mascil
mathematics and science for life

Analysis of the German policy context

mathematics and science for life

mascil

mascil aims to promote a widespread implementation of inquiry-based teaching (IBL) in math and science in primary and secondary schools. It connects IBL in schools with the world of work making math and science more meaningful for young European students and motivating their interest in careers in science and technology.

The project mascil has received funding from the European Union Seventh Framework Programme (FP7/2013-2017) under grant agreement n° 320693.

1.2 National report of Germany

PART 1: A DESCRIPTIVE, EVIDENCE-BASED ACCOUNT OF THE NATIONAL CONTEXT

Introduction: Organization of education in Germany

Germany is a Federal Republic consisting of 16 constituent states – these units of the federation are called "Länder" (singular: Land). Education structures and policy are determined by the federal structure of the Federal Republic of Germany and most responsibilities for the education system remain with the single Länder. Accordingly, despite sharing common features, there are 16 slightly different school systems.
The German education system is very complex due to the federal organization. A basic structure of the German education system is shown in figure 1 below which is, to be sure, an approximation that harmonises the 16 different systems in the Federal Republic. The most important specificities are (see also: KMK 2011a: 23ff.):[2]

a) the start of compulsory education for all children at the age of six years and lasting for at least nine years – depending on the school type and according to the respective Land. Primary general education comprises grades 1 to 4 (in some Länder grades 1 to 6) and caters to all pupils together in the *Grundschule*;

b) a differentiation of lower secondary education that selects students into different tracks leading to qualifications with different status, including a strong stand of special school; that is, the end of primary education is marked by a *highly selective transition* to a four types of secondary schools (see below);

c) at the age of 15, pupils complete compulsory education and move on to upper secondary education. Depending on the qualifications and entitlements acquired in the lower level, pupils may attend either full-time general education or vocational courses. Also, a major specificity of the German system is the „dual" vocational training system which combines apprenticeship training in companies with vocational education in professional schools according to centrally standardised profiles and curricula;

[2] The focus of this report is on Baden-Württemberg.

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d) a further important characteristic of the German education system is that the vast majority (93 %) of students attend public schools; although the number of students in private schools is increasing. Private schools are most often run by the churches. There are no fees for public schools in contrast to most private schools. Due to the low number of private schools there is no substantial competition between state and private schools.

e) finally, and with special relevance for the topic at hand, the percentage of pupils receiving regular tutoring in order to compensate for deficits in school education has been increasing in the past years. According to Klemm/Klemm (2010) some 14.8% of pupils receive private tutoring (most often in mathematics, science education, and language) (see also Bray 2011).

Most German schools are half-day-schools, but the number of all-day-schools has been continuously increasing during the past few years. Even in pre-primary education („Kindergarten“) only some institutions offer all-day child care. Another important notable feature is that from primary to upper secondary education, students with poor achievement (as documented in their marks) have to repeat classes.
As highlighted above, education in *primary schools* („*Grundschule*“)takes 4 years. The transition from primary school to one of the different *lower secondary school* types depends on legislation in the different Länder (marks, testing, etc.) and is usually based on a ‘recommendation’ by the primary school, pupil grades and parents’ decision.

Basic Structure of the Educational System in the Federal Republic of Germany

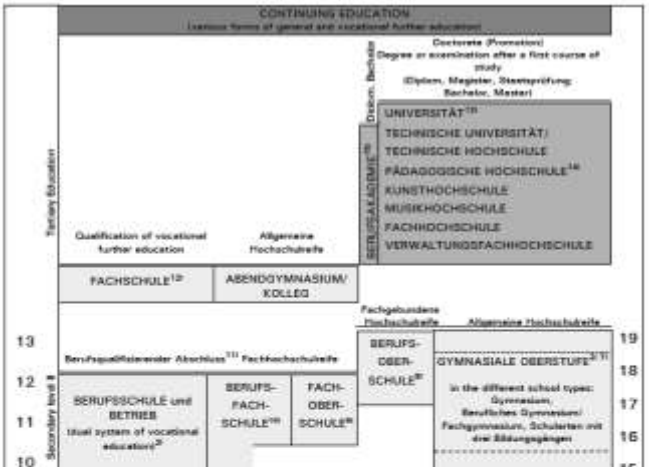

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Figure 1: Structure of the German Education System, Source: KMK 2011a: 30

The organisation of the *lower secondary school* system (grade 5 to 9/10) is characterised by the division into various educational paths with different leaving certificates and qualifications for which different school types are responsible. Lower secondary education varies according to the Länder. While there are no differences regarding Gymnasium, the other school types are organised differently. In *Baden-Württemberg* the „Hauptschule“ still plays a major role. However, in many cases it is being differentiated (and renamed into „Werkrealschule“) by adding an optional 10th grade for the better achieving students providing them the possibility to achieve the middle qualification (“Realschulabschluss”).

Upper secondary schools comprise three possible strands: in *general education* one may continue to Gymnasium, switch to professional Gymnasium (depending on achieved qualifications) or to vocational training which is either school-based or combines apprenticeship training with teaching in professional schools. The Abitur (certificate in a gymnasium) qualifies for higher education in general; but upper secondary schools also

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provide a qualification ("Fachhochschulreife") for entrance at polytechnics (or universities of applied science – "Fachhochschulen) and which can be obtained one year before the Abitur. The other part of upper secondary education consists in *vocational education* and training and does not provide direct access to higher education. A specific feature in Germany is the „dual system" of vocational training combining apprenticeship training in a company or institution with teaching in professional schools. Professional schools are divided into several branches (commercial, technical, etc.). Apart from the dual system, there is school-based vocational education and training, especially for occupations in the health and social sector (nurses, educator) and for public administration.

The *tertiary education* system offers two types of higher/academic education: universities as the traditional institutions with the highest reputation and „Fachhochschulen" (universities of applied sciences, similar to polytechnics) with a more job-related focus. *Special needs schools* usually offer education from the beginning of primary education up to graduating from lower secondary education; resulting in the segregation of special needs pupils. The possibility to achieve a regular degree, for instance the „Hauptschule", is dependant of the Länder regulations.
The graph below shows the participation numbers for general and vocational education according to age for the school year 2010/2011[3]. The share of boys and girls is nearly equal in general education; in vocational education boys are overrepresented in most school types.

[3] Data from the National Education Report 2012, published by the BMBF. Cf.: Autorengruppe Bildungsberichterstattung (2012), Table B4-1A, p. 234.

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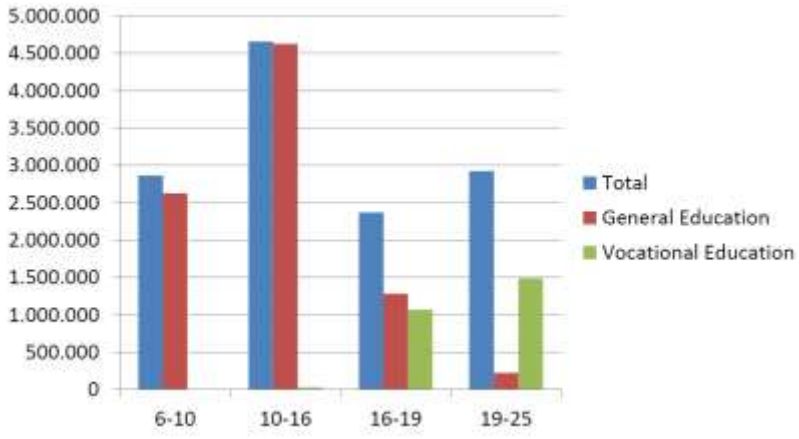

Graph 1: Participation in general and vocational education, acc. to age for 2010/11, absolute numbers, Source: Autorengruppe Bildungsberichterstattung 2012, p. 234

Education Governance and Education Policy in Germany

In accordance with a 'cooperative federalism' in education policy matters, the national or federal level has only restricted competences; one important feature is that it has only indirect steering capacities at its disposal. For this reason, the federal level mainly sets legal and institutional frameworks for the Länder. The main body at the national level is the Federal Ministry of Education and Research („Bundesministerium für Bildung und Forschung, BMBF"). Because of the Länder' responsibility for the school system, it does not include a department for schools or curriculum development in its internal organisation. Apart from research development, the tasks of the Federal Ministry are related to overall strategies, international coordination of education and research, and especially to vocational education and training as well as to adult education and further training (cf. KMK 2011a).

The Länder level is charged with legislative and administrative competences on all levels of education. A ministry is responsible for planning, regulating, monitoring and funding teaching.Legal provisions are passed by the respective ministries of the Länder in form of School Laws, laws on school administration, and school regulations. The Länder are responsible for teacher training and employment, although the latter is increasingly devolved to the level of the individual school, curricula, educational standards, admission

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of text books etc. all in all, the16 Länder ministries have the overall responsibility for the educationsystem and the main impact on the process of public education in schools. The Länder ministries have a rather similar structure of organisation including organisation of schools and teacher education, general education and pre-primary education, professional schools. In Baden-Württemberg the Ministry for Education ("Kultusministerium") is also responsible for youth and sports. The ministries of education at Länder level are also responsible for higher education; to fulfil this task they are required to cooperate with other ministries of science and research as regards teacher training, both at the federal and the Länder level.

According to the Basic Law „the responsibility for the supervision of the whole of the school system resides with the state." (GG Art. 7, §1) This refers to the historical role the church has played in school inspection until the 1920s. All Länder therefore have a structure of supervision of teaching issues, i.e., of content and methods („Fachaufsicht"); legal supervision of self-administration („Rechtsaufsicht"); and supervision of staff issues („Dienstaufsicht") (van Ackeren&Klemm 2009, p. 109).Each of the Länder and thus each ministry has one or more subordinated organisational units. In Baden-Württemberg, the state is divided into four regional districts („Regierungsbezirk") with educational department responsible for the employment of teachers. These districts in turn are divided into 4 to 9 subordinated local school authorities („Staatliches Schulamt") responsible for the single schools in their district.
Since the late 1990s a trend towards decentralization of education and increasing autonomy of schools can be observed which – compared to other European countries – is still marginal, yet increasing. Autonomy, however, is basically restricted to the level of implementation and accompanied by a shift from input to output oriented educational governance.While school inspection traditionally followed an 'interventionist' and control logic, current developments show in direction of a more advisory role for the agencies described above (van Ackeren&Klemm 2009, p. 111).

Educational governance at the level of the Länder is further shared with municipalities following a distinction of „internal and external affairs". The Länder are responsible for the internal affairs such as those relating to teaching staff (training and employment) and to curricula (goals and contents, school books, and all issues pertaining school trajectories of pupils). External school affairs related to the infra-structure (e.g., school buildings, furniture, technical equipment, etc.) and to the employment of non-teaching staff (e.g.,

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social workers, clerical personnel, etc.) fall under the responsibilities of the municipalities (cf. ibid., p. 106f.).

Due to this complex structure and the necessity to coordinate the education policies of the Länder there are several advisory and coordination bodies. One of the main bodies in educational policy is the *Ständige Konferenz der Kultusminister*(KMK), the Standing conference of Ministers of Education, as the main coordinating body. The KMK was created in the early years of the post-war period, right after the ratification of the Basic Law in 1949. In the KMK the ministers and senators of the Länder responsible for education, higher education and research as well as cultural affairs come together with the task of coordinating the educational matters of the Länder. KMK resolutions, however influential, only have the character of a recommendation and agreements. They have to be translated into legislation by the Länder to become binding.

Theme 1: **State of affairs-recent changes**

Several countries have recently been or are currently engaged in reforms especially focused on science and mathematics education. We seek to gain an understanding of the changing educational scenery as the main basis on which the project will be implemented. The following discussion refers to changes at three levels (macro-, meso- and micro-level) that bear potential implications for the work in mascil. This first thematic section focuses, *first*, on wider policy perspectives at national and Länder levels. Recent or envisaged policy changes in the way science and mathematics education is prioritized as evident in national policy making documents and as evident in national curricula are at the centre of this section. *Second*, it discusses development more closely related to the school level such as teacher initial and further training; and *third*, it looks into recent changes at classroom level related to implementation, i.e., taught time and classroom materials, methods of teaching and/or methods of assessment.
In the concluding part, we also refer to potentials and constraints in relation to the aims of mascil and highlight issues that have a direct effect in the completion of the project.
National and Länder policy documents of the past years have prioritized science and mathematics education. In particular, the KMK has issued a number of recommendations and negotiated some agreements among the Länder that aim at strengthening

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mathematics and science education in the country. Most of these initiatives have been started in response resp. after the publication of the results of international comparative studies that highlighted the rather low level of performance of German pupils in these subjects (e.g., PISA, TIMSS) (cf. (Klieme et al. 2004, p. 11f.). In the following pages some of the most relevant policy initiatives are reviewed and discussed as to their relevance to mascil. Then, a more detailed review of the activities in *Baden-Württemberg* is presented along the different levels of education.

Policy Initiatives and Strategies

National Education Standards

National educationstandards have been introduced in 2003/2004 (KMK 2004; Klieme et al. 2004). In primary education there are standards in mathematics; standards were also introduced in secondary school types: in Hauptschule (mathematics), Realschule (mathematics, biology, chemistry and physics), and Gymnasium (mathematics). For each of the school type/level – and due to the federal structure, for each Land – specific standards have been formulated. The national standards agreed upon at federal level encompass 6 general competencies: problem-solving, reasoning, communicating, using mathematical/natural science representations, dealing with symbolic, formal and technical elements of mathematics/natural science (cf.: Klieme et al. 2004).[4]
Federal policy has to be passed into Land legislation in order to become binding. As what refers *curriculum change*, *Baden-Württemberg* introduced a competence-oriented 'Education Plan 2004' (Bildungsplan 2004) for all primary and secondary school types.[5] There are three levels of bindingness of the 'Education Plan 2004': In the first level, government regulations are made that are compulsory for the individual schools. At the second level, these regulations are illustrated on the basis of selected examples, which are in themselves not binding but rather demonstrate the levels to be achieved. Variants for the practical implementation are made available at the third level. In contrast to mathematics, four areas of competences in the natural sciences were agreed on: specialized knowledge of the subject, gaining realization, communication and assessment. Standards are assigned to each field. The standards of gaining realization

4 see for the respective school types: http://www.kmk.org/bildung-schule/qualitaetssicherung-in-schulen/bildungsstandards/dokumente.html
5 cf.: http://www.bildung-staerkt-menschen.de/unterstuetzung/schularten

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refer to scientific working methods that are used to gain new insights within this science. *Performance testing* has been part and parcel of the standards movement from the beginning. Competence levels are tested in national exams and comparative assessment tests, for instance, in Baden-Württemberg there are centralized exams and comparative testing which refer to the first level of bindingness described above, that is, they are compulsory.

In sum, the introduction of national education standards and performance testing has inserted brought with it – at least in theory – some flexibility in terms of teaching methods and task types/structures to be used in classroom. This increased autonomy – in contrast to the former painstaking curriculum (Lehrpläne) regulation – offers the possibility for the introduction of inquiry-based learning. Teachers now have the option to use different methods and tasks, as long as the core themes and levels of the respective subject are respected.

SINUS Projects

A further policy initiative focusing science and mathematics education started as early as 1998. In response to the results of TIMSS 1996/97 and an ensuing German-based video study(TIMSS-Video) several projects were implemented to strengthen the efficiency of mathematics and science education ***Project SINUS***(1998-2003),***SINUS-transfer*** (2003-2007), and for the primary level ***SINUS-transfer Grundschule*** and ***SINUS-Grundschule*** (2009-2013).[6] The SINUS projects were implemented first as a federal cooperation with the BLK and Länder ministries of education and some Universities and included several modules that still left room for supplementation and individual development: Developing a Task Culture, Scientific Working, Learning from Mistakes, Gaining Basic Knowledge, Cumulative Learning, Interdisciplinary working, Motivating girls and boys, Autonomous learning, Progress of competencies, and Quality assurance. In the SINUS and SINUS-transfer projects cooperation among in-service teachers was viewed as a way to improve teaching styles. Together teachers followed a strategy of identifying a problem, developing a strategy for improvement, implementing the strategy and reflecting on it.

[6] SINUS is the German acronym for ‚Steigerung der Effizienz des mathematischen und naturwissenschaftlichen Unterrichts'. The programme was commissioned by the Bund-Länder-Kommission (German Federal and State Commission for Educational Planning) in order to *improve the efficiency of mathematics and science teaching (cf.* http://blk.mat.uni-bayreuth.de/programm/konzeption.html).

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Specific topics could be chosen out of the modules. To support the work in the school materials were provided and meetings with special mathematics and science educators took place. Networks among schools were set up (see footnote 2). Curriculum change, however, fell rather short, which also applies to teacher training, both for those in-service and for initial training, as the project foresaw 'further training' in terms of cooperation amongst teachers. Assessment remained untouched in the scope of this initiative. To conclude with, SINUS projects indeed appear to have brought about, at least in principle, a greater awareness for teaching methods and motivational structures in mathematics and national sciences education, which represents a good potential on which mascil can build its activities. One open question is the fact that since the national program has ended; initiatives are now being carried out by the single Länder and this might undermine its nationwide effect and further increase heterogeneity and disparity.

MINT Initiatives and Projects

A number of other initiatives were introduced to improve the social and cultural image of so-called MINT school subjects and professions (MINT = Mathematik, Informatik, Naturwissenschaft und Technik; MINT is the correspondent term for STEM = Science, Technology, Engineering, and Mathematics). The Federal Ministry of Education and Science widely promote innovation projects related to MINT. These are mostly related to two targets: securing the manpower need in related professional fields and improving their professional images in society, in particular for females.[7]These projects are carried out in cooperation with civil society stake-holders and include offerings for children aged 3 onwards, thus addressing children and youth in primary and secondary education. Although, MINT projects introduce a climate conducive of increased awareness and interest in mathematics and science, that is, they had a positive impact on the societal context of mathematics and science education, they did not have any direct impact on curriculum, teaching methods, etc. in this field.

"Physics in Context"

The project "Physics in Context" (piko)was a project funded by the German Ministry for Education and Research until 2007 (Duit/Mikelskis-Seifert 2010). Based on the experiences of SINUS and on findings of a nation-wide video-study on investigating

7 cf.: http://www.bmbf.de/de/mint-foerderung.php

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dominating patterns of introductory physics instruction in Germany[8] (see also: Duit et al., 2004; Seidel, Prenzel, & Kobarg, 2005), piko suggested that learning physics be embedded in three types of contexts: 1) contexts from everyday life, technology and society, 2) the learning environment as the context in which learning takes place for students, and 3) learning outside school. The project is based on three fundamental objectives: *First*, develop a new (constructivist) culture of teaching and learning to counter a teacher-dominated mode of "questioning-developing" teaching style. *Second*, to improve students' competencies of thinking and working like scientists to counter physics instruction thatin Germany has traditionally been restricted to teaching physics concepts and principles (Duit et al., 2004). *Third*, integrate topics of modern physics and technology in physics teaching (e.g., quantum and relativistic physics, non-linear and complex systems, cosmology, etc.). In sum, inasmuch as the project attempted to develop contexts that are connected to students' everyday life and to provide the chance to understand the fundamental principles of modern physics and modern technologies, it did inserted a logics to science education that is congenial for IBL. It helped propagate research evidence (for instance, motivation psychology) that recommended a different task culture, tasks which have a relation to reality, support the use of different ways of solution, encourage students to solve actual problems, reflect on questions and allow identifying students' weaknesses. In particular it yielded textbook and in-class work material for physics teaching (cf.: Duit/Mikelskis-Seifert 2010).

Recent Policy Changes Implemented

Important policy activities of the past years include the agreement of the Länder on the *'strengthening of mathematics and natural sciences education'* (KMK 2009), for which the Länder agreed on a range of action fields. In the following a review of recent activities in Baden-Württemberg is presented based on aKMK-monitoring (2011b):

Elementary Education

8 Cf.: http://www.ipn.uni-kiel.de/projekte/video/Videostudie_eng.htm

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The Orientation Plan for Kindergarten in Baden-Württemberg‘ (Orientierungsplan für Bildung und Erziehung in baden-württembergischen Kindergärten) focuses in its education and development field “*Thinking*” on the links between mathematics, science and technical contexts and holistic thinking of the child.
The following projects support the implementation of the objectives of the orientation plan:

- The initiative “TECHNOlino” (funded by the Arbeitgeberverband Südwestmetall) promotes playful interaction with natural phenomena through the establishment of experimental and researchers corners. Science content is linked to language, creativity, moral and musical education and movement education. In addition, work with parents and qualification of the participating educators takes place.
- In the initiative of “House of the little Explorer” (Haus der kleinen Forscher, funded by the Helmholtz-Gemeinschaft, McKinsey&Company, Siemens AG, Dietmar Hopp Foundation) children perform science experiments, science and technology can be experienced. The initiative collaborates with “local networks”, organizes local workshops for teachers and educators. Currently, there are 26 local networks in Baden-Württemberg, where 2,700 day-care centres are involved. The targeted range of training courses for kindergarten teachers and materials supports the further implementation in the kindergarten.

Primary education

The promotion in the field of mathematics and science teaching is a high priority in the education plan of the primary school. An integrative approach of subject field “People, Nature and Culture” (Fächerverbunds “Mensch, Natur und Kultur” (MeNuK)) was introduced that offers manifold linking possibilities with mathematics. Further activities are:

- participation of primary schools in the SINUS project for primary schools; coaching concept for new SINUS elementary schools;
- cooperation for the promotion of science and technology teaching and learning in the primary school;
- extra curricular research centres;
- cooperation with universities; cooperation with foundations; cooperation initiatives with other sponsors.

Secondary education

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Activities in secondary education are differentiated along the school types.
Hauptschule/Werkrealschule

- Introduction of electives (nature and technology, business and information technology);
- individual support on the background of diagnosis and promotion in the area of MINT (online diagnostics in mathematics, educational assistants, tutoring modules in mathematics (SchuB), 10 additional hours for individual support; 3 hours to strengthen the basic skills mathematics;
- vocational guidance in the area of MINT (continuous career planning oriented to the strengths of pupils; learning opportunities in school and out-of-school, internships;
- introduction of the 'Porsche Engineering Award' (from 2013) for the best graduates of the HS/WRS in the elective Nature and Technology.

Realschule

- The promotion of autonomous and problem-resolution scientific thinking in science education with the core subject of "Natural Science Work" (NWA);
- The theme-oriented project "Technical Work (TOP TA) in grade 5 or 6 introduces children to the basic principles of project-oriented work. Students acquire skills that allow project work at higher grade levels. Students develop their own solution ideas for designing and manufacturing technical items.
- Since autumn 2007, the Foundation 'Stiftung der Deutschen Wirtschaft' with the support of the BMBF and regional partners from the economy sector launched the project "MINToring", in which peer to peer mentoring takes place. The project is a part of the qualification initiative "Aufstieg durch Bildung" of the Federal Government. In Baden-Württemberg, general and vocational schools are included.
- NANU?! is a competition of the Realschulen in Baden-Württemberg, which promotes scientific questioning and practices in the classroom to promote the joy of experimenting and exploring science contexts in the student team.
- The "Junior Engineer Academy" aims at raising the technical understanding and interest of the pupils. It also supports the career choice process of young people in that it offers opportunities to develop and apply in practice technical skills.

General education – Allgemein bildendes Gymnasium

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Mathematics and science education in general secondary schools builds on the integrated subject field “People, Nature and Culture” (Fächerverbunds “Mensch, Natur und Kultur” (MeNuK)) from primary school level.

- In the subject “Natural Phenomena” in grade 5 and 6 first scientific-technical questions are addressed and worked on in praxis;
- In the subjects Biology (from class 5), Physics (grade 7), Chemistry (grade 8) and Science and Technology (NwT) (new profile from grade 8) a well-founded scientific and experimental basic education is offered to students and interest in technical issues promoted;
- A new profile subject Science and Technology(NwT) was introduced 2007/2008 and raised the number of hours in science subjects. Teaching in the NwT builds on the technical basics of the subjects of biology, chemistry and physics and brings together the approaches of these subjects and extends it to a multi-perspective point of view. Teaching in NwT is strongly oriented towards practice and project work.
- In the higher levels, the assignment of two science subjects has become mandatory;
- The school promotion of MINT in secondary school has been expanded for years. Latest projects include the expansion of the profile subject NwT in the grade levels (Jahrgangsstufen, pilot) and the lower school from grade 6 (Unterstufe,pilot) as well as the testing of a core subject of Informatics in the grade (school experiment). The school pilot project “International Baccalaureate” in biology strengthens the scientific profiling in a European and global context.
- A competition culture has been promoted in the area of MINT on all grade levels by the the Ministry of Culture, Youth and Sport in order to allow pupils to test and expand their scientific skills – even in an international comparison. The same is true for the various prizes in the scientific field, which are awarded to outstanding high school graduates.

Vocational Schools

In recent years, the development of the different types of vocational schools, emphasis was placed on strengthening mathematical, science and technology education.

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In the *Berufskollegs,* the further development of vocational schools with focus on Commerce and Languages (Kaufmännisches Berufskolleg I and II, Berufskolleg Fremdsprachen) –both of which have each a female student share over 50% – the number of hours in mathematics has been increased and became a compulsory subject in the past few years.

In the three-year*Berufliche Gymnasien,* an applied focus was placed in the subjects agriculture, biotechnology, nutrition and technology respectively; one course in mathematics and onein natural science or informatics is mandatory; other courses in the latter two subjects may be elected additionally; intensive dealing with relevant issues and methods in cooperation with teachers motivates students to orient the further career in the fields of engineering or science; real-world facts from the world of work can be used for teaching under application of scientific, mathematical instruments as well as laboratory lessons. In particular the use of information technology instruments varies depending on the foci of the vocational Gymnasium. For instance, computer algebra systems are partly deployed (with appropriately modified examination); 3-hour-courses can be chosen as electives in the qualification phase. The students work individually or in groups on cross-curricular topics geared to the respective profile of the vocational Gymnasium; the vocational Gymnasium take part in many MINT-specific competitions, and explicitly support the participation of girls.

The canon of subjects of *Berufsoberschule* includes amendatory 6-hour course with focus on physics and mathematics at the ‘Technische Oberschule’ and a 6-hour course on mathematics and “biology with health education” at the vocational school with focus social services; other natural sciences are mandatory or elective in all types of Berufsoberschule; the use of computer algebra systems is schedules as is project work in the first grade of the Berufsoberschule and leads the students to interdisciplinary.
The two-year vocational school(leading to higher education at applied universities) provide 4 hours per week support teaching, internships, physics/chemistry/biology or professional specialization and thus aim at the promotion of MINT.
Curriculum development, school profiling

- The development of a MINT curriculum in a school-specific profile education is supported by the contingent schedule in all types of schools and the introduction of the integrated and profile subject fields MeNuK, MNT, NWA and NwT. Projects such as “SINUS Grundschule” or “Primarforscher” support these processes.

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- With the increased number of hours in mathematics in vocational schools with focus on Commerce(Kaufmännisches Berufskolleg) new content was included in the binding curriculum.

Teacher education

Initial Training

- Competence in Mathematics (20 ECTS) has become binding for all teacher students for primary school;
- teacher students for primary school specializing in the subjects of biology, chemistry, physics or technology must take mandatory scientific and technical competence (20 ECTS) to acquire of interdisciplinary basics;
- Setting up the course of Science and Technology (NwT) for Gymnasiumin 2010/11
- Mandatory 102-hour additional training in NwT in the in-service-training for teachers in secondary schools for all those with the subjects of biology, chemistry, physics, and geography (physical G.)

Further Training in MINT Subjects

- regional training offerings during school year 2009/10 for lower secondary schools (Gymansium) in mathematics and physics; regional training courses for biology and chemistry in lower secondary education 2010/11 and 2011/12;
- Science and Technology (NwT) contact studies for the qualification of at least one teacher at every secondary school in the field of technology, runtime 1 year (since 2006/07) content: bionics, engineering, project management, food and medical technology, energy technology, micro-controlling, automotive engineering, bridge construction;
- Natural Science work (NWA) contact studies for the qualification of at least one teacher in each Realschule (2010/11 pilot course with 25 teachers), then annually about 100 teachers. Content: Spaceship Earth (keyword sustainability), energy, materials, information (information transmission in different systems);
- New media technology (NwT and Realschule) - since school year 2009/10 as a three-day regional training introducein micro-controlling, CNC milling machine, automation (Festo Didactic); from academic year 2011/12: a deepening module on these three

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issues in the national training center for environmental education Adelsheim - eight NwT courses in the academic year 2009/10;
- During the the school year 2009/10 nine half-day courses were held, including the topics of astronomy/NwT, neuro-biology, chemistry, biodiversity, human evolution;
- GuT (Gymnasium and Technology) training course; 4 Modules: Automation (Festo), robot programming (Qfix), construction and electronics.

Promotion of gender-oriented MINT Education

- Baden-Württemberg also implemented the nationwide Girls' Day; in 2011, 15.532 students participated in 1,348 events in the field of "Girls in Technical Professions".
- The inter-ministerial working group "BoMTec - career guidance for girls in technical professions" („BoMTec - Berufsorientierung für Mädchen in technischen Berufen") has created a common Internet platform in 2010, on which over 70 projects promoting gender oriented MINT education are listed (cf.:http://www.Scientifica.de/girlsdotech.html);
- The Ministry of Science, Research and the Artsin cooperation with the Regional Directorate of the Federal Institute Of Labor of Baden-Württemberg has launched the project "Students Research" with the aim of further arousing the interest of girls in science issues;
- The universities of Education in Karlsruhe, Heidelberg and Schwäbisch Gmünd and the University of Konstanz offer laboratory space for school groups (target grade level 7 of the Realschule and Gymnasium). Natural sciences can be closely experienced and tasks be solved in gender homogenous teams.

Financial resources and Personnel

The municipal school boards are responsible for the material equipment of the schools according to the Education Act (section 48). They build and maintain school buildings and classrooms, provide other necessary facilities for the school and materials, provide teaching and learning materials and supply the personnel, who are not in public service. The local school authorities decide autonomously and the Land does not have decisional authority in these matters. The local school authorities are supposed to leave to the school the independent management of resources (budget). Within their own budget, each school can decide on its own priorities – also for MINT education.

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Baden-Württemberg allows different of entry to the teaching profession in MINT fields in order to supply the need for qualified teachers:

- lateral entry to teaching profession in mathematics, physics, Informatics and chemistry (Gymnasiumand vocational schools);
- direct entry into mathematics and physics and technical disciplines in the vocational education;
- candidate generation through school-related job postings; job advertisements in national newspapers)
- allowances for direct entrants from the professional field of metal and electrical engineering in vocational schools;
- improved employment opportunities in natural sciences in Realschule/Werkrealschule;
- deployment of teachers from Realschule in vocational schools and Gymnasium.

Summary

In Germany, science and mathematics education has been highly prioritized as expressed in policy making national documents and the several initiatives of the recent years reviewed above. The strategic action lines encompassed equally primary as well as secondary general and vocational education. This priority setting is slowly but surely mirrored in *national curricula*, both in form of standards for learning outcomes and assessment/testing. As what refers *initial teacher training*, the impact remains at a rather low level, of course there are substantial differences between the different types of schools which required separate training, especially at secondary level. *In-service teachers* are being increasingly offered further training and career development opportunities in science and mathematics/MINT, but to varying degrees and in highly heterogeneous ways. Also, there has been some effort to recruit teachers laterally and directly from professional fields (e.g.: from metal and electric branches of engineering).*Curriculum organization* at a school and classroom level also received attention, in special the introduction of integrated and profile subject fields as described above highlight the connection points of MINT-related subjects and aim at a more comprehensive understanding on the side of the students both at primary and secondary schools. In relation to *teaching methods* there have been substantial efforts to improve the teaching styles of teachers at all school levels. In particular the SINUS projects have attempted to introduce changes in teaching styles through the cooperation among

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teachers and the dissemination of materials on the topics. At the same time, these efforts remained at the level of the projects and have not been introduced across the board. Vocational schools have only partially benefited from these developments, since the focus of SINUS was on general education.

All in all, there are some important implications of this situation for the mascil project. The mascil project will surely profit from *raised awareness and interest* in the topic, which has the potential of facilitating cooperation for the dissemination of IBL amidst policy and practice circles. With particular reference to the implementation of mascil (WP8) special attention should be given to *teachers and practitioners*, who appear to have only had little say in the initiatives described above (e.g., teachers were only seen as participants although the mainstay of the project was cooperation among teachers). In light of evidence of implementation studies, these stakeholders are crucial in the successful introduction of innovation. Further, the highly differentiated and selective organization of the German education system, in particular at secondary level, poses some challenges for mascil activities since they require a *high level of differentiation and specialization* due to the specific foci of the school types; this might pose mascil the challenge of too much fragmentation or an approach that is too focused. Apart from this more conceptual or pragmatic issues, there are also *ethical open questions* since differentiation and specialization entails forms of inequality among the school types and pupils they cater to (we return to this topic below). Related to this, the *deep-seated beliefs about 'talents'* (German=Begabung), which underlie the differentiation of secondary education in the country, also plays out heavily on notions and attitudes related to mathematics and natural sciences. A separation of students in those 'talented' in scientific subjects and those more 'practically' or 'artistically' gifted remains influential, despite research evidence showing that other factors are more important (e.g., the social, temporal, and thematic organization of the subject).

The mascil project will surely profit from the *orientation towards the world of work* as visible in the focus on professional orientation, in particular for females. The project may dock on the various ongoing initiatives and projects in order to scale up its activities. The next section discusses this relationship in more detail.

Theme 2: **Schooling and the world of work**

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The main aim of the project is to promote a widespread use of inquiry-based science and mathematics teaching in primary and secondary schools. The focus is laid on general education as well as on vocational education and its connections to the world of work. Also here three levels are considered: the macro-level in terms of policy orientation, the meso-level in terms of schools/institutions and micro-level as far as 'how things are' in classrooms. The *first* part addresses *wider policy perspectives* and inquires the connection between general education and the world of work in policy making national documents, in the national curriculum, in science and mathematics national curriculum in terms of aims/objectives. We ask, for instance, in what ways vocational education is prioritized (or not) by policy. *Second*, this thematic section also looks into issues and development regarding the school level. Connections between general and vocational schools and the industry, between schools and providers of informal education as well as between vocational and general schools are highlighted. Finally, *third*, we discuss *issues regarding the classroom level* that are related to curriculum support materials and topics in science and mathematics education. Also, assessment of skills/competences in science and mathematics in relation to the world of work are thematized as are predominant teaching methods. The section closes with a discussion of potential constraints in relation to the aims of MASCIL, thus highlighting issues that bear direct implications for the success of the project.

In terms of overall *policy orientation*, the connection between general education and the world of work has become a priority for policy makers in Germany. The federal ministry BMBF promotes numerous initiatives related to MINT-professions. The following webpages illustrate well the extensive work that is ongoing at the moment: http://www.mintzukunftschaffen.de/; http://www.komm-mach-mint.de/; http://www.znl-mintatlas3-10.de/. Most of these projects are involved in improving the social and cultural image of MINT professions, in particular among girls. More to the point, these initiatives are concerned with ensuring that the need for qualified personnel in these fields is met; for this reason, they promote MINT on all school levels and types and aim at passing "a realistic picture of the engineering and science professionals and at showing the opportunities for women in these fields" (see: 'objectives' at: http://www.komm-mach-mint.de).

Education ministries have also sought to initiate and expand cooperation with private firms and other actors from civil society, for instance several foundations, the Federation

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of Employers (BDA), etc., in order to promote the world of work within schools. Activities takes place take bear potential for the introduction of IBL such as cooperation between schools and out-of-school learning sites, internships, etc. in the field of MINT; however, some activities may have a negative effect on learning such as the extensive focus on competition and prize awards, which while promoting interest in science and mathematics for some, creates a separation between some 'winners' and the majority of 'losers'.

The priority of the connection between general education and the world of work becomes evident in the *national curriculum*. However, this takes a rather general form in that topics in science and mathematics education is made comprehensible in real-world situations. The challenge is still to strike a balance between systematic and applied knowledge of the function of these topics in the real world. According to the curricula (Bildungs standards) for general education, mathematics and science education has a more holistic role to play, but is still more or less directly related to the world of work. Science and mathematics education standards in Germany display a rather loose connection between schooling and the world of work in terms of the aims and objectives of science and mathematics education. For instance, primary education mathematics standards foresee the development of basic mathematical knowledge and skills such as basic understanding of numbers, mastery of arithmetic, including orientation in space and level, ideas about sizes and their application and importance in daily life, reading and applying different forms of representation and proper handling of simpler drawing instruments (cf.: Bildungsplan Grundschule, Baden-Württemberg, 2004, p. 54). In the Realschule mathematics teaching includes types of argumentation and justification as part of understanding mathematics. Systematic thinking is developed through activities such as asking questions, expressing conjectures, collecting content information (including their relevance), constructively dealing with errors, establishing secondary connections, factual and reasonable response to questions and criticism (cf.: Bildungsplan Realschule, Baden-Württemberg, 2004, p. 60).

Connections between schools and providers of informal education are also visible in Germany. The Ministry of Culture, Youth and Sports support extracurricular research centres to promote MINT-related topics. These out-of-school research centres provide the opportunity for in-depth scientific and technical dealing with MINT-content to students from all schools types. This is complemented by regional-related projects and a large number of initiatives and cooperation between schools, universities of education

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(Pädagogische Hochschulen), universities, and the economy sector. Further, in the project MINToring pupils are accompanied by university students during their qualification phase and during the first year in higher education (cf.: KMK 2011).
The vocational school system has only little connection with general education schools as the school types are much differentiated. It offers qualifications in abroad spectrum of professions. There is full-time vocational education in schools and in the dual system, which integrates work-based and school-based learning to prepare apprentices for transition to full-time employment. Full-time vocational education includes the *Berufsfachschule*, the *Fachoberschule*, the *Berufliches Gymnasium* or *Fachgymnasium*, and the *Berufsoberschule*. The curriculum includes general, multi-disciplinary and subject- or occupation specific subject matters; science and mathematics are included as separate subjects. Teaching methods have a particular focus on task-based and practice-oriented education. Assessment is conducted via performance testing (exams) that verify the meeting of the education standards (see also: KMK 2013). The OECD report 'A Skills beyond School Review of Germany' (cf.: Fazekas/Field 2013) however, calls attention to 'limited evidence of adherence to clear standards' in vocational education (ibid., p. 10; see also BMBF 2012). Indeed, in the dual system, assessment focuses practical exams (Chamber exams) and school subjects often risk being neglected by students. This may pose a challenge for mascil implementation activities.
The German specific system of vocational education in 'dual training' include a close connection between vocational school system and the industry since students are trained in-service (some branches include part-time school education and part-time work). Vocational guidance, while not a separate subject in the curriculum, takes a more general form in lower secondary general education; vocational secondary education is structured in a differentiated way catering to the different professional branches. Also, internships have become a standard also in vocational guidance and career planning. Some industry branches, however, misinterpret this as a way of selecting and 'creaming off' the best students rather than serving the counselling of students in the first place.

Summary

In sum, a close connection between schooling and the world of work has become a high priority for policy makers during the past years. This, however, takes place and is pursued more via extracurricular projects and initiatives than through the curriculum or via classroom activities. Yet, as discussed in the previous section, much change has taken place in this field during the past years. This picture appears very conducive for the

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introduction of IBL in schools in Germany. Even if it seems necessary to reiterate the challenge brought by the highly differentiated secondary system.

Theme 3: Science and Mathematics curricula and IBL

IBL in policy making documents and national curricula

In the following we refer to the 'Education Plan 2004' of Baden-Württemberg (Bildungsplan 2004), which is the result of the last curricular reform conducted in Baden-Württemberg, which set, among others, new standards in education, listed competences pupils are to reach, indicated methods teachers are supposed to use and gave examples of lessons as illustration of the new standards. "'Education Plan 2004' gives an overview of the educational guidelines which are required by policy makers" (cf. Maaß et al. 2010), specifies contents and competences that pupils have to reach during their education on every school level. Standards in terms of detailed guidelines and explanations how contents and competences should be understood are found in this policy document as well. 'Education Plan 2004' covers almost all types of schools in Baden-Württemberg. The vocational education is not affected by this curricular reform.

At each educational level personal, social, methodological and professional competences have to be acquired (cf. von Hentig 2004). Some IBL activities are listed as part of these competences: observation, evaluation, estimation, to investigate, to plan all steps of work, to pose questions, to choose between different points of view, to summarize, to cooperate etc. Especially the development of marketable skills (which are not named explicitly) has to be supported.

The methodical and didactic principles have to support the learning process. The most important principle is "learning by doing", where pupils should assume an active role. They should take part by choosing the structure of the lesson and which tasks to do. Partly, they should have the control and responsibility for their own learning processes. Teachers have to be open for new solutions and for pupils' creativity. The learning processes have to stay close to their everyday life. One of the main purposes of school

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on the policy level, which is not followed on the level of implementation, is to give pupils a professional orientation.

> ”On the other hand, school hast to prepare long term for a later career, vocational training or studies.” (Education Plan 2004, Gymnasium)

Important issues for the new curriculum arise from this policy document. The new curriculum only prescribes the content for 2/3 of the lessons (core curriculum). The remaining part may be completed with a school’s own curriculum in order to allow schools to develop their own profiles. The curricula in Baden-Württemberg are competence-oriented and emphasize the following competences for mathematics: solving problems mathematically, mathematical reasoning, communicating, using mathematical representations, dealing with symbolic, formal and technical elements of mathematics and mathematical modelling. (cf. Maaß et al. 2010)

In contrast to mathematics it has agreed on four areas of competencies within the three sciences – biology, physics and chemistry: specialized knowledge of the subject, gaining realization, communication and assessment. Standards are assigned to each field and are described in “Education Plan 2004”. The standards of gaining realization refer to scientific working methods that are used to gain new insights within this science. These standards have been the basis for the curricula in many Länder in particular in Baden-Württemberg. (cf.Maaß et al. 2010) Cooperation with other educational institutions is demanded. Experts, associations or churches should participate in the learning processes of young people.

Primary education

The special part of the “Education Plan 2004” that refers to primary schools quite strongly prioritizes IBL in mathematics and sciences. The contents that have to be learnt on the primary level are not as challenging as on the further educational levels, so that it is possible to put the focus on competences that play an important role in the learning processes. Pupils have to learn to pose questions that refer to everyday life, to look independently for the solution possibilities, to investigate them and to choose the best one. The creativity is in demand. The stress is put on the activity- and inquiry-oriented learning. To investigate, discover, conduct the experiments, compare, analyse, sort and document the facts belong to the methodological principals of pupils’ work. The active

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role of pupils in the classroom presupposes intensive group work and allows making mistakes that are discussed and that new solution ideas result from. Pupils in the classroom have to communicate and cooperate with each other. The time for tasks which refer to the children's real world has to be provided.
The curriculum on the primary level is, as mentioned above, competence-oriented and strongly supports the IBL approach especially in mathematics.[9]Pupils should gain, among other content-related competences, general mathematical competences as well (cf. KMK 2004). Following skills are emphasized: solving problems, reasoning, communicating, using mathematical representations and modelling. Only few IBL elements occur in the content-related mathematical competences. In the field of “Data, frequency and probability” pupils should learn how to observe and investigate facts, how to collect, structure and present data and how to conduct simple experiments. The mathematical competences should be developed from everyday life experiences of pupils. The emphasis is put on the reflection and description of different ways of problem solving and on pupils’ cooperation whilst working.

The sciences are all taught together as one subject named “People, Nature and Culture”. The IBL situation in the teaching of this subject looks good. There are 2 content fields where many IBL elements occur. One of them is “to inquire, to conduct an experiment, to document, to create” and the second one is named “inventor, artist”. In this subject learning processes have to be strongly linked to pupils’ experiences from everyday life. By investigating the world in inquiring way creativity, activity and discovery should play an important role. Additionally, a list of experiments that have to be conducted on the primary level is attached to the “Education Plan 2004”.

General secondary education

Similar to the primary level, the curriculum for the secondary education implies two kinds of competences that should be learnt by pupils. The competences of contents belong to the first group of competences. The universal competences build the base of the second group. Competences like learning, reasoning, problem solving and communication are

[9] cf. http://www.bildung-staerkt-menschen.de/service/downloads/Bildungsplaene/Grundschule/Grundschule_Bildungsplan_Gesamt.pdf

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included in the group of universal competences. Many IBL elements occur in the specification of each of them.

Problem solving is the core and aim[10] of all mathematical activities on the policy level (Education Plan 2004.). The solution process is as important as the solution itself. Mistakes made during the process of searching for a solution should be treated as learning elements. Pupils should be able to work out certain solution possibilities, to estimate them and to choose the best one in a given context. During learning the emphasis is put on social competences like teamwork and cooperation as well as on the autonomous working of pupils whilst planning, organizing and structuring their work. During their independent acting they are able to use existing support materials and electronic equipment and to collect and interpret data. The class activities are based on pupils' active participation. They have the responsibility for their learning process. Tasks should be more open than ever to ensure pupils are developing their personal competences.

Similar to the mathematics curricula, science curricula expect an ever stronger cooperation between subjects. This results from the purpose of science at school which is to help pupils to understand the world and actively create their everyday life. The strong connection between real world and sciences should be guaranteed. The follow-up education should be built on pupils' experiences from real life and on already acquired knowledge to guarantee the continuation of learning. Learning activities should focus on life-related implementation. Pupils should get an appropriate education to be able to design their world in the future. The methodological principals are based on inquiry- and discover-oriented learning. Especially in physics and chemistry lessons, experiments should be an important way of learning.

According to "Education Plan 2004", it is important to deal without preconception with gender issues, especially within subjects like physics, mathematics and chemistry. Schools should prepare pupils for their future professional life or for their future study. To accomplish this goal schools need to cooperate with support institutions like churches, associations, companies etc.

[10] "The development of problem-solving competences is still, besides the contentwise structure, at the centre of all mathematical activities." In: Bildungsplan 2004. Allgemein bildendes Gymnasium. p.92.

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Vocational education

The curricular reform, that took place in 2004, didn't cover the vocational education. Therefore, there are no common educational plans for vocational schools. Every type of vocational school has its own curriculum. Some of them are quite new, others are even 20 years old. There is one policy paper, published 2008, "General statements regarding the formal curriculum" ('Allgemeine Aussagen zum Bildungsplan') which can be seen as the introduction for all vocational curricula and which includes a description of the mission of vocational education. In this part we refer to this document and to several education plans for concrete types of vocational schools. [11]

The main aim of vocational education is to prepare pupils for their future professional life, to give them the opportunity to acquire a professional qualification and to guarantee them a general education. (Kultus und Unterricht 2008) The professional preparation happens by giving insights into the asked profession. Pupils have to acquire professional-oriented skills and knowledge. Learning processes have to be practice-based. Similar to any other educational levels, vocational schools have to fulfil a pedagogical mission and give pupils some kind of life orientation.
It is not possible to clearly state if the vocational education in Germany prioritizes IBL or not. The diversities and differences are too great between single vocational schools. Curricula of some schools emphasize such competences like problem solving or modelling. The experimenting and linkage to everyday life are at the core of students' activities in some schools. But there are educational plans as well where the pupils' work is reduced to repeated activities.[12]

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11 Cf. Bildungsplan für das berufliche Gymnasium der sechsjährigen Aufbauform wirtschaftswissenschaftlicher Richtung. Allgemeine Fächer. Biologie; Lehrpläne für das Berufskolleg. Berufskolleg für Mode und Design. Mathematik I.; Lehrplan für Bildungsgänge die in zwei Jahren zur Fachhochschulreife führen. Lehrplan für nichtkaufmännische zweijährige Bidlungsgänge. Mathematik; Lehrplan für das Berufskolleg (Vollzeit) mit Ausnahme – der zweijährigen Berufskollegs für technische Assistenten. Projektarbeit.; Berufskolleg I und II – Verzahnung mit dualen Ausbildungsberufen. Kaufmännisches Berufskolleg I. Physik.; Berufskolleg I und II – Verzahnung mit dualen Ausbildungsberufen. Kaufmännisches Berufskolleg I. Chemie.; Berufsoberschule – Mittelstufe (Berufsaufbauschule). Mathematik – gewerblicher Typ (G).; Bildungsplan für die Berufsoberschule. Oberstufe der Berufsoberschule. Allgemeine Fächer. Mathematik.

12 cf. http://www.ls-bw.de/bildungsplaene/beruflschulen/bk/Mode_Design/BK-Mode-Design_01_3225.pdf

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Compared to primary and secondary education the curricula are not competence-oriented but rather content-oriented. The vocational education, unlike primary and secondary schools, did not make the step from input-oriented to output-oriented learning. Not in every vocational school mathematics occurs as a separate subject. In some types of them (e.g. schools focusing on nutrition) mathematics is integrated in learning fields. The concept of learning fields was developed in Baden-Württemberg about 20 years ago. (2) The learning fields are based on the principal that lessons should be activity-oriented and as a consequence interconnect subjects. Learning processes don't need to be structured based on subjects but by the activities which should be conducted.

There is also no general guidance concerning how sciences should be taught. In some vocational schools sciences are taught as one subject or according to learning fields, in others subjects like chemistry, physics and biology occur separately. There is no clear recommendation regarding group work as well. The curricula of some vocational schools put a strong emphasis on this kind of pupils' activity others don't even mention it.

In the curricula of the vocational education there is some free space which can be filled with IBL elements. 17% of the curriculum of every type of vocational school is booked for "Activity- and Subject-oriented Work" (handlungsorientierte Themenbearbeitung). It is recommended that the project-learning interconnects a few subjects. It is a place where pupils can learn how to plan, conduct and evaluate smaller and bigger science projects. Group work and individual support is required.
In general, IBL has a prioritised place in policy documents in Baden-Württemberg. Pupils-oriented lessons, acquiring social competences such like cooperation, problem solving or modelling are strongly favoured on the policy level. But there are many difficulties in implementing policy recommendations into the scholastic life.

IBL implementation on the school level

The prioritised place of IBL in policy documents in Baden-Württemberg is not transferred on the school level. Every school, irrespective of educational level, has its own guidelines regarding classroom activities. According to the "Education Plan 2004" these guidelines should be content-oriented. The overstuffed curricula on every educational level and bigger and bigger requirements concerning a teachers' role at school cause that there is often not enough time for the realization and development of universal competences. Teachers are aware that a big part of pupils' competences is not practiced in classrooms but they are stretched to their limits regarding time and energy resources. The structure

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of assessment (see 3.3), which doesn't support IBL, is one of the reasons why teachers go back to traditional teaching methods. Consequently, general competences that take up so much space in "Education Plan 2004" often get lost on the level of school implementation.

The vocational education with her compulsory hours of "Activity- and Subject-oriented Work" is a nice exception on the educational map. There is an institutionally assured possibility to practice IBL teaching. According to teaching plans in many vocational schools, mathematics and science have to be taught in a professional context. It is not an activity-oriented teaching but at least contents are taught in regard to the real world.

IBL in curricula supported materials and assessments

The German textbooks and teaching resources for primary education as well as for secondary education are very wide. There are a lot of materials with traditional tasks without IBL elements but tasks for teaching IBL exist as well. Some IBL-oriented materials collections have been developed as a result of diverse projects. Therefore, there are materials for teaching science and mathematics which are a product of such projects like: Sinus, Physics in Context and PRIMAS. However, the German collection of tasks in IBL style does not cover all of the topics both in science and in mathematics. The existing IBL-oriented tasks concern only some subjects on selected school levels. Additionally, tasks that exist in Germany and include IBL are on different levels regarding elaborateness and access. "Further, there are also new textbooks, some of which especially emphasize tasks for problem-solving and others which are more traditional. Every school decides on its own which books to use. So this decision can be taken in favour of problem-solving books or – if not - teachers can at least look at those textbooks providing respective tasks". (cf. Maaß 2010, S.8)

Some tasks for teaching mathematics and science have been added to the "Education Plan 2004". There are also tasks recommended by the policy makers that can be found on the official website of the Ministry of Education of Baden-Württemberg.[13] Most of these tasks link to traditional teaching methods. However, a few of them are IBL-oriented and can be used at different educational levels.

[13] Cf.:http://www.bildung-staerkt-menschen.de/unterstuetzung/schularten/Gym/umsetzungsbeispiele/M

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The diversity of textbooks for vocational education corresponds with the diversity of professions vocational education prepares their pupils for. Generally, textbooks which are used in vocational schools have not really the newest standards regarding teaching methods. It is not possible to find traces of competence-oriented teaching methods. Almost all tasks in those textbooks are closed. There is only one solution possibility, which pupils have to follow. The tasks don't give the opportunity for creative thinking and autonomous work. Tasks for group work aren't present at all.

The assessment structure in Baden-Württemberg is much differentiated and contains a diversity of forms which depend on the school type. The most popular and most frequently conducted form of assessment in Gymnasium is written class tests. Although the tests offer a lot of space for open tasks, they are usually based on non-IBL tasks. The structure of assessments in Hauptschule and Realschule develops slowly towards opened tasks. However, the centralized summative assessment for the final exams or intermediate formative assessments on all educational levels mainly does not include tasks for problem-solving. (cf. Maaß) They still stay content-oriented and predominantly in form of tests. The final exams of Hauptschule build an exception. This exam has a form of project. The pupils choose the subject as agreed upon with the teacher. They have to plan the project, conduct it and present the results during the final discussion. The project-work is also possible in the Realschule but only in the field "Professional orientation" (Themenorientiertes Projekt Berufsorientierung).

Similar to non-vocational education assessments are predominantly based on non-opened tasks.[14] The most popular form of assessment is written work with many closed tasks which are sometimes related to topics from the real world (at least the tasks from the part "economic applications" are real life related). In some types of vocational schools there are assessments within the practical part. In some cases the practical part can be replaced by the group or individual project assessment, which can be compared to the project assessment in Hauptschule.

Summary

[14] Cf. Berufskollegprüfung Musteraufgaben ab 2009; Abiturprüfung am beruflichen Gymnasium im Schuljahr 2007/2008

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The educational situation in Baden-Württemberg and in some parts of Germany opens many possibilities as well as many difficulties for the implementation of the project mascil. They are different for vocational education and on the primary and secondary levels.

First of all the aims and purposes of mascil are strongly prioritised in policy documents and curricula of primary and secondary education. Therefore, it is a strong advantage for the project that it can build on all these values. Secondly, the cooperation with non-school institutions is explicitly required in “Education Plan 2004”, so that mascil can contribute to the further development of cooperation between schools and out-of-school institutions.

No obligations concerning the use of textbooks at school give mascil the opportunity to selectively provide needed materials. Although some IBL–oriented tasks already have their place in German teaching resources for primary and secondary schools, there is still a lot of work that can be done within the framework of the mascil project. The quality of IBL related tasks is very different and partly it is difficult to locate them. In this field, it can be one of the aims of mascil activities in Germany to structure IBL-oriented tasks, to improve the quality and to make them easier to find. There are good advantageous conditions for this purpose based on the PRIMAS materials collection. There are also a lot of possibilities to provide IBL-oriented tasks to vocational schools. The existing textbooks are based on traditional work methods and don’t give pupils the opportunity for creative, autonomous work.

Additionally, a new curricular reform is planned in 2015. The curricula will still stay competence-oriented but the competences will be described more exactly.[15]On the one hand, it is not a good change regarding the aims of mascil. It is obvious that the more exact the competences are defined the less free space for interpretation exists. On the other hand, new perspectives and opportunities for mascil will occur.
On the part of the Ministry of Education it is planned to offer a wide spectrum of professional development courses, which will prepare teachers for the challenges of the new curricula. The structure and way of work of the Ministry of Education in Baden-Württemberg is very strict and it will be really difficult to establish a long-term cooperation with the Ministry of Education regarding the IBL-oriented professional development courses. The challenge of mascil is to offer new professional development courses which

[15] cf. http://www.kultusportal-bw.de/,Lde/Startseite/schulebw/bildungsplanreform2015#anker970004_Beteiligung

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build on the requirements of the new curricula and which can be seen as a valuable complementary offer.

The workshop with policy makers, which will take place in 2015 within the frame of work package 2, can link to the new curricular reform. The planned changes in the Educational Plan as well as hindrances and chances by their implementation can be discussed during the upcoming workshop.

Other chances for mascil will open up on the vocational level which will not be covered by the curricular reform. Many vocational schools lost their popularity in society, so that they have to fight for surviving. Consequences are that they are ready to implement many new elements in their teaching practice in order to be more attractive for pupils on the educational market. Another possibility for vocational schools to survive is to transform in Gemeinschaftsschule. This step requires a lot of time and personal resources. The teachers have to be prepared to teach new subjects and to use new tasks. The mascil project in Germany has a unique possibility and challenge to accompany vocational schools by their transformation processes.

Themes 4 and 5: Pre-Service and In-Service teacher training in relation to i) IBL and ii) the world of work

Teacher training in Germany - overall concepts, organisation, structure and teaching methods

Teachers' initial education consists of two phases: 3-5 years at University and 1.5 to 2 years induction phase in schools; compared to other European countries a rather long training phase (Sargent et al. 2013). The length of the phase at the University depends on the school level, in which teachers will teach later in their professional lives (see table below).

Table 1: Description of teacher training in Baden-Württemberg

Track	Institution	Duration	Degree	Admission

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primary	University of Education	8 semesters	State Examination	Upper secondary certificate (Abitur) plus *numerous clausus* (N.C.) in some subjects
lower secondary	University of Education	8 semesters	State Examination	Upper secondary certificate (Abitur) plus N.C. in some subjects
lower secondary	University of Education	8 semesters	State Examination	Upper secondary certificate (Abitur) plus N.C. in some subjects
upper/lower secondary	University of Education	10-13 semesters	State Examination	Upper secondary certificate (Abitur) plus N.C. in some subjects
special education	University of Education	8 semesters	State Examination	Upper secondary certificate (Abitur) plus N.C. in some subjects
vocational training	Full University	depending, up to 13 semesters	State Examination	Upper secondary certificate (Abitur) plus N.C. in some subjects

Teachers for the *Hauptschule* and Primary school go to University for about 3 years and are “generalists”. The focus of their education is on pedagogy, they are expected to teach almost every subject later on. Teachers for the *Gymnasium* receive a higher level scientific education and a lower education in pedagogy and subject-related education. In some universities, there is almost no focus education on didactics, whilst in others it has a high standard. Teacher in Gymnasium are specialists and teach two subjects. The education of teachers for the *Realschule* can be found somewhere in between, but is quite similar to the education for teachers for the *Hauptschule*. Prospective teachers have to pass an exam at university (written and oral exam) and a second one at the end of the induction phase (oral exam and teaching two lessons). Most teachers become civil servants 2 years after the entry into profession (in Western Germany), for which they have to pass a more practical examination (teaching two lessons).

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The figure below shows the teacher training in Baden-Württemberg in its basic structure, according to the different teaching careers, phases, duration, final degrees and practical elements.

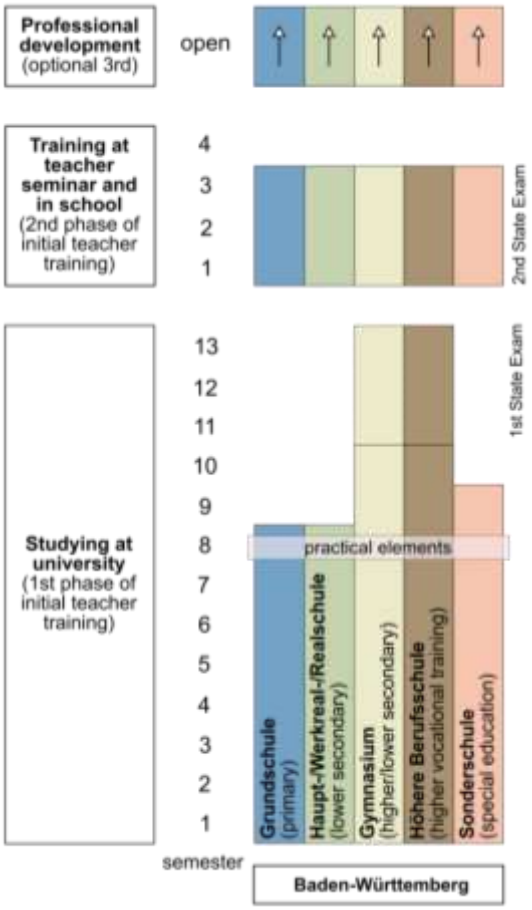

Figure 2: Teacher training in Baden-Württemberg, according to the different teaching careers, phases, duration, final degrees and practical elements, Source: adapted from Bohl/Cramer 2011

The pre-service and initial teacher trainings are compulsory in all Germany. In-service teacher trainings are voluntary in Baden-Württemberg, both in general and in vocational education. However, head teachers have some resources to put pressure on teachers regarding participating (or not participating) in teacher training. Generally, there are no

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incentives for teachers to attend teacher training. The birth-rate in Germany stays still very low[16] and there are many young teachers, who are waiting for a vacancy.

Pre-service teacher training

In the state of Baden-Württemberg, the Universities of Education are responsible for the education of teachers for primary school (Grundschule) and for lower secondary school (Hauptschule and Realschule). The teachers' education for upper secondary school (Gymnasium) takes place at general universities. The professors who teach at universities and at Universities of Education take on responsibility for the training of prospective teachers. Usually, they are academics; therefore the emphasis in their work is put on research and scientific education. Many of them have little experience in didactic and no experience at all in pedagogy

In Germany and especially in Baden-Württemberg there are clearly defined criteria for the selection of prospective teachers. Admission for studying other subjects depends on the grades of the Abitur or on the Vocational Certificate of Education. To study some subjects, like foreign languages or physical education, there are qualifying examinations.

The structure of the pre-service teacher training was described in a detailed way in the first part of this document. In general, it is useful to mention that the differences in the concepts of the pre-service teacher training regarding different school types are due to two main aspects: pedagogy/didactic and subject-specialised knowledge. The higher the targeted educational level of the pre-service teacher is, the more importance the expert knowledge has and the less time remains for pedagogy and didactic.

Pre-service teacher training is both subject- and practice-oriented. On primary level as well as on secondary level, the pre-service training in Germany contains many practice-oriented elements. Before the beginning of the training or in some cases within the first 18 months, each candidate for the teacher profession has to complete 2 weeks of work experience at school. Approximately in the middle of the study a compulsory praxis

16 cf. http://de.statista.com/statistik/daten/studie/235/umfrage/anzahl-der-geburten-seit-1993/

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semester is to be absolved at school. Additionally, 1 year school experience has to be absolved within the 18 months long induction phase. [17]

Usually, the profession-oriented elements do not occur in the day to day teaching. Most prospective teachers do not learn how they can support their pupils in developing their professional lives. Therefore, the linkage between school and the world of work barely exists at all at the pre-service teacher training for the primary and secondary level.
Teaching methods at German universities are in principle very school-like and are dominated by teacher-centred teaching. IBL-oriented teaching occurs more and more, especially at universities of education. Unfortunately, the science-oriented general universities mainly work with traditional methods. However, some structural changes are in progress. The students-centred teaching occurs more and more. Working methods based on teamwork have their fixed place in some type of lessons.

Vocational education

There is no standardised study program for prospective teachers for all vocational schools. The general concept of vocational education is based on two pillars: science with pedagogic and practice. Depending on the taught subject, one of those elements takes more space in the pre-service teacher training and the second one has to be complemented by additional courses. Teachers on the vocational level can be clustered into two groups: scientific teachers and technical teachers. There are different requirements and criteria for the selection for each of these teacher groups. The training of scientific teachers focuses on the scientific knowledge. The training of technical teachers is based on practical knowledge and experience.

The universities and/or the Universities of Education assume responsibility for the pre-service training of scientific teachers. Technical teachers gain their professional experience within their vocational education and their professional lives.

[17] Cf. Berufsziel Lehrerin/Lehrer. Lehramt an Grundschulen. Für Studierende mit einem Studienbeginn ab WS 2011/2012 (2012); Berufsziel Lehrerin/Lehrer. Lehramt an Werkreal-, Haupt- und Realschulen. Für Studierende mit einem Studienbeginn ab WS 2011/2012 (2012); Berufsziel Lehrerin/Lehrer. Lehramt an Gymnasien. Für Studierende mit einem Studienbeginn ab WS 2010/2011 (2012); Berufsziel Lehrerin/Lehrer. Höheres Lehramt an beruflichen Schulen (2012); Berufsziel Lehrerin/Lehrer. Lehramt an Gymnasien. Für Studierende mit einem Studienbeginn ab WS 2010/2011 (2012).

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In the majority of vocational schools in order to become a scientific teacher it is necessary to finish a course of studies similar to the upper secondary education.[18] Additionally, they have to absolve some practical training. One compulsory semester of teaching practice at a vocational school and 3 to 12 months of practical professional experience, depending on other qualifications and grades, are required to gain access to the induction phase of the in-service training. The criteria for the selection of scientific teachers are similar to those for the pre-service training for the upper secondary education. Usually, the candidates for scientific teachers have to possess Abitur. The overall concept of training to become a scientific teacher in Baden-Württemberg consists of two parts: the general education at university and the practical training at a vocational school and in enterprises. These two elements of training are not synchronized with each other. To become a technical teacher a Vocational Certificate of Education as a school certificate is sufficient. However, the long experience on a professional level is an obligatory requirement. In some specific vocational schools a particular school certificate is necessary (e.g. Vocational School for Office Management for technical teachers who want to teach commercial subjects). Additionally, a pedagogical training or in some cases teaching practice which lasts 12 to 24 months has to be absolved on the induction stage. Because the majority of the training for scientific teachers takes place at universities, the teaching methods typical for this institution are relevant as well. The school-like teacher-oriented working methods with some elements of teamwork are typical in pre-service training for the vocational education as well. The linkage to the world of work is not established through the education at universities but is developed within the practical training absolved at enterprises for scientific teachers or by practicing the profession for technical teachers. Many technical teachers are employed in another area at the same time.

[18] cf. http://www.kultusportal-bw.de/site/pbs-bw/get/documents/KULTUS.Dachmandant/KULTUS/kultusportal-bw/pdf/120813%20LA_Beruf_2012.pdf

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Induction phase (after pre-service teacher training at University)

The theoretical training is carried out by the Public Seminary for Pedagogy and Teacher Training. It is an educational institution under the functional supervision of the Ministry of Culture, Youth and Sport in Baden-Württemberg. The Regional Council located in Freiburg has an administrative supervision for seminaries. The Public Seminaries for Pedagogy and Teacher Training build some kind of bridge between science – represented by universities and practice – represented by schools. The employees of the seminaries are teachers with long time teaching experience who passed the second public exam with distinction and were selected in the course of the public application procedure. (cf. Stellenausschreibungen 2013) The schools, where new teachers absolve the practical part of the training, assume partial responsibility for the teacher training on the induction stage. Every young teacher is supervised by one or two mentors. Teachers who want to guide young colleagues within their induction stage can apply for this post at seminaries. To carry out this activity they have to absolve some particular advance trainings. Teachers who successfully complete the pre-service teacher training can apply for a post at the initial in-service teacher training. The final grad of the pre-service training and passed aptitude test are significant for the distribution of vacancies of in-service training. Additionally, the individual family circumstances play an important role with the teachers' allocation to schools.

The teacher training on the induction stage lasts 18 months and is split into two-parts. The first part always starts at the beginning of the year (depending on the type of school in January or in February) and lasts until the beginning of the school summer holidays. The practical part of the training takes place at the schools the new teachers are associated with. Young teachers become acquainted with schools' roles and atmosphere. They learn how a school is organized and which obligations are linked with the teacher profession. In this phase of the training they are obligated to observe lessons conducted by other teachers and to prepare and conduct about 10-11 lessons per week by themselves but their work is still controlled by their mentors. The teachers gain insights into the theoretical background at sessions organized by the Public Seminaries for Pedagogy and Teacher Training. There they have to attend some lectures and trainings concerning pedagogy, didactics, school legislation, etc.

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The second part of the training takes one year and consists of the theoretical part based at the seminary and the practical part located at school as well. In comparison to the first part of the training the new teachers teach about 12-13 lessons per week independently and take full responsibility for them. They continue their education at the seminaries. They have to absolve some projects concerning the distribution of teaching contents and planning of lessons. In some types of school (Hauptschule, Grundschule, Realschule) a presentation at the pedagogical colloquium and a demonstration lesson within a didactic colloquium have to be performed. At the end of the training the second state examination has to be passed.

The main aim of the initial teacher training is to prepare teachers for teaching activities. During training new teachers learn how to plan and conduct lessons, how to distribute teaching contents for the whole semester and which knowledge should be transferred and how. They learn theoretical basics regarding e.g. pedagogy, didactic or school legislation, needed by the teacher profession. The connection to the world of work is a topic which is not addressed during the initial in-service training. The new teachers do not have contact to the representatives of the professional work. There are no meetings or workshops organized with representatives of diverse professions. The institutional support for any activities connecting school with the world of work is missing. The teachers in the induction stage do not gain experiences about collaborations with enterprises and other educational or cultural institutions.

The theoretical part of the initial teacher training is largely based on the traditional, teacher-centred teaching culture. In some subjects like pedagogy, some elements of project work (teamwork, presentation of the results) occur. The teaching methods used during the practical part of the training strongly depend on the common teaching practice at school where the training takes place. The new teachers gain insights into the teaching methods of their experienced colleagues and often implement some interesting elements into their own teaching style. In schools which are open to new teaching forms young teachers can have a more diverse teaching experience than in schools which only work by means of traditional teaching methods.

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Vocational education

There is not just one design of initial in-service teacher training for vocational education. The initial training for scientific teachers is similar to the initial training for Gymnasium teachers. The new teachers have to complete theoretical training (didactics, school legislation and complementary lectures) at a seminary specialized in vocational education and practical training at a vocational school. At the end of the induction stage the young teachers have to pass several exams (similar to those for teachers for general education).

In Baden-Württemberg there are many possibilities to complete the initial in-service training for technical teachers. The reason for it is the diversity of the possible paths which lead to this profession. The initial in-service training is tailored to them. For young technical teachers who completed the Realschule, have a certificate of a vocational training and at least two years of professional experience, the 18 months long teacher training is compulsory. Similar to the initial training for general education, the training is split into two parts. However, the first part takes two half-years at school. The theoretical part takes place at a Public Seminary for Pedagogy and Teacher Training and involves sessions concerning e.g. pedagogy, psychology and psychology of profession, school legislation, employment law, rights of parents and other complementary subjects. The observation of other teachers' lessons happens at vocational schools. The second part of the training lasts one and a half years and includes exams about e.g. pedagogy, psychology, school legislation, employment law and the rights of children supervised by the Public Seminary for Pedagogy and Teacher Training and autonomous teaching of 12-14 lessons per week at a vocational school.

The new technical teachers who possess a master certificate and have at least two years practical experience need to absolve only the pedagogical training in order to get access to the teacher profession. The pedagogical training takes one year and is extra occupational. Teachers have to attend some sessions (pedagogy, psychology and school legislation) at the Public Seminary for Pedagogy and Teacher Training and teach the practical exercises in one class. At the end of the training, two oral exams have to be passed.

There are some more possibilities for lateral entrants. The structure and contents of the initial training stay the same (practical and theoretical part). The length of the training

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varies depending on the previous professional experience of the applicant. However, it has to be at least 2-3 years of training. Vocational teachers have more work experience than teachers on the level of general education. Many of them still work in the professions that they teach at school. Therefore, it is easier for them to establish a connection to the world of work. However, there is no institutional support for the linkage of the world of work with school. At the initial training the vocational teachers do not learn how they can effectively apply their professional experience in their teaching in order to better prepare pupils for their professional life. At the initial training the focus is put on teaching practice and the gain of the missing skills of a teacher. The connection to the world of work seems to be self-evident because of the long-term professional experience of the vocational teachers. Within the initial training they don't get any support to implement their further professional experience into their teacher profession. In the theoretical part of the training the common teaching methods are school-like. The class activities are still teacher-centred and tasks are predominantly closed. At the practical part of the training the new teachers have many opportunities to watch the teaching methods used by their experienced colleagues. It can be assumed that many new teachers will borrow some elements of the teaching methods and styles from them. Some vocational schools use innovative teaching methods like blended learning. These give the new teachers more space for autonomous learning.[19] They have the possibility to test new teaching methods and to gain new learning experiences by themselves. This can serve as new inspiration regarding teaching methods for their future teaching.

In-service teacher training

There is a wide range of training offers for teachers. The aim of the in-service teacher training is to support teachers with their professional work. In Baden-Württemberg teachers have a chance to influence topics and the structure of the offered teacher training.[20] The planning groups that are comprised of several teacher representatives have a possibility to make course suggestions to some institutions responsible for in-service teacher training.

[19] cf. http://www.seminare-bw.de/site/pbs-bw/get/documents/KULTUS.Dachmandant/KULTUS/Seminare/seminar-karlsru he-bs/pdf/sembska_Organisation-PS-2007-08-30.pdf

[20] cf. http://www.rp-freiburg.de/servlet/PB/menu/1207402/index.html

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Those institutions responsible for teacher training try to react to teachers' needs regarding professional development and to adjust their offered training program. They witness the changes and processes conducted in the school environment and actively react on them. However, in order to effectively help teachers with their professional development constant communication between responsible institutions and teachers is necessary. Currently, teachers are informed per email about training offers. Information that they receive this way is not sorted or classified. Teachers themselves carry the responsibility for their professional development. They have to find appropriate offers and register on their own. Training offers from both public and private providers exist on the market of teacher training in Baden-Württemberg. Teachers do not have to pay for participation in courses offered by public providers. The costs for other courses have to be paid by teachers themselves or can be assumed by the school.
21 school boards (Schulamt), 4 regional councils (Regierungspräsidium) and 5 public institutions specialized in teacher training belong to the authorized public providers in Baden-Württemberg. All these institutions are delegated by the Ministry of Culture, Youth and Sport in Baden-Württemberg.[21]Additionally, other institutions (e.g. universities) can offer teacher training. However, they work independently and if they want, they can try to get political support from one of the authorized public providers. The lengths of in-service teacher trainings are very different. Most of the courses take only half a day or a day, but there are also trainings that last about 2-3 days and other offers that are built as a sequence of several meetings. Some regularity can be found in the structure of the offer by some providers. There is for example a public provider that offers only two and half day long courses.

The range of teacher training in Baden-Württemberg is very plentiful and diverse. It is possible to find a teacher training about almost every subject. The evaluation of existing offers regarding teacher training in Baden-Württemberg has already been conducted by the project "EvaluNa" located at the University of Education in Freiburg. The first project's results give a summary of the topics of teacher training in Baden-Württemberg. Most teacher trainings were about lesson-related topics (almost 65% of all courses), more than 20 % of all teacher trainings concerned the atmosphere in the classroom or at school. The training courses regarding school management and professionalism of teachers are

[21] cf. http://www.schulaemter-bw.de/,Lde/Lehrkraeftefortbildung

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6,6% each and only 1,1% of all trainings concerned partnerships at school and between schools.

Graph 2: Categories of evaluated teacher trainings[22]

There are no professional development courses about IBL explicitly. However, it is not difficult to find trainings both for general and vocational education that concern IBL-related topics.[23] Training courses about cooperation and teamwork, problem solving, conducting of experiments or pupil-centred lessons exist at the training market. It is possible as well to attend courses concerning the development of diverse pupils' competences, conducting project- or portfolio-work or the creative performing of lessons.

A connection to the world of work is not common during those teacher training courses. There are really few offers where teachers can experience something about some branches of the professional world.[24] From time to time, teacher training is organized with cooperation of a company, where teachers can gain an insight into the work in enterprises and, together with some employees; they can create a project, which they will conduct with their pupils at school.

The teacher training opens more and more for new teaching methods. The majority of in-service teacher training have a traditional structure (teacher-centred, couple of hours lasting meetings). There are more and more offers that suit the structure of teachers' life. A lot of online trainings are offered, especially by public providers which offer training for teachers from all Germany. The in-service trainings in Baden-Württemberg are often in

22 Source: https://www.ph-freiburg.de/berufs-und-wirtschaftspaedagogik/projekt-evaluna-lfbw/erste-ergebnisse-der-laengs schnittstudie.html

23 cf. http://www.rp-freiburg.de/servlet/PB/show/1332620/Fobi_OES_SE_2011_2012.pdf

24 cf. http://www.rp-freiburg.de/servlet/PB/show/1341896/RPF77-Anschreiben-WIPP-L-2013.pdf

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form of a seminar, where teachers can cooperate in groups. There are courses as well that last several days and where teachers work by means of mixed methods – online, teamwork, individual, IBL or teacher-centred.

Vocational teachers can attend trainings prepared for teachers from general education. However, in some institutions responsible for teacher training there are special departments competent to prepare professional development offers for vocational teachers. These institutions strongly collaborate with representatives of vocational schools.[25]

In general, the pre-service and initial teacher trainings are under strict control of public facilities. By contrast, the in-service teacher training is not submitted to any firm frame. This duality reflects the general shared perception of teacher training in society. It is generally thought that the teachers' apprenticeship ends after the induction stage and that there is no need to attend any in-service teacher trainings. Because of the specific structure of teachers' apprenticeship in Germany we don't distinguish between pre-service and in-service teacher training. The location of the divide depends on social or formal criteria. The position of the induction phase in this structure is very important and ambiguous. The initial teacher training belongs to teachers' professional development, because people who participate in them are obligated to teach independently and to assume the responsibility for their activities at school. In social perception, people who are in the induction stage of teacher training are still not teachers. The formal regulations, which make almost automatically all teachers working in the public sector to civil servants, contribute to the fastening of this generally shared opinion. Below we will analyze the structure of German teacher training in general with distinctions concerning pre-service teacher training, induction phase and in-service teacher training if needed.

Policy priorities for teacher training

In Baden-Württemberg, except for teacher training on the induction stage (see below), there are almost no policy recommendations regarding in-service teacher training both for general and vocational education. Teachers' duties are listed in the document "Berufsziel Lehrerin/Lehrer. Lehrkräfteausbildung in Baden-Württemberg." (Professional aim: teacher. Teacher training in Baden-Württemberg) which can be treated as the policy

[25] cf. http://www.rp-freiburg.de/servlet/PB/menu/1207402/index.html

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perspective on the teacher profession. Development of professional competences through participation in in-service teacher training belongs to one of them.[26]Apart from that, the issues of teacher training do not occur in any policy documents or papers.
The role of a teacher is detailed descripted in this policy document. Additionally, there are separate documents "Berufsziel Lehrerin/Lehrer" for teacher of every educational level, where they can find detailed descriptions of requirements related to their work.[27] The policy priorities illustrated in this part relate to all those policy documents.
Teachers in Germany are seen as professional people for learning, teaching and organisation of lessons. They are responsible for the transmission of knowledge and for the general education. They have to plan and organize learning processes, raise pupils' interest for learning and support their individual abilities/talents. In cooperation with non-school partners, they should ensure the development of the personality of single pupils. Sense of fairness, assuming the responsibility and management of conflicts belong to the necessary skills that teachers have to bring with them to their profession. Additionally, teachers have to demonstrate the willingness to their own further education. Regarding the teaching methods, teachers should be able to work by means of projects and to connect several subjects. More and more emphasis is put on team work. There are some specific abilities which teachers have to possess on different educational levels.

Teachers of the primary level have a widespread educational mission. The transmission of knowledge is still very important, although other principals slide into the foreground.[28]Elementary learning strategies have to be taught and basic social values have to be transmitted. This happens with a close cooperation with parents. The educational teachers' mission in primary schools is reflected in the second assessment, that pedagogic and didactic are part of.

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[26] cf. http://www.kultusportal-bw.de/site/pbs-bw/get/documents/KULTUS.Dachmandant/KULTUS/kultusportal-bw/pdf/120813%20Berufsziel%20L%2BL-Lehrkrfteausbildung.pdf

[27] Cf. Berufsziel Lehrerin/Lehrer. Lehramt an Grundschulen. Für Studierende mit einem Studienbeginn ab WS 2011/2012 (2012); Berufsziel Lehrerin/Lehrer. Lehramt an Werkreal-, Haupt- und Realschulen. Für Studierende mit einem Studienbeginn ab WS 2011/2012 (2012); Berufsziel Lehrerin/Lehrer. Lehramt an Gymnasien. Für Studierende mit einem Studienbeginn ab WS 2010/2011 (2012); Berufsziel Lehrerin/Lehrer. Höheres Lehramt an beruflichen Schulen (2012); Berufsziel Lehrerin/Lehrer. Lehramt an Gymnasien. Für Studierende mit einem Studienbeginn ab WS 2010/2011 (2012).

[28] cf. http://www.kultusportal-bw.de/site/pbs-bw/get/documents/KULTUS.Dachmandant/KULTUS/kultusportal-bw/pdf/120813%20LA_GS.pdf

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In the specific schools on the lower secondary level (Hauptschule, Realschule, Werkrealschule) the following important three teachers' functions can be specified: transmission of knowledge, preparation of pupils for professional life and developing the processes of autonomous learning.[29]Teachers and schools on this educational level in general should be some kind of mediators between parents, pupils and the world of work. A strong focus is put on the transmission of knowledge. The pedagogical factors become less important, which the second assessment without didactic reflects.
On the upper secondary level the focus is put almost just on the transmission of knowledge.[30] Teachers are experts regarding the teaching subjects. The linkage to the world of work isnot mentioned even once in the policy documents. There are no assessments in didactic and pedagogy in the training plan for those teachers.
The short analysis of study plans demonstrates policy priorities regarding the prospective teachers training. On the primary and lower secondary level there are quite a lot of pedagogic or didactic sessions. The study plans for prospective teachers for the upper secondary level focus on subject-oriented sessions which aim is the transmission of knowledge. With most subjects there are no recommendations regarding the teaching process. Some specific teaching methods (like experiments) are suggested in the curricula in such subjects like physics or chemistry.

The preparation for the professional life seems to be very important to the vocational education.[31] Here the policy prioritises the acquisition of key competences and specific knowledge needed in each profession. Teachers in vocational education are responsible for the organisation of learning processes, for the support of the development of pupils' personalities and their social competences. Lessons should be created pupil-oriented with emphasis on teamwork. One of the teachers' roles is still to transmit knowledge but the priority of this role is lower than in the past.

[29] cf. http://www.kultusportal-bw.de/site/pbs-bw/get/documents/KULTUS.Dachmandant/KULTUS/kultusportal-bw/pdf/120813%20LA_WHRS.pdf

[30] cf. http://www.kultusportal-bw.de/site/pbs-bw/get/documents/KULTUS.Dachmandant/KULTUS/kultusportal-bw/pdf/120813%20Berufsziel-L-Gym2.pdf

[31] See Berufsziel Lehrerin/Lehrer. Höheres Lehramt an beruflichen Schulen (2012) and Berufsziel Lehrerin/Lehrer an beruflichen Schulen. Ausbildung – Aufgaben – Perspektiven.

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Policy priorities for the induction phase

The induction stage of the in-service training is very important in German teachers' profession at least on the level of general education. There are many policy documents[32] that we refer to and which describe in a very detailed way the aims and standards of the training and competences that have to be acquired.

The main aim of the initial training is to learn how to transfer knowledge to pupils and teach the competences and contents contained in the curricula. The new teachers should learn to implement their skills acquired at university (or University of Education) in practice. (cf. GHPO II) The development of the teacher (profession) personality and responsibility is a substantial training purpose as well.[33]The further pedagogical and didactical education is also an important training element. The initial training, similar to curricula, has to be competence-oriented. Implementation of the educational standards, using new media, planning a lesson and creating learn processes belong to the most important competences which should be gained by teachers (cf. http://www.seminare-bw.de/,Lde/819810). The new teacher should know methods to make pupils become active and to open lessons for external support. The current subjects should be processed and the education should build on the present knowledge of pupils.
By contrast, the policy priorities concerning the induction stage for the training of vocational teachers are rather sparse. The implementation of experiences, knowledge and competences that are acquired within the study is the main aim of the training. Similar to the general education, the development of the teacher personality and pedagogical competences is substantial as well. (cf. APrObSchhD and/or APrOTL) To address professional ethical questions is an important element of the initial training.

[32] Verordnung des Kultusministeriums über den Vorbereitungsdienst und die Zweite Staatsprüfung für das Lehramt an Grund-, Haupt- und Werkrealschulen (GHPO II). Vom 9.März 2007; Grundlegende Informationen zu den Ausbildungsstandards; Effektiv. Informationen und Hilfen zum Vorbereitungsdienst.; Ausbildungsstandards der Staatlichen Seminare für Didaktik und Lehrerbildung (Grundschulen, Werkrealschulen und Hauptschulen); Mathematik.; Ausbildungsstandards der Staatlichen Seminare für Didaktik und Lehrerbildung (Grundschulen, Werkrealschulen und Hauptschulen); Physik.; Ausbildungsstandards der Staatlichen Seminare für Didaktik und Lehrerbildung (Grundschulen, Werkrealschulen und Hauptschulen); Biologie.

[33] cf. http://www.bildung-und-erziehung-vbe.de/wp-content/uploads/2012/11/VBE_Referendariat_Endfassung2012.pdf

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Teachers' voice – in-service teachers' beliefs, attitudes, motivation and interest in professional development and regarding IBL and the world of work

Individual and group interviews were conducted with teachers from diverse school types in order to gain insight into teachers' motivation and beliefs concerning in-service teacher training and their attitude towards IBL and towards the world of work (in June and July 2013)

Teachers' attitude and beliefs towards inquiry-based learning

All interviewed teachers know what inquiry-based learning is and what it means to teach with IBL. However, it is very interesting what teachers understand under IBL. According to interviewed teachers, three main aspects belong to the IBL repertoire: group work, open tasks and everyday life related activities. Some of them received a lot of information about IBL during their pre-service teacher training, others during the training at the induction stage. Few tried to find more information about open tasks online. Among the interviewed group of teachers there are diverse experiences concerning using IBL at schools. In some schools IBL seems to be an often practised method, in others teacher-centred lessons are to the fore. All of the interviewed teachers estimate IBL very positively.

A discrepancy between the young teachers' opinion and the point of view of teachers with many years of experience can be observed. Teachers in the induction stage admit, that they "try to implement" (Interview Nr. 3) IBL in their lessons but it is difficult because of many hindrances. By contrast, the experienced teachers mention that IBL has its place in classrooms, but they often speak about how the classroom reality should be and what is wanted and not about their own practices.

> *"Student-centred teaching is always there. There little whole-class teaching [at school]. I like to have a teacher presentation somewhere in the lesson. (…) Quite often we get classroom observations. (…) You could never dare to show whole-class teaching there. (…) It is expected that you offer something student-centred, that you work student-centred and the further away it is from the teacher the better." (Interview No. 6)*

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Pre-service teachers often have the impression that they “haven't done anything but IBL during their studies” (Interview No.1) Even though the same teachers, as well as the teachers in initial training, point to traditional teaching methods, if they are asked about teaching methods used within the apprenticeship. In consequence, due to IBL being everywhere - in curricula as recommendations, in teaching plans and from time to time in classrooms - teachers feel that they have something in common with IBL, even if they don’t practice it.

Teachers name many advantages in using IBL for teaching. They also point out hindrances in using IBL and mention the requirements necessary for successful lessons with IBL elements.

First of all, teachers believe that IBL lessons are very motivating for pupils. To investigate and to try autonomously to find solutions for a problem are the incentives per se for pupils. The main teachers’ role in IBL lessons is to arouse pupils’ interest and curiosity. “For children with ambition […] it is the best method of learning.” (Interview No.5)

> *“I believe, it is very motivating. That the inquiry-based teaching is one of the most motivating one, that they [pupils] are addressed directly [..] and are motivated on their own to get a solution. I will try that [IBL lessons] again and again und try my hardest because I know that they will put their heart in it, all of them.“ (Interview No. 2)*

To raise pupils‘ learning motivation it can be helpful to set up a connection between taught topics and the real world. Sometimes pupils lose sight of the importance of some subjects. They have no passion and pleasure in learning anymore because they don’t know for which professions their knowledge could be used in the future. They have a feeling of senselessness of the learning processes. IBL lessons with appropriate materials establish a link between learning contents and the real world and give pupils the pleasure of learning back.

> *“Very often students don't understand why they actually have to learn something, especially if it is everyday phenomena or problems, then suddenly they understand why they need maths. (Interview No. 3)*

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Secondly, the interviewed teachers are very convinced that IBL lessons have a positive influence on pupils' learning performance. Pupils' independent preoccupation with a learning topic has an effect on the absorption of the knowledge. The more time pupils occupy themselves with a topic, the more knowledge they gain.

> *„If the students look and solve by themselves, they retain it better, because they have worked for it and not put in front of them." (Interview No. 6)*

Thirdly, IBL offers a great possibility to learn from mistakes. It is a competence that is very important, not only in the pupils' future professional life but also in the everyday life of every person. "To learn from mistakes, they [pupils] will do it for their whole life." (Interview No. 5) Additionally, a range of social competences is adapted during IBL lessons. Pupils learn to "work together, to share knowledge and to help each other". (Interview No.6) Pupils' creativity is strongly developed by IBL lessons as well. .

> *„[In IBL] you have a sense of achievement, you have components from social learning there because often with such [IBL] stories you have to work with someone. Those are all things which, later on, will be important in their professional life too. Many things happen incidentally, with such a learning method." (Interview No. 5)*

The interviewed teachers indicate that a successful IBL lesson is not always possible. In their opinion some topics can be taught better by means of traditional teacher-centred methods. Teachers also mention two pupil-related demands, which are necessary to conduct an IBL lesson. Above all, pupils have to be used to work with IBL. At best, they should learn and practice IBL already at primary school. They have to take the IBL lesson seriously and should be conscious that some knowledge or skills have to be acquired at the end of the lesson. A good learning culture is required from pupils at an IBL lesson.
Additionally, pupils need to take interest in something. The more topics pupils find fascinating the easier it is to perform an IBL lesson. It is almost impossible to conduct a successful IBL lesson if the teacher cannot make a linkage between the lessons, topic and pupils' interest. This case often occurs with pupils who display behavioural problems. If teachers want to get the attention of such pupils, they can face ethical conflicts.

> *If I do pure school-oriented lessons relating to everyday life, then it would be best if I choose such topics like 'the best way to pick bikes' (…) it's a difficult balance. (…) I work a lot with young people who really aren't interested, especially not in normal*

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stuff. They know really few things that happen in their milieu. (…) With kids where the main hobby is to chill, it's difficult [with IBL]." (Interview No.5)

Almost all interviewed teachers claim that there are many available offers concerning teaching with IBL or some IBL elements. Only one teacher, who is currently doing his in-service training at the induction stage, hasn't seen such courses with IBL elements yet. However, teachers are still interested in IBL training.) There is less need for training concerning general aspects of IBL. Interviewed teachers wish for IBL training regarding concrete subjects not only in the field of mathematics or science but also in other fields like teaching foreign languages.

"Training concerning concrete topics would be interesting. You always need new ideas." (Interview No.5)

Neither the pre-service teachers nor the professional teachers have ever encountered materials related to the world of work. Although teachers know a lot of teaching resources related to IBL, they admit that there is still a need for more tasks and other teaching materials. They complain that there is not enough time to prepare each lesson from scratch.

Connection to the world of work at schools

All interviewed teachers mention that "it is very important that pupils gain professional competences at school" (Interview No.1). Almost all of them have some professional experiences in other fields than teaching, which they value as really helpful at their current profession. To know how it is to work, what bad, exhausting or boring work means, can change pupils' way of looking at professional life.

The teachers' point of view regarding more connection between school and the world of work varies and depends on the type of school where they teach. Teachers from Realschule have the impression that there are enough elements from professional life at school and that pupils gain enough insights into diverse professions.

A different opinion is shared by teachers who work at a Gymnasium. As far as they can see, there is a great need for more work-oriented activities. After the latest educational

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reform[34] 18-year old pupils leave the Gymnasium. The majority of pupils don't know at all what they want to do when they leave school. The common practice is to travel abroad for a longer time. More support at realizing the future profession or at least to become aware of possessed competences and of possibilities to use them is needed at secondary school level.

Even though, teachers from Gymnasium have no idea what could be done to give pupils more support concerning professional orientation. The filled to capacity curricula and overwork of pupils are considered the main hindrances for introducing more professional elements.

Pre-service teachers, especially those who do not have experiences from a vocational education, have diametrically different opinions about the role of general schools for the professional orientation of pupils.

> *"General schools should rather establish general knowledge and general competences. (…) To refer even more [than now] to professions is not the aim of a general school." (Interview No. 1)*

It is very interesting to see how the teachers' perception is related to the role of school in establishing a connection to the world of work. Not a single one of the interviewed teachers came up with the idea to provide more professional orientation by means of appropriate tasks. The following quote reflects distinctly the shared understanding of professional orientation at schools.

> *"It's already included with this BOS35. They have to do an internship. (…) Year 9 presents the professions they visited in the internships, in the way of a market place and a presentation, and the next year the new year 9 does an internship again and presents it to the year 8. They deal a lot with that profession. And they try it again and again, because of the curriculum, to integrate it in subjects. (...) So some business representatives come, (…) and of course the career counselling from the employment agency or pupils go to the employment agency and inform themselves. They get a thick brochure which includes all professions. (...) Here they try to do it*

34 An educational reform that covered almost all „Länder" and introduced the reduction of the school time in Gymnasiums from 9 to 8 years. In Baden-Württemberg the reform came into effect in 2012.

35 BOS stands for „Berufliche Oberschule", a type of vocational school.

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> *in profile weeks. That are 3 weeks in the school year without lessons and where specific fields are addressed. (…) For example, how to behave during an interview, how to make a call because of an internship, how to present themselves, (…) what to write in a CV. It's a very important field, but it's not everything. I would leave it at that." (Interview No. 3)*

Teachers stress as well how important it is to establish a connection between the taught subject and real life. This can be supported through the cooperation with external facilities. Class excursions into diverse cultural institutions can emphasize the significance for many school topics to pupils. In this way, they can also get to know new facilities and gain new experiences. Many teachers mention, that there is no institutional support in establishing cooperation with non-of-school facilities. Usually, all ideas for out-of-school lessons are initiated by teachers.

Teachers' attitude towards professional development - reasons for and against participating in teacher training

The teachers we interviewed have a positive attitude towards professional development. All of them admitted that teacher training is an important element of the teacher profession. Interviewed teachers named some reasons, why they attend professional development courses. First of all, they hope to get some new ideas for lessons. Sometimes new topics have to be implemented or teachers would like to make some changes in their lessons. They look for new tasks or new methods, for something that makes the old lesson more interesting. They expect that some new contents or methods will be presented and discussed in detail.

> *„I go to a training course because I want to learn something. I expect that there are people who know more than I and who impart this knowledge to me." (Interview No. 6)*

Some teachers believe that the knowledge that they receive during study and the in-service teacher training at the induction stage is not enough to practice the teacher profession.

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Development of their own interests is the third big reason for participating in teacher training. Teachers would like to intensify their knowledge about topics they take an interest in.

The possibility for cooperation with other teachers is a feature of teacher training which cannot be clearly associated as an advantage or disadvantage of professional development. Some people perceive the opportunity for exchange as a chance. By contrast, there is a group of teachers that thinks of it as redundant or even annoying.
Although teachers see a lot of advantages that result from teacher training, they attend only rarely in professional development. Some serious hindrances are named by teachers. The most important impediment is time limitation. The curriculum is brimming with contents and there is no free space for additional topics or events. Teachers need a lot of time to prepare tasks and lessons. Additionally, they are obliged to assume other important roles and to do other jobs.

> *"A teacher is showered with tasks which have nothing to do with teaching, e.g. school development (…), new assessment systems, new competence grids. All of them kill time, that hasn't got anything to do with teaching." (Interview No.3)*

Limited time is a very important factor for teachers at induction stage. They feel overloaded with the work at school and in seminars. Additionally, they need more time to prepare lessons than teachers that have years of experience. There is no time left for additional training.

The school environment plays an important but not definite (categorical) role for teachers' participating in training. Teachers need to get permission from the head teacher if they will miss their lessons. In schools where the attendance in professional development is required and expected it is easier to get permission.

Usually, schools are interested in professional development and try to encourage teachers to participate in teacher training. Some schools go one step further and oblige their teachers to continue their education.

> *„Because to that training one of us, a history colleague, had to [go]." (Interview No.6)*

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The family circumstances were mentioned as being very important regarding the length of the professional development, at least for teachers who are parents. The organisational problems, which result from the participation in teacher trainings which last longer than one day, are so big that these trainings are out of the question for teachers with children.

> *„ [training] with overnight stay, over a couple of days are difficult, I think, if you have children. Then it is difficult to organize it.“ (Interview No. 2)*

Summary

Analysis of the regional landscape of the in-service teacher training and the statements of the interviewed teachers let us determine diverse implications for the upcoming mascil professional development offers. IBL is a teaching method that becomes more and more popular and required at schools. Although “most teachers don't really know what possibilities exist” (Interview No5) and they do not use it. However, the common shared perception that IBL is present at schools and at teacher apprenticeships, can be a big hindrance for mascil teacher training. Some teachers could think that there is no need for training related to IBL if IBL is already a part of teaching culture.

The in-service teacher trainings in Baden-Württemberg are voluntary. Teachers themselves and head teachers decide which training they would like to attend. It is a great opportunity for the mascil project, which can win participants over by means of a high quality of training, requested topics and specific publicity.

Schools have quite a big interest in professional development offers for their teachers. Head teachers want to keep up with the news on diverse didactical and methodical fields, so they want representatives of their teachers to participate in in-service training. There are still not enough materials about IBL and “no materials at all for work-oriented lessons.” (Interview No. 5) Teachers look incessantly for new ideas for their lessons. There is an opportunity for the mascil project to offer training by means of interesting teaching methods with a focus on work-oriented IBL tasks.

The positive perception of the fulfilled work-oriented function of the Realschule as seen by her teachers can be a hindrance for their participation in mascil teacher training. There is reason to fear that teachers, who do not wish more scholastic support with professional

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orientation, will not be interested in professional development in relation to the world of work.

But there is still much work to do for mascil related to the world of work. Teachers' perception of pupils' professional orientation at schools is very simplified and incomplete. Teachers associate school connection to the world of work with visiting enterprises or with technical preparations to the career entry (CV writing, doing job interviews etc.) They are not aware that they can give pupils a better understanding of the world of work by means of tasks. mascil can try to change teachers' perception how the connection between schools and the world of work should look like.

Overwork and lack of time are permanent companions of a teacher in the induction stage. The in-service training for those teachers is compulsory and very extensive. There is barely space for additional training in relation to this target group. Lack of time is a big hindrance for experienced teachers to participate in professional development as well. Therefore, a big challenge for mascil occurs to win teachers for its training, although they have no time for participation.

One of the main hindrances for promoting IBL at schools is the overload of work for pupils. The pupil-centred teaching method shifts almost the whole work to pupils. They have more and more events to attend and contents and competences to acquire. It can be a great hindrance for the implementation of mascil purposes.
The phenomena of "passing the buck" can be observed in the group of the interviewed teachers. They often suggest that some duties should be done earlier or later. The acquiring of professional competences can occur after the general education, but the practice of group work can take place earlier e.g. on primary education. [36] To overcome teachers' tendency to shift the responsibility to other persons or institutions can be a challenge for mascil. Without teachers' awareness concerning the implementation of IBL, to win participants for the mascil teacher training will be very difficult.

[36] Interviewees stated that: „They have to start practicing early. If they don't practice it from year 5-6 onwards, that they work independently, then it won't work." (Interview No.5) or "General education as the prime aim is crucial, vocational matters come later on, in vocational training." (Interview No.4)

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mascil concept of in-service teacher training

Our target group are experienced teachers from all school types and educational level. Teachers in the induction stage are welcome as well but due to a lack of time and high workload they are not targeted.

In Germany there is a strong group affiliation among teachers from the Gymnasium. In consequence, they distance themselves from teachers who work in other types of school. Additionally, our teacher training will be supervised by a University of Education, which does not have enough authority from the teachers from secondary level point of view. Therefore, we are convinced that addressing our professional development courses aimed to teachers from Berufsschulen, Realschulen and Gemeinschaftsschulen lets us utilize the available resources in an optimal way.

Naturally, we will not exclude Gymnasium teachers. We will be happy to welcome them at some of our courses addressed to teachers from all types of school.
The basics for the mascil concept of in-service teacher training arose from formal and informal dialogues with teachers from different types of schools. In the draft of the training we try to react on the teachers needs and to integrate all wanted elements. In the conception phase of the training preparation we cooperate with several vocational teachers, with a Regional Council in Freiburg, which is one of the public providers of teacher training and with a big regional enterprise. In this way we would like to ensure that we meet teachers' needs. Our professional development concept is strongly open and task-oriented. Not only acquisition of knowledge and new skills but also new IBL tasks from the world of work should be the output of our teacher training. mascil teacher training will be based on scholastic topics as well. Teachers who will participate in mascil training will find support and new ideas needed for their lessons. Additionally, the majority of the mascil trainings will be based on the theoretical approach of long-term professional development.

We are in the process of developing three concepts of professional development. Each of them is on another level of preparation. The short description of every concept is provided below.

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Linking teachers from general education and vocational education

The first one, based on long-term professional development approach, was developed especially for vocational teachers, who teach mathematics although they aren't trained for it. The participation of teachers from Realschulen, Hauptschulen and Gemeinschaftsschulen is expected as well. We will pilot this concept with vocational teachers who educate future butchers and bakers and teachers from the *Hauptschule*, as the mathematical level seems to be similar.

The planned training will seize concrete topics taught at vocational schools. The whole training will be composed of three whole training days counted as the phases of theoretical input and reflection and long implementation phases (about 3 months) between meeting days.

The professional development course will be prepared by three preliminary working meetings with vocational teachers from the professional area mentioned above. There is a strong willingness for implementing IBL in classrooms on the side of vocational teachers because they consider the traditional teacher-centred teaching methods as less effective and seek for new ways of teaching. The meetings will allow teachers from different school to exchange their experiences. They will further work on aspects of inquiry-based learning, on topics of mathematics education (fractures, percentages), get introductions into the world of butchers and bakers and will work collaboratively on IBL tasks situated in the world of bakers and butchers for use in both general and vocational schools. In addition, a professional development course only for vocational teachers will be offered. This training will last 3 consecutive days. The aim of the training is first to learn how to produce good IBL tasks and to develop some kind of task-sets as a basis for mathematics lessons at vocational education. Second, they will learn how to use these tasks in an IBL-way. It is to be expected, that the cooperation with the vocational work group will continue and that further teacher trainings will be the result.

Linking general education and enterprises

The second concept of training is designed for dedicated teachers from all types of secondary school. We aim to reach some PRIMAS multipliers and other teachers, who want to gain insights into how to connect mathematics and science education to the requirements in an enterprise. The training is planned for 3 whole days and aims to create tasks, which refer to the world of work. The detailed draft will be set up in autumn 2013

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during the meeting with the representatives of the enterprise SSS Siedle. We would like to offer a type of teacher training which is missing in Baden-Württemberg and which gives teachers an opportunity to learn about the way of work in an enterprise. The process of preparation of tasks from the world of work should be initiated. Tasks connected to the world of work and new ideas for IBL lessons are expected outputs of the training. Further cooperation with the SSS Siedle is mutually desired.

The third planned professional development will address teachers from all educational levels. Experiences gained by the first two concepts should be used for getting through to a bigger group of teachers. We would like to react to teachers' wishes [37]and offer multi-days training with subject-oriented lectures and workshops. This preliminary draft of teacher training has to be further developed through discussions with regional stakeholders and the international consortium. This concept can still change.

PART 2: EMERGING ISSUES FOR REFLECTION

The aim of Part 2 is to raise and reflect on issues that emerged as crucial in the previous discussion. In a more synthetic form, it addresses the links and interrelations between the themes discussed in Part 1 of this report. By doing so, it emphasizes issues related to promoting equity– in particular, gender- and ethnicity-related inequalities. Related to the topic above, it also addresses questions as to the effectiveness of the education system that pertains to issues of students' achievement and ways of supporting under-performing students. Also, enhancing entrepreneurship among students emerged as a strategic priority for education, in particular related to IBL.

Beyond discussing and reflecting on these issues as a way of contextualising the activities in mascil, Part 2 earmarks important issues for discussion and debate during the workshops with policy-makers that are planned in the country. The aim is to inform and engage policy makers in a discussion on supporting a more widespread uptake of inquiry-based learning, which includes issuing concrete recommendations on the topic.

Equity specific issues

[37] „Why not a specialised lecture, which tells me: there are new basic approaches for example for IBL. It's like this. And then practical examples." (Interview No. 6)

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Although much has changed over the past 10-15 years, as indicated in studies such as TIMSS or PISA, boys outperform girls in mathematics and science on average by 12 points across the OECD-world. For Germany, the results of PISA 2009 indicate that boys outperform girls in mathematics *and* science by approximately 15 points (see graphs 2 below) and that there are statistically significant differences. The OECD-average in mathematics is 496 (score mean), Germany's score is 513. In science, Germany has a score mean of 520 (OECD mean = 501). Comparing this with the OECD-average, it becomes visible that Germany fares doubly above average, i.e., while students perform above average when comparing performance levels across the region, it also becomes clear that there are significant differences between boys and girls, pointing to gender inequalities in science and mathematics achievement (cf.: OECD 2010).

The percentage of females in higher education in the fields of science and mathematics is still lower than for males; out of the 447.607 students in the fields mathematics and natural sciences in Germany's higher education institutions, only about a third (164.523) is female (cf. Statistisches Bundesamt 2013, p. 21). Although in general and vocational education 65.7% of the teaching personnel is female (Baden-Württemberg 62.1%) (cf.: Autorengruppe Bildungsberichterstattung 2012, Table B2-3A, p. 230), mathematics and science professions are still considered to be masculine domains.

As discussed above (Theme 1) Germany's tradition underlying the differentiation of school tracks builds upon a notion of talent (Begabung) that has ripple effects for gender-related 'talent' in these subjects. Many parents, teachers and students themselves are often convinced that boys have higher abilities than girls in fields such as mathematics and science. Also, in relation to the transition from school to work, traditional orientations still prevail in Germany. That is, professions that are related with mathematics and natural sciences (e.g., technical professions, engineering, sciences), still represent male domains and are less frequently chosen by girls. For this reason, gender issues have been prioritized by policy maker sin Germany (see Part 1).

However, neither national curriculum/standards not teacher initial/further training has yet changed much so as to be able to tackle gender differences and inequalities in science and mathematics education. Gender-related issues have been prioritized in policy-making and official rhetoric, yet no actual changes can be detected in school and

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classroom activities. This represents one crucial issue for further work in WP2, e.g., workshops with policy-makers, etc.) and for implementation (WP8) in mascil.

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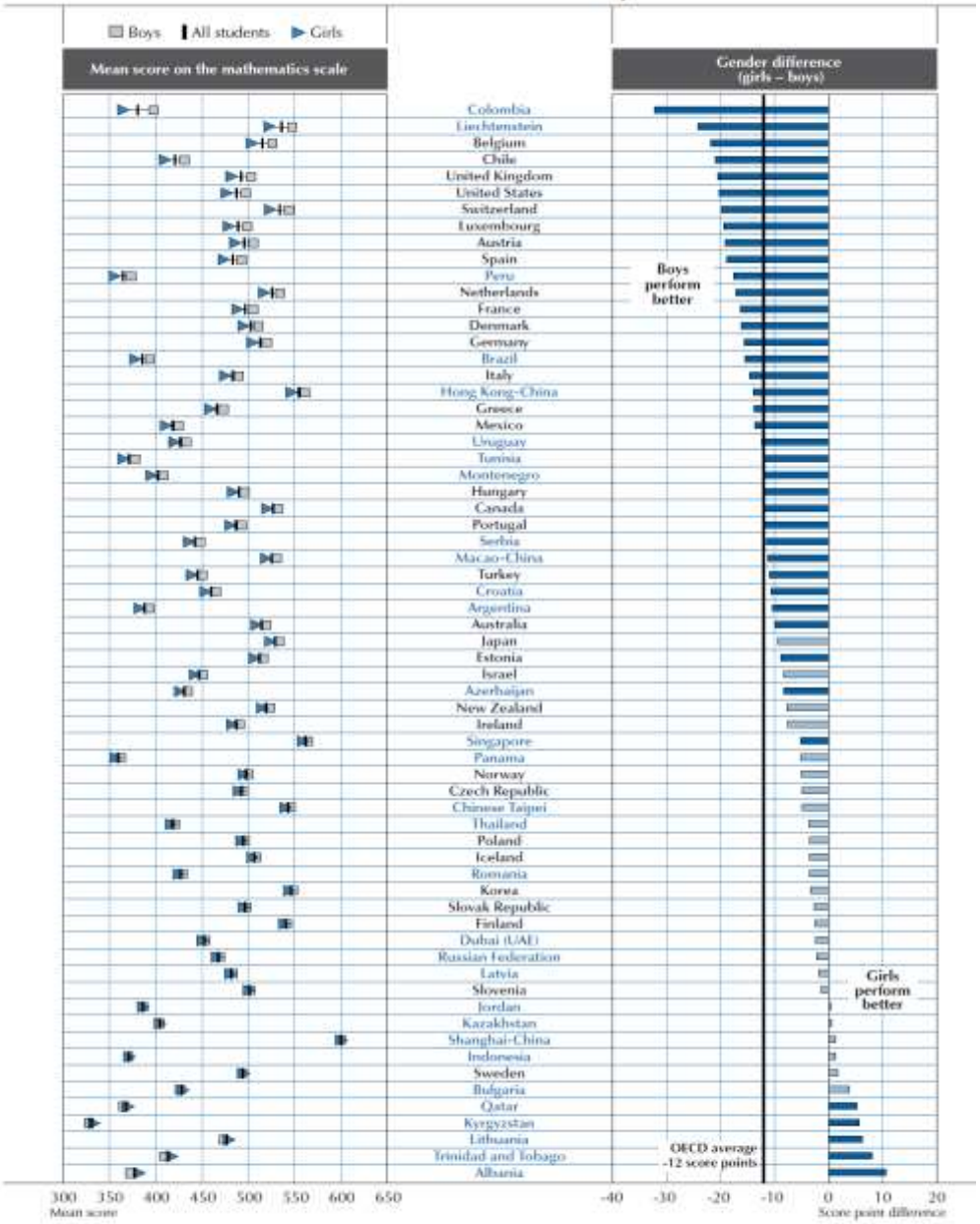
■ Figure I.3.12 ■

Gender differences in mathematics performance



Note: Statistically significant gender differences are marked in a darker tone (see Annex A3).
Countries are ranked in ascending order of the gender score point difference (girls – boys).
Source: OECD, *PISA 2009 Database*, Table I.3.3.
StatLink http://dx.doi.org/10.1787/888932543152

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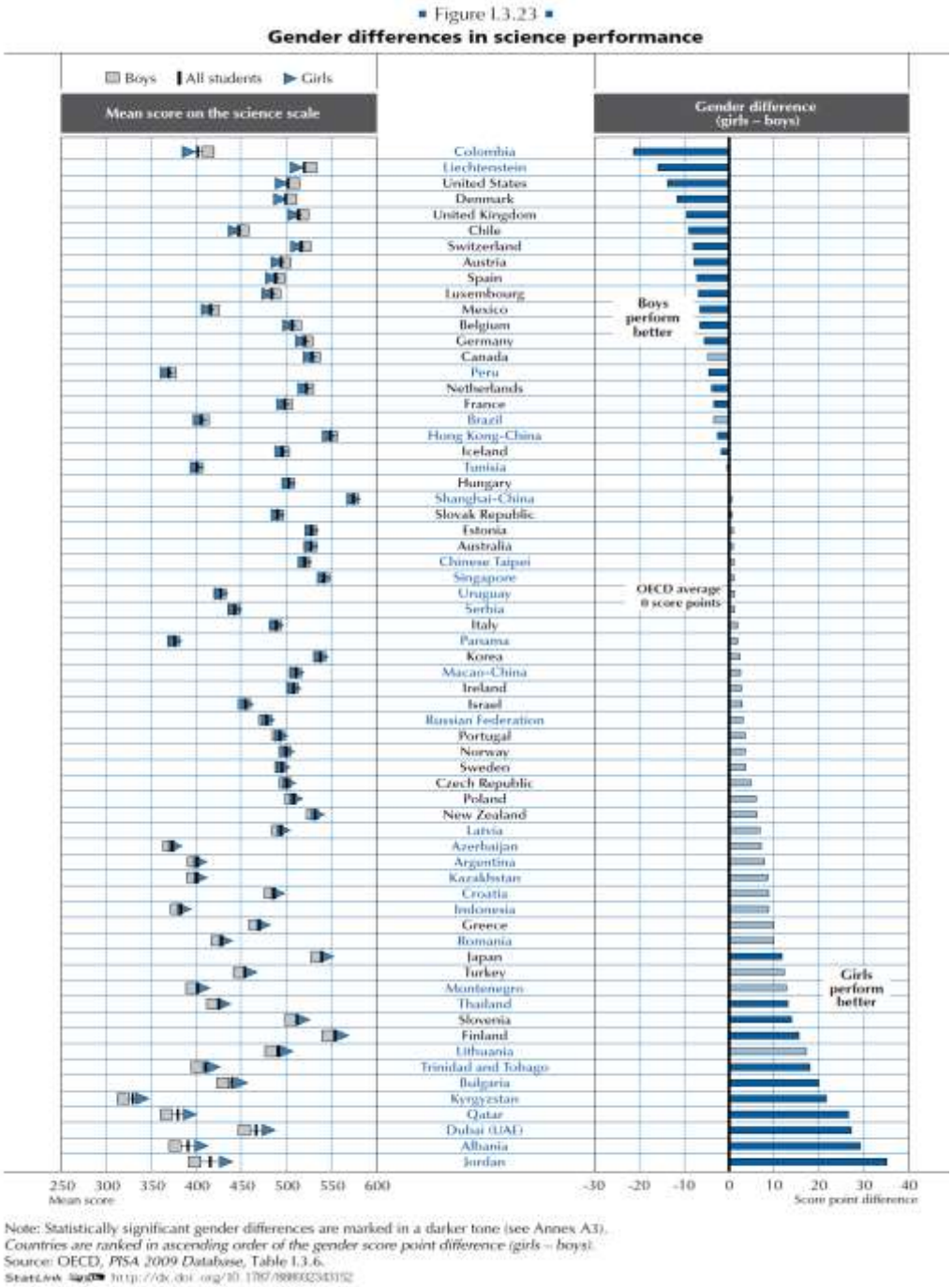
SEVENTH FRAMEWORK PROGRAMME



Note: Statistically significant gender differences are marked in a darker tone (see Annex A3).
Countries are ranked in ascending order of the gender score point difference (girls – boys).
Source: OECD, *PISA 2009 Database*, Table I.3.6.
StatLink http://dx.doi.org/10.1787/888932343152

both: Graph 3: Gender differences in mathematics and science performance in PISA 2009, source: OECD 2010, p. 136, 155

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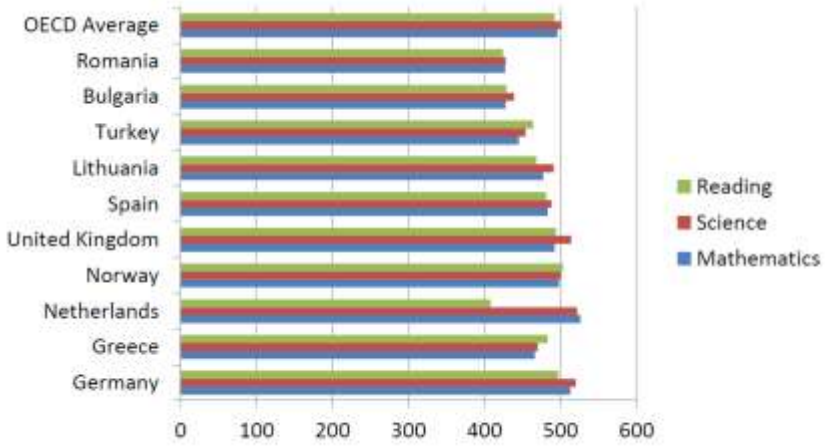
Addressing low achievement

Low achievement in mathematics and science is a common concern for all European countries. It is an issue associated not only with the effectiveness of teaching and learning, but also with providing an equitable system of education. A range of approaches have been developed to support under-performing students and to attempt to close the persistent gap between the highest- and lowest-achieving students.

Graph 4 below shows the mean scores in reading, science and mathematics for mascil countries (Austria, Cyprus, and Czech Republic have not participated in PISA 2009) and the average scores for the entire OECD-region.



Graph 4: Mean scores performance in reading, mathematics, and science in PISA 2009, Source: Data from OECD 2010, p. 155

As seen above, Germany's scores (Reading 497, Science 520, Mathematics 513) are all above the OECD-average (Reading 492, Science 501, Mathematics 496). However, there is a great range of variation when results are further differentiated along performance levels (graph 4). More than a third of all students tested performed on level 2 or below in mathematics and science.

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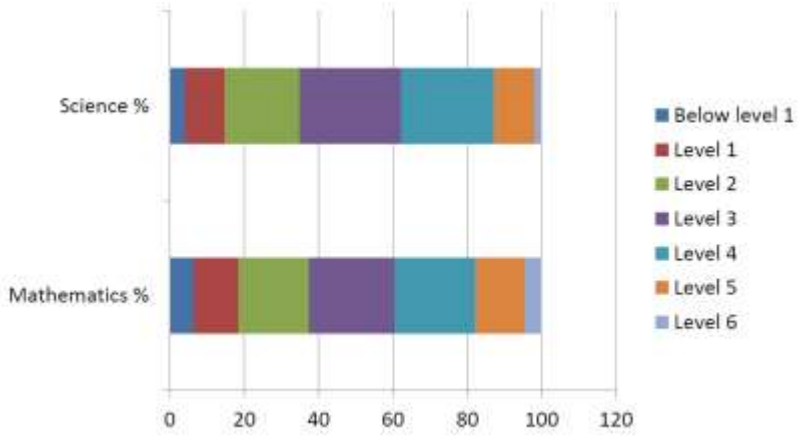

Graph 5: Percentage of students acc. to performance levels in mathematics and science in PISA 2010, Germany. Source: OECD 2010, http://dx.doi.org/10.1787/888932343152

In Germany, PISA results have from the start triggered a public and scholarly debate because results show a close relationship between performance level and social background. Indeed, it seems as if for Germany, the most decisive trigger for an encompassing and far-reaching education reforms in recent times had been the first PISA-Study (cf. Kuhlmann/Tillmann2009). All-day schooling has been seen as a response to the social inequalities reproduced by the social education system and meant to give all pupils an equal access to resources positively influencing their educational careers. It answers to several issues: All day schooling addresses educational deficits ascribed to parents with little economic, cultural and social capital and may, thus, be seen as a compensatory measure (integration and migration issue). It answers to concerns by future employers about the “lack of employability and ‘trainability’” of major parts of the population (labour market/training issue). And, related to the issue at hand, all-day schooling is seen as a means of equalizing performance disparities due to socio-economic differences in the families, since support is less dependent on parents’ education level and financial means for instance for private tutoring and the like (low achievement issue). These measures have a more general character and do not tackle specifically low achievement in science and mathematics education. On the other hand, research evidence shows that homework support is one of the main activities in all-day schools; even if, it also shows that children from lower SES (socio-economic status) participate far less from all-day school activities than their peers with higher SES (Fischer/Klieme 2013).

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Also, even a cursory review of teacher training curricula suggests that teacher training in Germany does aim at preparing future teachers to handle educational disadvantage of pupils. Looking at different dimensions related to this issue, two main aspects come to the fore: diagnosis, support and counselling regarding individual learning processes and individualised teaching, handling of heterogeneity and differentiation in classroom. However, the question arises as to their relevance and application in practice. Importantly, educational disadvantage seem predominantly defined as lack of cultural and socioeconomic resources; educational disadvantage and low achievement are only seldom described as a core problem and challenge for teacher education. There is so far only little evidence that issues related to disadvantage and low performance are tackled via IBL approaches. Nevertheless, as the discussion on SINUS above hinted at, teaching methods and styles have come into focus of professional development during the past years.

Promoting entrepreneurship

Entrepreneurship is currently seen as a key competence and refers to an individual's ability to turn ideas into action. It includes creativity, innovation and risk taking, as well the ability to plan and manage projects in order to achieve objectives. The overall goal of promoting entrepreneurship in education is to give students the attitudes, knowledge and skills to act in an entrepreneurial way, for either a commercial or non-commercial objective.

According to a survey of the 'Global Entrepreneurship Monitor 2012' Germany ranked 20th of 24 comparable innovation-based countries; also, gender seems to have particular importance for entrepreneurial propensity. The activity rate of individuals in the working-age population who are actively involved in business start-ups (Total Early-stage Entrepreneurial Activity, TEA) is 7.2% for males and only 3.5 for females. Setting up businesses depends heavily on the perception of abilities and skills of the potential founder (not necessarily whether the estimate is accurate). This perception seems to influence actual entrepreneurship: 37% of respondents responded to have sufficient skills and experience to set up a business (cf. Sternberg et al. 2013).

Entrepreneurship education has been prioritized in policy making in Germany. One main action fields in the country has been the promotion of MINT-related topics among students

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in primary and secondary education. The current strategies and initiatives presented in Theme 1 are all related, directly and indirectly, to entrepreneurship education in general education at primary and secondary level. In particular, there have been many competitions in MINT-related topics among students; awards and prizes sponsored by large firms and foundations complement the promotion of entrepreneurship at the macro or societal level. As what refers the national curriculum, it seems that developments have been slower. This is, however, not necessarily a lack of innovation will but is rather consequent with the German tradition in the education realm (Allgemeinbildung), which is concerned with personal development in the sense that mathematics and science education is first and foremost with helping students understand the society they live in, with supporting their processes of identity formation and with putting the in the position to (feel) integrate in society. The whole discourse of the Knowledge Society or Knowledge-based Economy has, of course, impacted heavily on the understanding of what this social integration means in terms of skills and competence, yet curriculum developments have included entrepreneurship education at a rather abstract level. The same can be said for teachers' professional training and development, which only indirectly addresses issues around entrepreneurship education.

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mascil
mathematics and science for life

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Contact Information
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