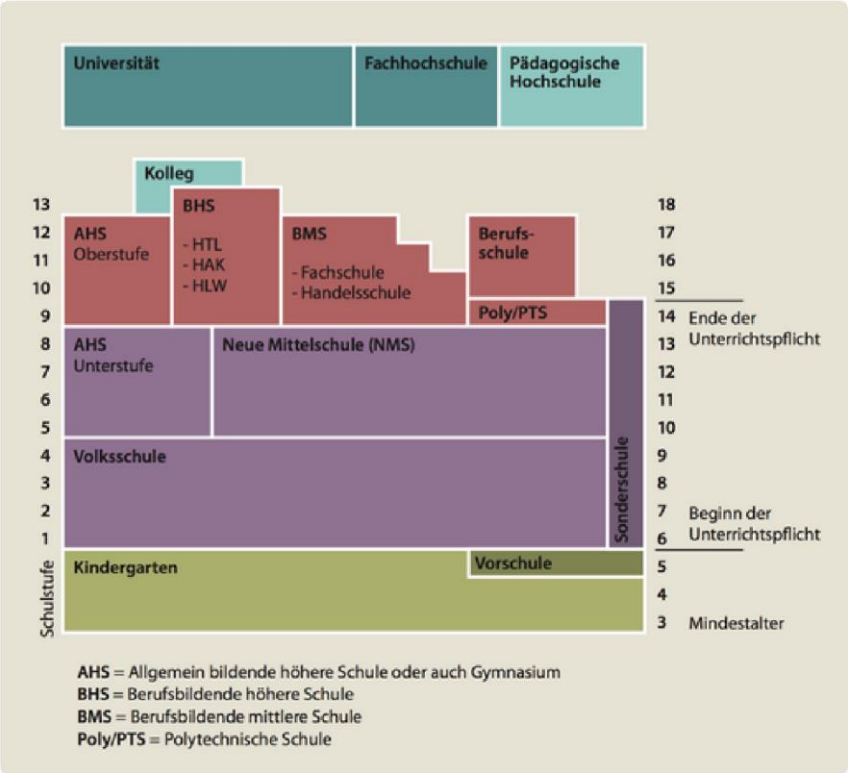

Figure 2. The Austrian school system (Source: https://www.demokratiewebstatt.at)

Education for Secondary School Teachers through Approximately 2015

Teachers in Austria are educated at pedagogical universities of applied science, universities and also private universities. Whoever wants to teach at the primary level must attend a pedagogical university of applied science. Those who wish to teach at the secondary levels can undertake an appropriate course of study at either a university or pedagogical university of applied science. The primary level teaching degree qualifies one to teach at a "Volksschule", while the successful completion of the secondary school teaching degree provides the possibility to teach general education subjects at a higher-level general-education school ("AHS"), a new middle school ("NMS", formerly called "Hauptschule"), a special school, a polytechnical school ("PTS"), or a vocational middle or higher-level school ("BMHS").

In its current version, the teaching-degree program is a twelve-semester two-tier Bachelor's-Master's program.

The Bachelor's portion of the program encompasses eight semesters and includes 240 ECTS points[1]. At the end of the Bachelor's portion of the program, a Bachelor's thesis is required for each teaching subject – in Austria, two subject areas are typically studied – candidates have chosen as their areas of specialization. With this a Bachelor of Education (B.Ed.) degree is attained as well as the allowance to continue on with the Master's program.

The Master's program consists of four semesters and includes 120 ECTS points. The final component of the program is a Master's thesis which focuses on a specific topic within one of the two areas of study. Alternatively, the thesis can deal with questions regarding educational science fundamentals. Graduates of the program, after successful Master's exam results, attain a Master of Education (M.Ed.) degree.

Prior to ca. 2015, a multitude of tertiary educational institutions with limited connections to one another separately organized their own teacher education programs, whereas after this point universities and pedagogical universities of applied science formed a development network to cooperatively generate curricula and to jointly offer them. This was largely a result of political pressure from the Austrian Education Ministry.

[1] As a result of the Bologna Reform Process, ECTS ("European Credit Transfer and Accumulation System") points were established to ensure the compatibility, transferability, and overall acknowledgement of academic achievement within the EU. Instead of continuing to calculate weekly semester hours (SWS), achievement points (credits or credit points) are awarded for successful course completion. The number of credit points (CP) varies depending upon effort necessary for the particular course. One credit point represents approximately 25 to 30 hours of work.

Development Networks Since 2015 [2]

At the latest since 2015 and influenced to a degree by the geographical conditions which prevail in Austria, the tertiary educational institutions – that is, universities, colleges, and pedagogical universities of applied science – together began to establish a unified teacher education program adhering to the Bachelor's-Master's formula. Ultimately, four groups crystallized from this, each of which necessarily included at least one university since pedagogical universities of applied science ("PH" – "Pädagogische Hochschulen") are legally prevented from offering Master's programs. In alphabetical order, these are:

- "Verbund Mitte" (Middle group: Salzburg, Upper Austria – see Website 1);
- "Verbund Nord-Ost" (Northeastern group: Lower Austria, Vienna – see Website 2); - "Verbund Süd-Ost" (Southeastern group: Burgenland, Carinthia, Styria – see Website 3); - "Verbund West" (Western group: Tyrol, Vorarlberg – see Website 4).

How can we characterize these educational institutions which also compete with one another for students? One possibility exists in the cursory presentation of essential general sections of the curriculum, namely the competencies expressed there.

The groups maintain a generally similar style in the curriculum preambles. Concurrently, the competencies listing leads to the presumption that a distinctly pedagogical education theory provides the basis for the formulation of these competencies. This is demonstrated, for example, in areas which indicate reflection with a scientific basis or reflection on media usage, but also in areas which hint at the tension between subject and methodology. To be able to assess the possible source of this pedagogical connection, we use educational theory flash feedback.

The basis, especially for the mathematics-teaching curriculum described below, was, among other things, the book by Hans Werner Heymann *Allgemeinbildung und Mathematik* (*General Education and Mathematics*) (Heymann, 1996), which was heavily discussed in the beginning of the 2000s in German-speaking circles dealing with mathematics didactics. In his model Heymann introduces a catalog of 7 reasons why mathematics should be taught in secondary schools. Since this book was not published in Italian and it had significant influence on the development of the mathematics curriculum in Austria, at least that of the southeastern group, we want to present some of Heymann's ideas.

Heymann gives "preparation for life" as the first reason for teaching mathematics (Heymann, 1996, pp. 51 ff.). However, the author argues less in terms of the saying "Non scholae sed vitae discimus", rather he means that mathematics is a cultural technique, like reading and writing, which is a necessary prerequisite for coping with everyday life in our daily lives.

As a second reason, Heymann postulates that mathematics can provide cultural coherence (Heymann, 1996, pp. 65 ff.). For one thing, this means the assimilation of cultural assets, which were created in the past, so mathematics is viewed as an historical inheritance. Furthermore, this can also be viewed as the interdependence of societally relevant cultural segments demonstrating mathematics as a tool in other aspects of science.

An orientation to the world is his third reason (Heymann, 1996, pp. 79 ff.). Here teaching mathematics has the task to convey a general education to pupils. But here the focus is not practical application, as with the first reason as a means for "life preparation", rather striving towards the development of a differentiated worldview).

With the fourth reason, the guide to critical thinking (Heymann, 1996, pp. 88 ff.), Heymann views teaching mathematics as a paradigmatic example of not only the application of science but also the ability to recognize its limits. The next reasons, the development of responsibility acceptance (Heymann, 1996, pp. 104 ff.), practice in communication and cooperation (Heymann, 1996, pp. 110 ff.), and the strengthening of the pupil-ego (Heymann, 1996, pp. 117 ff.), aim at the expansion of critical thinking as cognitive-intellectual capacity through the ethical principle of cooperation. The teaching culture of appropriately organized mathematics instruction can play an exemplary role by synthesizing individual thinking capabilities and social competencies.

Turning back to the curriculum, we concentrate on the general description of the subject mathematics in the Bachelor's program while keeping Heymann's first three reasons in view. These are a possible criterium for integration of the curriculum's (see Website 5a, pp. 408 ff.) formulated catalog of competencies (in part or with certain examples). This catalog should formulate the competencies for future teachers and thereby implicitly mirror the expectations of a successful mathematics lesson: preparing for life (mathematics in practice), cultural coherence, world orientation.

[2] As the official regulations of the teaching program for mathematics, especially the corresponding curricula, are subject to constant adaptation, internet sources will be disproportionally used in the following text.

So much for our look at selected competencies for the Bachelor's program. How did these demands affect both the mathematical as well as the subject didactical courses, provided these were formulated in a curriculum? The following tabular overview (Figure 3) illustrates the various course foci, their respective hour amounts, corresponding ECTS points, and the recommended semester in which the courses, which are combined into a module, should be completed.

Module overview Bachelor's program	Semesters hours	ECTS	Semester
Elementary Mathematics 1	6	8	1 , 2, 3
Analysis	15	20	1 , 2
Linear Algebra und Analytical Geometry	13	18	3 , 4
Fundamental subject-didactical questions of teaching math	5	5	4 , 5, 6
Didactics of Geometry und Analysis	7	7	5 , 6, 7
Stochastics	7	9,5	5 , 6
Elementary Mathematics 2	4	5	6 , 7
Didactics of Arithmetic, Algebra and Stochastics	7	8	5 , 6, 7, 8
Application und Reflection	10	12,5	7 , 8
Total	74	95	

Figure 3. The Bachelor's program

The titles of the above module listing and their intended contents are essentially clear. Within the two Elementary Mathematics modules are the themes discrete mathematics, elementary number theory, and geometry. But what is the module Application and Reflection, which is recommended at the end of the program? This module consists of a series of courses whose content are, on the one hand, mathematically oriented and, on the other hand, are historical and epistemological questions regarding mathematics. The first includes lectures covering basic differential equations and applications of mathematics in a science-technology context. The graduates should thereby be prepared to teach mathematics in vocational schools. At the same time, the courses "History of Mathematics from Antiquity to the Modern Era" and "Philosophical and Epistemological Bases of Mathematics" belong to this module (Website 5a, p. 425). In accordance with Heymann's claim that teaching mathematics also contributes to a general education, these two courses should bring students closer to the meaning of mathematics in the context of cultural history and the history of ideas.

Practical Training

Looking at the total ECTS points for the mathematics teaching segment and adding the corresponding total for the second teaching subject, which future teachers also have to take, we come up with 190 ECTS points. Since the Bachelor's program requires 240 ECTS points, the remaining ECTS points are split between two other segments of the teaching program. The first segment is the pedagogical training, and the second requires the students to complete a practical training. We will concentrate on this practical training. It consists of 20 ECTS points which, depending upon the conversion key, converts to a commitment of approximately 500 hours. The following table shows the recommended semester breakdown of this practical training requirement for the mathematics segment. Note here that the numbers in parentheses represent the other teaching-subject programs' semester recommendations for their practical training. The commission which designed the mathematics teaching plan was convinced that completion of the practical training would only be relevant after the completion of particular mathematical and didactical courses. This practical training[3], which must take place in secondary schools, is accompanied by a series of courses. These are both subject didactical and pedagogic in nature.

[3] The practical school training in this new Bachelor's program differs significantly from the practical work experience of the former teacher program. Previously, as a rule, an internship in a school combined with subject didactical and various pedagogical courses would be completed in the fifth semester. After the completion of the teaching program, the graduates would be assigned to a school where they would complete their so-called teaching internship (probation year). Under the direction of two specially trained teachers from this school, they taught several classes. After the successful completion of this probation year, they were eligible to teach independently in the years thereafter.

Semester	Name	Parallel didactical course	Parallel pedagogical course
2	Internship Orientation	-	Teaching Theory and Practice
5 (4)	School Internship 1	Subject Didactics Course 1 (from the corresponding subject)	Introduction to Pedagogical Research
6 (5)	School Internship 2	Subject Didactics Course 2 (from the corresponding subject)	Diversity and Inclusion
7	Research Internship: Quality Assurance and Evaluation	-	Quality Assurance and Evaluation
8 (6)	School Internship 3	Subject Didactics Course 3 (from the corresponding subject)	Pedagogical Diagnostics, Support, and Performance Assessment

Figure 4. School Work Experiences

There are five practical training elements, of which only three have a corresponding subject didactics course. What are the goals of these practical trainings (Website 5a, p. 26)?

The internship orientation should make the transition from a pupil role to a teacher role possible through a change of perspective, but at the same time afford the opportunity to once again reconsider their choice of occupation. In School Internship 1, the students acquire coping skills for the topic's observation, questions, and investigation regarding the particular lessons. They will thereby be confronted for the first time with content of practical research. The content of School Internship 2 deals with the complex topic of diversity and heterogeneity in educational classroom processes, specifically how one designs lessons in heterogenous groups, how one organizes what happens in the classroom with focus on the interaction of existing socio-cultural and gender-specific differences. School Internship 3 focuses on lesson planning and implementation. Here students practice academic-level assessment, subject-didactical diagnostics, and performance evaluation. Concerning class management, the students concentrate on class leadership which enhances learning and prevents disruption.

In Research Internship, which is paired with only a single course, the students learn how to empirically support scientifically based practical research.

The multiplicity of internships, for one thing, mirrors the wish of lawmakers for a practical education, but this also faces a host of concerns. The first of these is the pragmatic necessity of organizing the course of study. School visits result in absence from one's own campus. Attending lectures, exercises, and seminars is made more difficult as students must also create their own schedules while paying attention to numerous additional constraints. A second possible concern is the difficulty in finding an adequate number of schools and qualified teachers who are prepared to support and instruct a large number of teacher candidates. As a third concern, it is questioned whether the students with so many internships during the course of their studies can learn to maintain an adequate distance as a teacher from the school and class itself when they are constantly confronted with the daily teaching routine. The future will show if, as a result of any of these stated concerns, school internships will be newly organized.

The Master's Program

A 4-semester Master's program with 120 ECTS points is attached to the 8-semester Bachelor's program, as mentioned previously. According to current rules, graduates of the Bachelor's program who attain teaching jobs have the possibility to enter the Master's program while working. However, in the near future this will no longer be available. What form does this segment of the course of study have? Consider the following table (Figure 5):

Modules	Semester Hours	ECTS	Recommended Semester
Mathematics Deepening	7	10	1 , 2
Mathematical Lessons as a Complex Process of Networking Between Teachers and Learners	3	5	2 , 3
Teaching and Learning of Mathematics as a Subject Didactical Research Field [4]	3	5	3 , 4
- Or -			
Scientific Deepening in the Subject and Subject Didactics	3	5	1 , 2

Total	13	20	
Pedagogical-Practical Studies: Master Mathematics	2	10	1 , 2, 3, 4

Figure 5. The Master's program

One recognizes from the assigned ECTS points that mathematics-specific and subject-didactical education are essentially evenly split. The mathematical deepening allows the student to choose from many different courses, mostly from the Bachelor's program. As most of these will be standard courses, we will concentrate on the subject didactics and consider the module "Mathematics Lessons as a Complex Process of Networking Between Teachers and Learners" as an example. In the relevant courses, the students should be brought as closely as possible to the conduct of an ideal teacher. We understand the intended competencies from the curriculum for the Master's program (see Website 5b), such that the graduates "[can] adequately apply various methods of sequencing and building of (yearly) lessons, or rather the introduction of mathematical terms and concepts through the construction as well as the analysis of teaching sequences" (Website 5b, p. 210).

This means that the students at this point in their studies are expected to survey an entire teaching year from the perspective of the subject material (mathematics) and subject didactics. A high demand!

Another competency as formulated in the same module description is the potential teachers' ability to react to the differing pupil behaviors in regard to mathematics in school. The graduates "can adequately apply methods for enhancing attitudes and positions of pupils regarding mathematics and mathematics lessons ("beliefs", "mathematical worldview", mathematical self-concept or similar) and utilize these lessons learned for teaching" (Website 5b, p. 210). One recognizes here also the demand from the subject-didactic education that concepts from the program's research mathematics didactics are to be incorporated into the teaching program at least as descriptions of the desired competencies.

What can subsequently be reported about the practical training component, which includes 30 ECTS points, of the Master's program?
In both teaching subjects, a total of 20 ECTS points needs to be completed. This means that a mathematics teaching activity with the value of 8 ECTS points is to be accompanied by a mathematics didactics course with 2 ECTS points. This applies, correspondingly, to the second teaching subject. The "courses" for the remaining 10 ECTS points are alternatively organized. The pedagogical-educational science portion in this practical education of the Master's program presents a unique aspect. A special pedagogical internship with a total of 6 ECTS points must be completed. Here the students are not tied to a school, rather this internship can also be carried out outside of a school environment (e.g., in various youth centers, at the youth welfare office, or in service or information centers for pupils).

[4] At the University of Klagenfurt and the Pedagogical Technical University Burgenland, the "subject didactical research field" is taught, while at the University of Graz and the Pedagogical Technical University Styria further delving into mathematical subjects needs to be completed.
The current societal developments of the past few years have been formative in shaping the nature the final 4 ECTS points. These serve questions of language education with regard to multilingualism and competencies in the use of new media in teaching.

Conclusion

The previous explanations provide an extract of the current teacher education program in Austria. The extension of the relevant courses of study and the prescribed necessity of university inclusion for the Master's study programs are significant innovations in comparison to the previous teacher-education program. In doing so, the program extension leads less to a broadening of the mathematics subject-specific or didactical education but more to an intensification of practical school experience. If this proves to be warranted will be shown in the future, especially as this practical orientation can create a series of problems. The educational theory orientation of essential portions of the teacher education program, as indicated in the above text, especially which regarding the study of the teaching of mathematics, will remain for the next few years.

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