Invited Paper - Faculty Professionalization in Industry Sponsored Projects in Austrian Vocational Education and Training Schools

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Her interests are all areas of engineering education, esp. in professionalization of engineering faculty in general. She trains professionals starting to teach in Austrian VET Schools in the STEM sector, her expertise is also in teaching first and second year students in chemistry and chemical engineering, and recently her research interests also include pre-school didactics in STEM field and the professionalization of kindergarden personnel in STEM.

Faculty professionalization in industry sponsored projects in Austrian Vocational Education and Training

Since the end of the 1990s Austrian VET college student can work on industry sponsored projects in their last two semesters of study. As the term capstone project is not used in Austria, these projects are called diploma projects, their final examination has also the term diploma examination.
The Austrian school system has a strong branch in the vocational and technical field, where students from 14 to 19 years old are trained in Upper-Level secondary technical and vocational Colleges. Additionally in the VET system beside VET colleges also VET schools can be chosen, but they do not end with a graduation. Figure 1 gives an overview about the Austrian education system starting from the age of 14.

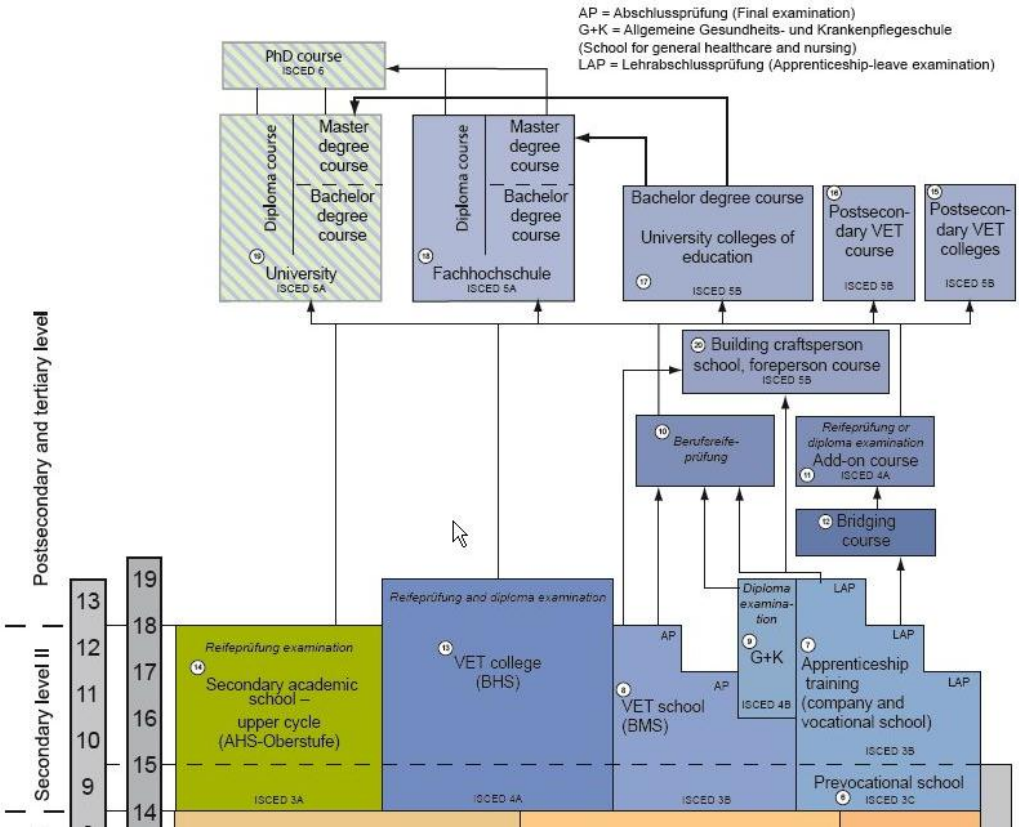


Fig. 1: The Austrian Educational System (source: WKO[1])

The VET colleges (in German called BHS, Berufsbildende Höhere Schulen) are classified in the ISCED 4A level according to ISCED 2011. ISCED is the international classification used to ensure cross-national comparability of data about education systems on the basis of uniform and internationally agreed definitions by UNESCO. ISCED 3 is defined as Upper secondary education, ISCED 4 as Post-secondary non-tertiary education (ISCED 1997)[2]. ISCED 2011 has

revised the classification in the fields of education and training[3]. As in Austria the vocational and technical training starts in this type of educational program ("BHS") with the age of 14 which is rather specific and not internationally a standard age for the start of an engineering education, the classification by UNESCO is fundamental for the graduates (with the age of usually 19 or 20) if they want to work in other countries. All graduates of these programs can apply in Austria for the title of an engineer if they have worked for at least three years in the technical field of their education. The title of an engineer is a professional title, which is granted by the Federal Ministry of Economy, family and Youth[4], but the education system lies in the hands of the Federal Ministry for Education, Art and Culture. The graduates of VET colleges are also entitled to study at any university or university of applied sciences. This title system is an Austrian particularity, formerly the professional title was called "little engineer" (in German abbreviated as "Ing.", Ingenieur) in differentiation from the "big engineer" who had graduated at a technical university (abbreviated as "Dipl. Ing", Diplom-Ingenieur). Meanwhile, most technical universities had changed their curricula according to the Bologna system with a Bachelor / Master /PhD program[5], although they still allow their Master graduates to use the title of "Dipl. Ing"[6, 7], so within the next decade the Austrian title system will loose its importance. Nevertheless, for the graduates of any ISCED classification it will be important that industry and trade is familiar with classification system.

Student enrolment in VET programs

In 2011 in total 42,000 young students graduated in Austria with a certificate that allowed them to study[8] , they had finished either a Secondary academic school – upper level (in German AHS, Allgemeinbildende Höhere Schule), or a VET college. More than 56 % of them graduated from a vocational and technical college with a diploma examination. Were in the 1980s more graduates from the AHS, now classified as ISCED 3A, turned this into an overload of graduates from the vocational training since 1989. In comparison, in 1960 graduated more than 10,000 students, at that time only 32 % graduated from a vocational and technical college[9].

At present, more than 300 VET colleges are distributed all over Austria, with a number of almost 138,000 students[10]. Disciplines of engineering colleges are civil engineering, interior design and wood technology, electrical engineering, electronics, mechanical engineering, mechatronics, materials engineering, media technology and media management, information technology, chemistry, chemical engineering, food technology, IT and computer science, industrial engineering, operations management, art and design and others[11].

Curriculum of VET colleges

There are several types of Austrian VET colleges[12]. The reformed curriculum of 2011 includes subject courses with a total of 100 to 110 hours, depending on the engineering program[13]. It has to be mentioned, that in the Austrian education system for everyone at a VET college about 15 hours of mathematics and applied mathematics and 10 hours of physics and science are compulsory, in addition to the engineering program. In total, 175 hours are basis of the reformed engineering syllabus.

Not all discipline have their syllabus reformed at present, some have still curricula from the Nineties. The syllabus which has been used until now[14] included about 55 hours of engineering subjects, plus 16 hours of mathematics and 10 of science, a total of 185 hours was necessary to fulfill the syllabus. As mentioned above, the vocational training is combined with an educational training (mother language, English, geography, history, political education, economy and justice, and sports). All projects discussed here had been under curricula of 1997[14].

According to the curricula for the various disciplines of higher technical and vocational colleges, additional to the required theoretical and practical subjects internships of eight weeks in industry or trade are compulsory. As the curricula ask for expertise, methodological skills, social and personal skills and language skills, these skills can be acquired during an internship[13].

Faculty

In 2011, the personnel in the vocational and technical colleges are given as 22,600 of which more than 8,000 are teaching engineering subjects[8, 10]. These teaching personnel are mostly academics trained at technical universities, who had been working in industry or trade at least for four years before they had started to teach at a VET college, and before they had started their pedagogical study. Not the entire teaching faculty in technical universities worldwide has the prerequisite of several years of industrial experience. The focus on the curriculum of these teachers of technical subjects lies on pedagogy[15], but lies on practical work in laboratories, building yards and others[16, 17]. The curriculum dates from 2008, according to the federal status of Austria nine versions are in use[18].

Diploma projects for groups of students are supervised by one or more members of the faculty in parallel, mostly combining experts from different fields. To rely on the quality of the projects the Austrian ministry for Education has published standards already in 1999[19] (for schools and for colleges). Didactic guidelines said

- differentiation according to the individual possibilities, demands and needs of the student within the learner group,
- acquiring new knowledge and realizing connections and structures with the help of examples (learning by examples)
- ability of autonomous learning and knowledge management (learning to learn and to use what has had been learned),
- connection between theoretical-conceptual learning and learning through action and experiments.

Student focused approach

Faculty were mentioned in that ministerial guideline for diploma projects only marginal: as far as they should support the projects they are interested in (and the students are interested in); their role lie in the subject competence as background, but mainly in providing assistance with structuring of planning and decision-making processes, to help with methodological expertise, to work on intergroup dynamic processes and to help with evaluation and reflection.

Projects

In 1999 the Federal Austrian Ministry for Education and Culture published a report about projects on Austrian VET schools and colleges, to "show the performance of the schools and colleges to an interested public"[20]. 40 % of the 471 reviewed projects had partners from industry. Students had studied the disciplines building construction, chemistry, IT, electronic, electrical engineering, interior design, wood technology, food technology, manufacturing systems engineering and others while doing their projects.

In 2002 another review showed that in the teaching period 2001/2002 42 teaching institutions with 1336 projects had been evaluated. 66 % of these projects had a practical impact, in 44 % of the project an external partner were involved[21]. This is quite interesting because at that time it was not so clear if the teaching institutions (and their students who were not yet graduated and had not finished their education) should have a deeper involvement with industry and trade. The ministry therefore wanted to make a statement that VET schools and colleges are not only educational institutions but also partners of the economic sector. No statement is made of the involvement of teaching personnel.
"Practical" teaching instruction is one focus (of four) stressed by Dorninger, where working in labs overcomes remote techniques and simulations. Industrial Certificates, f.e. in IT, are also wanted[22, 23].

HTL innovativ

HTLinnovativ

More than 4000 projects are registered with website of HTL innovativ[24] as diploma projects of students of Austrian VET colleges. They include many specializations; most prominent figures are projects in Electrical Engineering / Electronics, Mechanical Engineering / Mechatronics, Informatics (Electronic Data Processing and Organization) / Information Technology, Construction Engineering / Interior Design & Timber Technology, Chemical Engineering / Food Technology and Material Engineering. Some 40 % of the registered projects had partners from industry, trade, public authorities, local administrations, private partners and others.

Other initiatives

Jugend Innovativ

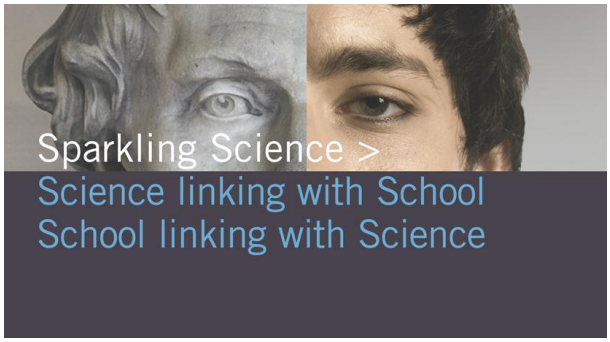
jugend innovativ
www.jugendinnovativ.at

Already in 1987 an Austrian school projects contest competition had been started, which is now Austria's biggest nationwide school contest for innovative and original ideas with more than

6,000 projects so far and more than 26,000 students participating. Engineering and science is included, but also business, design, sustainability, idea.goes.app and tech&society project are excepted[25].

Committed students (from the 10th grade upwards) get the opportunity to translate their innovative ideas into projects and to present them to a broad public under the umbrella of *Jugend Innovativ*. Prizes are awarded to the best and most innovative contributions, and financial support is granted to all the projects submitted. In 2012 the winning team participated in the 24. EU-Contest for Young Scientists in Bratislava, Slovakia; other teams were awarded at the 27. Chinese Adolescents Science & Technology Innovation Contest in Yinchuan, or at the Stockholm International Youth Science Seminar, Sweden.

Sparkling Science



This research program was launched in 2007 by the Austrian Federal Ministry for Science and Research. It is another unique path of promoting young talent from schools and colleges - this program is open to all types of Upper level secondary education, not only VET colleges. Funding is reserved to projects under which students are actively involved in the academic working process. These junior researchers are important in stimulating the research approach, they are involved in designing the concept for and implementation of research projects, they conduct surveys, collect data, interpret them together with academics and present the results at schools, universities and even at academic meetings. The topics range from Green Chemistry, nano-materials, robotics, and climate change[26]. At present more than 209 projects have been funded, with 45,000 students and 1,000 teachers from 358 schools partnering, *Sparkling Science* allows also projects with partners in other countries, Spain, Italy, Germany, Slovenia, Slovakia, Serbia, Poland, Japan, Cameroun, and Turkey. As the Austrian students speak German as mother tongue, the competent use of English is intrinsic in all international projects.

Project Area	number	completed by 2012
Science	61	32
Social science	41	19
Information technology	27	17
engineering	26	19
teaching-learning research	27	11
humanities	15	7
medicine and health	12	8

Tab. 1: *Sparkling Science* area 2007-2012

Relying on these materials the professionalization in industry sponsored projects of the coaches is obvious. All coaches are teaching personnel, academics from technical universities with at least four years of working experience as said. Austrian VET colleges don't do research, but due to the projects of their students the coaches are involved in what one could call training-on-the-job.

Although no effort is made to support the coaches in an institutional way, the project work is successful since more than 20 years.

Seal of Approval "Young Science"

Young Science[27] is given to Austrian schools and colleges for their commitment to work together with research institutions. It is said explicitly that the professionalization of students and teachers are valued. This initiative was started in 2012, 30 % of the awardees were VET colleges.

JUNIOR Companies

Another initiative values JUNIOR Companies, where students of VET colleges start a project which ends in a product, the project also includes an involvement in the open market – the products should be financially successful. The categories of the award are sustainability, organisational culture, sales and marketing, but also innovation. In 2012, more than 1,800 students were coached by 200 teachers[28, 29].

Future diploma projects

From the year 2016 on changed graduation examination rules will take place at the Austrian Upper level secondary technical and vocational colleges (as well as at the Secondary academic schools upper level, ISCED 3A) with emphasis on e. g. project work, including presentation and discussion (also dislocated in co-operation with companies and other institutions), and therefore, on the professionalization of the coaches of industry sponsored projects[30].

The diploma thesis is the hands-on product of a team of at least 2 (up to 5) students with a defined length, where a co-operation with external partners, such as businesses, public interest bodies or other areas is welcome, it is never a study of references and literature.

A graduate of an Austrian VET collage has to be educated according to the Directive 2005/36/EG[31] which manages the recognition of professional qualifications, which states the a postsecondary education of at least one year is equivalent. The diploma thesis should therefore be equal a standard graduation project of a Short Cycle Higher Education programmes of a university[30].

Conclusion

As faculty of Austrian VET colleges is actively involved in project and diploma project work since more than 15 years a solid basis on project finding, project management, coaching students and co-operating with industry and trade has been led. Student could find their way from a school or college environment to a workplace and career life in industry or trade. The professional qualification of the faculty members had been proven by many thousand successful diploma projects, projects of student of Austrian VET colleges of 18 or 19 years of age.

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