



**Promotion of Lifelong Learning of Scientific Subjects:**

**Challenges, Opportunities and Strategies**

**The German National Report**



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# NATIONAL REPORT OF GERMANY

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## ABSTRACT

*After the disastrous results of the first OECD study (Pisa), Germany started a nation wide educational initiative to enhance and change the educational system and structures to facilitate Lifelong Learning strategies .In this study German pupils had under average results in all of the tested categories. The results showed the most obvious gap between inefficient and efficient pupils. In the category "Natural Sciences" German pupils got range 20 (out of 31). The reasons for these results were named as the old fashioned teaching methods.*

*One of the results that showed the need of fundamental changes in the German educational system was that education in Germany is still a privilege. Access to higher education is still focused on a higher social status. One of the weakest points of this system is the insufficient integration of children out of social underprivileged families and Migrant children.*

*The German „Kultusministerkonferenz“ draw the consequences out of the results, starting in 2001.*

*This body decided for 7 "Fields of action"*

- 1. Measures for enhancing the language competencies, starting in the Kindergarten*
- 2. Measures for a more sufficient interlocking of pre-school and primary school focused on an early school start*
- 3. Measures to enhance education in primary schools, especially facilitating the reading competencies and the comprehension of Mathematics and natural sciences*
- 4. Measures to promote children of educational deprived families and migrant children*
- 5. Measure to develop systematically the quality of teaching at school and a continuously evaluation*
- 6. Measures to promote professional teaching especially methodologically competencies*
- 7. Measure for a systematically facilitation of all-day schools and off-schools incentives to promote pupils in need of more support.*

*These measures still form the reference framework of the activities of the German government, especially of the Federal Ministry of Education and Research, for the obligations taken in the European strategies of Lifelong Learning activities.*

- A. The main reasons and causes that create barriers to the full development of Life Long learning strategies as far as scientific subjects (and chemistry in particular) are concerned*
- B. The main successful national educational initiatives and methodological approaches that are put up at school level for raising students interest towards scientific issues, again with a specific focus on chemistry*
- C. The National and regional strategies to promote Life Long Learning of scientific subjects.*

## 1. State of Affairs

The strategies to support and promote Life Long Learning in Germany must be seen in context with a fundamental national report of the German government. This report followed the first World Summit on Sustainable Development; WSSD, 2002 in Johannesburg.

The national report is the framework for a sustainable development during the period 2002 – 2005.

After 2005 this was followed by the start of the UN world decade 2005 – 2014 for “Education for sustainable development”, leading in Germany to new “Guidelines for Sustainability” which was released by the Bundeskabinett in 2005.

In 2008 the German Government released the “Conception for Lifelong Learning” in order to improve the situation in this area.

For the German Government Lifelong learning is one of the biggest political and societal challenges facing Germany and one of the priority tasks of education policy.

This development is due to the shock of the first OECD study: “PISA” in 2000. This study showed the disastrous state of the German educational system in comparison to its European and international partner countries.

The results induced a chain reaction and a profound and systematic change in the education policy.

In the named “Conception for Lifelong Learning” the aims reflect the results of the study. After a decrease of participation in continuing education to 43% in 2007 (all 19 to 64-year-olds) and in general and vocational continuing education (same group) to 27% the aim of the education policy in Germany is to increase the participation in Lifelong Learning programmes to 80% till the year 2015 (in the group of the 25-64 year olds).

The participation in formal vocational educational trainings shall be increased to 50% and for people with lesser qualifications from 28% - 40%.

In an OECD study (Education at a glance, 2008) Germany is attested to have an under average participation in continuing educational programmes and a special deficit concerning the participation of formal lesser qualified people.

### **1.1. Problems**

Fundamental problems in Germany are:

demographic changes

globalization and the need of new competencies

migration and integration

changes on the job market

missing networks between all responsible partners meaning explicitly the regional administrations, companies and other regional or local partners

### **1.2. Restraints and Barriers for Lifelong Learning Strategies**

The “Conception for Lifelong Learning” names some of the most important restraints and barriers for the participation in Lifelong Learning programme:

- lack of motivation

- insufficient consultancy and advice

- insufficient involvement in scientific orientated vocational training

In a congress of the German Federal Ministry of Education and Research" in 2007 these restraints and barriers and possible solutions were discussed. The lack of motivation to participate in Lifelong learning programmes is depicted as a multifaceted problem.

It has been shown that especially the formal lesser qualified people also tend to lesser participation in Lifelong Learning programmes or in vocational continuing education programmes. So it is possible to say: the more a person is qualified the more often he is willing and motivated to participate in learning programmes. This fact is known as: "Education paradox":

The question is how to integrate people in these trainings who really are in need of it because they have to be enabled to find a job, get a new job or even to be able to participate in social life without being excluded.

Certain groups have been pinpointed, e.g.: young male migrants, especially young male Turkish migrants.

The conclusions of the congress were:

that it is necessary to start with Lifelong Learning in the Kindergarten,

to provide a network of all responsible partners including governmental and non-governmental organizations and institutions, regional partners and companies as well as the social partners, so to be able to support every person individually.

To activate and motivate people it is necessary to support everyone individually. The consultancy, support and guidance for educational and vocational training have to be developed and expanded.

The lack of consultancy and support with high professional quality is one of the restraints and barriers for successful Lifelong Learning Strategies. The often missing quality of the educational consultancy in institutions and organizations has to be changed to reach the aims of the Lifelong Learning Strategies.

In close relations to the two points: early start to get into Lifelong Learning and professional consultancy, a third one is named to be a barrier and restraint in Lifelong Learning strategies:

the insufficient involvement in scientific orientated vocational training.

The future of the economic development in Germany depends on new products and services and therefore on scientific trained and qualified people. So the graduates of non-academic education have to be interested in additional vocational scientific orientated training.

### **1.3. Case studies**

The case studies that were done in a further training course for "Nutrition Consulter" (all the participants were women) support the above statements. The women were not really interested about the topic: "this is dull", "I don't know anything about chemistry", "I am not interested in that matter", "I can't see the context to nutrition" etc.

Even if a participant was interested in the subject at the beginning of her school or training career, she lost that interest after a while, often because she could not see a professional future in that field or because it was too much mathematics, or because the teacher wasn't able to motivate her.

The results of a small chemistry test within the case study were underwhelming. In combination with the comments the women gave, their reluctant behaviour and disappointing results seem to

be the consequence of a motivational problem or a problem of attitudes or both that started in the beginning of their school careers.

#### **1.4 Reasons for restraints and Barriers and solutions/Good practice**

The participants of the congress pointed out that there are fundamental problems creating the named restraints and barriers: People are not motivated because they are not acknowledged if they do so. They don't see any perspectives that appeal to them.

The Federal Ministry of Education and Research is developing a system of incentives to motivate people to participate in training programmes, e.g. a continuing education bonus, an amendment of the Capital Formation Act and a loan for more comprehensive continuing training. The maximum bonus is to be 154 Euro. It will be granted to anyone who contributes the same amount from his/her own funds. Including the minimum amount of 30 Euro, the budget for continuing education is thus 338 Euro. With this amount, the fees of over 75 percent of all continuing training measures currently taken by individuals can be paid. The particular incentive is that almost half of all costs are covered by the state in the form of the continuing education bonus. A comparable model has triggered a continuing education boom in Great Britain. The participation rate was three times higher than expected. This shows that a relatively small contribution can have a considerable impact. On the other hand, the British experience seems to indicate that the effectiveness of funding can be much increased by obligatory counseling.

The core of the lack of motivation to participate in Lifelong Learning programmes more often yet is a part of the socialization and social surrounding of a person, so that solutions might be sought after in quite another direction e.g. in the value system and the behavioral group standards. This is a fundamental societal problem and a challenge for the future

Another problem concerning motivation is about recognition and vocational perspectives on the job market.

In Germany quite often continuing education or continuing vocational training doesn't pay off and a new or a better job is not always the result of the additional training efforts. So quite often persons have to wait to see the positive effects of their efforts or are left alone in their search for the most suitable choice of training or a job perspective, so they don't even try.

The choices for training programmes matched to the need of working people nowadays are numerous and of good quality standard e.g. online, part time, distant learning, blended learning etc. programmes.

The need of the already named network of consultancy, support and guidance obviously is a real need for the increase of participation in Lifelong Learning programmes.

Another restraint people named as a pre-condition to participate in programmes is the distance of offers to their place of residence. So there is a need of regional learning-networks including companies functioning as "supporting alliances". These networks of guidance and training can also support and promote the participation of more people in scientific orientated continuing vocational trainings, in that way showing people what, how and why they should go for additional trainings, also giving them good practice examples.

To answer the challenges of the demographic changes in Germany there still is the restraint, that policy and companies do not focus their job market policy or human resources development on the aging workforce, still referring to "generational replacement".

The Federal Ministry of Education and Research therefore strongly recommends to stress and promote the development of internal continuing education and vocational training within the companies as well as accompanying measures e.g. part-time or distant-learning study programmes for older employees in a regional network..

Another restraint in Lifelong Learning strategies is the often missing transparency, porousness and linkage of educational programs.

The recognition of certificates, reports or non-formal acquired competencies and more flexible access to higher education are pointed out as a need to enhance the efficiency of Lifelong Learning strategies.

To sum up, the strategies are focused on:

facilitation systems (e.g. educational saving)

transparency and accessibility

recognition of informal learning

regional learning networks including companies

individualisation/modulisation

promotion of continuing educational/vocational training for older employeesdevelopment of a system of consultancy in high quality

## **2. Training of chemistry teachers in Germany**

### **2.1 Education system**

In Germany there is no uniform education policy. Education and culture is focused on the "Länder" the states of the federal organised Germany.

So there are as much different education laws as there are federal states, differing sometimes slightly, sometimes profoundly from each other. This often leads to problems for families if they move from one federal state to another. There is one institution called: "die Ständige Konferenz der Kultusminister"(standing conference of the ministers of culture) responsible for coordination and compensation of too much differences.

Germany has a three-tier school system:

"Hauptschule" – "General-education secondary school, level 1, yrs 5-9",

"Realschule" – Intermediate school, level 2, yrs 5-10",

"Gymnasium" – "secondary school, level 3, yrs. 4-12"

and the "Berufsschule" – "vocational school, yrs.9-12".

The graduation of each school provides access to a certain kind of further training. After completion of the secondary school it is possible to study at a university without further training or graduation. After the completion of the intermediate school it is possible to study at a university of applied sciences and after the completion of this study a transition to the university is possible. After the completion of the general education secondary school the students usually attend the vocational school to complete a vocational training.

There are possibilities of transition under certain conditions at some points even for the students of the general secondary school.

### **2.2 Teachers' training**

The training of the teachers follows this matrix. Teachers are trained to be a teacher at the /primary/ general secondary school/intermediate school or at the secondary/comprehensive school.

The training of the teachers takes place at university, usually starting with a bachelor in form of a "two-subject bachelor" study course. These subjects can be chosen following the subjects the "teacher-to-be" wants to teach at school. It is mandatory to study two subjects to become a teacher.

After the completion as a Bachelor the student may leave university to find some kind of job, however, if he wants to become a teacher she/he has to complete a master study course. This training is a specialised pedagogical training for the subjects that shall be taught.

At the same time, it is mandatory to do internships at school already during the bachelor study if the student really wants to become a teacher

These studies are different in each federal state. In North-Rhine Westphalia, e.g., the students can study pedagogy as a subject straight from the beginning, in other states this is not the case.

Internships at school during the study are mandatory for the training of teachers, but the number and lengths of these differ between the states.

The students graduate with a Master of Education or the "first state exam".

After this, the student has to do a two year traineeship at school. During the first year of this traineeship the student has to attend simultaneously an accompanying teacher seminar and usually has only a few lessons to give.

In the following year the student teaches own lessons , but is controlled by trainers. After these years the student will get the "second state exam" to be a teacher.

### **2.3 Chemistry teacher education**

Becoming a chemistry teacher the student needs to specialise in a science learning area in contrast to the social science learning area. Core subjects are Biology, Chemistry or Physics.

These subjects are studied with either a focus on "school" (primary/general secondary schools) where educational science outweighs the scientific concepts, or a focus on "science" (secondary/comprehensive schools). Thus, the study of the core subjects includes items that qualify specifically for pedagogical and didactical aspects of that subject, but in different proportions.

The "skill profile" of a chemistry teacher was published by the Standing Conference of the German Federal Ministers of Culture:

Chemistry teacher graduates have an open-minded scientific and pedagogic knowledge in chemistry, which enables them to create goal-oriented placement, learning and educational processes in chemistry and to contribute autonomously to new technical and interdisciplinary developments in the classroom and school. They

have open-minded chemical expertise that enables them to understand more recent chemical research,

have open-minded knowledge of the contents and chemical-related research and industrial facilities,

can grasp, evaluate and present chemical issues of different applications and context in adequate oral and written communication skills

can structure chemical areas by identifying consistent issues through networking and make cross references to school chemistry and its development,

know the basic working knowledge and methods of chemistry and can experiment safely,

know the history of ideas of selected chemical and scientific theories and terms and are aware of their significance,

know the process of production of chemical knowledge (knowledge of chemistry) and can justify the individual and social relevance of chemistry,

can develop teaching concepts and media on the basis of their expertise, rate content of newer chemical research, follow in in overviews and introduce new topics into the classroom target group ,

are capable to establish and to present the importance of the principle of sustainability for chemistry

have open-minded pedagogical content knowledge, particularly basic knowledge of the results of chemistry-teaching-learning research, didactic concepts and curricular approaches,

have diagnostic skills for identifying learning disabilities and student performances in the subject areas of chemical education and the basic standard and competence-oriented teaching processes of chemistry,

have first reflected experience in competence-orientated planning and implementation of teaching chemistry and know basics of performance diagnosis and assessment in the subject.

## **2.4 Bachelor degree Chemistry with teaching option**

The study course at the Freie Universität Berlin (FU) will be presented as an example for a study course "chemistry" for teaching at secondary 1 (for all pupils till the 10th class) and secondary 2 schools (for all students from class 10-12).

The training consists of approximately 40% of chemical education, 20% of educational training and another 40% in a second study subject. The standard study time is nine semesters (4,5 years).

### **2.4.1. General information**

In 2004, the bachelor degree program with teacher training option was introduced in the federal state Berlin where chemistry can be studied only at the HU and FU. The transition from the current teacher training with the degree first state exam into a BA / MA study offers several advantages for the students. The study is strengthened, since content-related courses, whether lecture, practice or training are combined into one module. At the end of each module the student's performance is tested and marked. The sum of all individual scores will be calculated for the final Bachelor grade. Academic achievements are therefore rated while studying, whereas previously two mandatory exams, consisting of a written and an oral examination were necessary for the first degree.

The Bachelor is followed by a one-or two-year master's program. The previous training as a teacher would correspond to a two-year master's program. For the requirements and contents of the Master courses only a framework exists, the details are worked out in the coming years. After the Master's program follows, like before, the two-year traineeship at school.

### **2.4.2. Course overview**

In the six-semester bachelor degree program with teacher training option a total of 180 credit points can be achieved, with the distribution of

190 LP in core subject

60 LP in the second subject

30 LP in the general professional science (EMI, didactics)

In the course of the study, basic chemistry skills, including the appropriate scientific methods and practical skills are taught that qualify for a school teachers master degree program. These include:

a systematic, methodical and practical laboratory work based knowledge of inorganic, organic and physical chemistry and biochemistry;

familiarity with key concepts and the structural and substantive relationships between the different fields of study of chemistry;

knowledge of the history and development, and social and industrial importance of chemistry;

an overview of modern research methods in chemistry and

practical, small-scale experiences in the various laboratory activities.

The degree program consists of a four-semester basis and a two-semester recess period. The basic course is identical for students with chemistry as a core subject (90 CP) and second subject (60 LP)

In the following, the recommended study plans are presented, which would be optimal in the given time sequence from a technical point of view. However, the challenge of a teacher certification program is mainly to coordinate courses from two different subjects and this is difficult because of the unavoidable time overlap. Compromises must be made and any deviations from the recommended curriculum taken into account.

### 2.4.3. Recommended study plan for basic studies

Study areas	1.sem	2.sem	3.sem	4.sem
mathematics	mathematics (lecture/practice)			
general and organic chemistry	gen. and org. chemistry (l,p)	gen. and org. chemistry (p), combined with practice quantitative analysis		

analytical chemistry		quantitative analysis (l,p)		
physical and theoretical chemistry		basics of pc (l,p)	physical chemistry practice (p)	
organic chemistry			basics of oc (l,p) Empirical spectroscopy (seminar; s)	basics of oc (p)
didactics of chemistry			introduction into didactics of chemistry (l,c)	design of learning environments for teaching chemistry (p,s)
biochemistry				biochemistry 1 (L,p)

#### 2.4.4 Developments in the training and education of chemistry teachers

The given examples reflect relatively new developments in the training and education of teachers, especially chemistry teachers.

These developments are due to the problems and restraints Germany has in training sufficient young people in fundamental necessary skills mainly in natural science. As shown above in the National Report, Germany depends on skilled workers in these industrial areas.

However, chemistry, like all natural sciences, as well as mathematics, is considered as "difficult", "dull", "not practical", "too much to learn", or "study too long" by students. Referring to a long lasting prejudice and compared to the higher number of men in chemistry studies or vocational training, the majority of women doesn't have a positive attitude to natural sciences. In the case studies done for the project, this is obvious (again). But even for men natural sciences /chemistry is not a prior choice for studies. They mostly choose technical or engineering studies or take up vocational training.

So far, the developments mentioned above do not seem to be efficient to ensure a skill profile as demanded by the Standing Conference of the German Federal Ministers of Culture.

Becoming a chemistry teacher in Germany especially for secondary schools means a mostly scientific diploma-like study with only a small part of didactics and teaching methodology of chemistry. (This is, by the way, not only a problem for chemistry teacher students. Specific teaching methodology for a subject forms only a small part of a teacher training study for secondary schools. The basic idea seems to be that you need teaching methodology mostly for primary school and that one focuses on the subject and scientific information in secondary schools - no need for teaching methodology, because pupils are "already educated".)

On top of that, study of chemistry at university takes a lot of time, organisation and effort especially with regard to laboratory work and study. As a compulsory part, laboratory work is nevertheless difficult to organise and usually tears apart a normal timetable. This makes it more difficult for students to take additional lessons in teaching methodologies even if they want to.

And last, but not least, most lecturers at university are not trained in teaching methodologies themselves. This way they are not always role models or best practice examples for future teachers.

### **3. Specific Strategies for scientifically and technically based continuing vocational training**

#### **Decrease of participants in chemical and technical studies and trainings**

Germany is dependant on his technical development, on new products and services, that means: it is dependant on the education of people who are qualified in technical disciplines.

Since the middle 1990ties it is to be observed that much to less people decide to study technical disciplines or do vocational training or continuing vocational training for technically orientated jobs..Even if there is a difference between applied technical disciplines or explicitly Chemistry, Physics or Mathematics.

So the Federal Ministry of Education and Research initiated and strongly supports numerous kinds of facilitation and promotion for scientifically and technically based continuing vocational training programmes or studies.

#### **Good Practice examples**

Referring to the strategies and their impetus shown above, those iniatves are focused on schools, primary as well as secondary ones. Good practice examples show their specific concern, e.g.:

early contact with regional companies and networks

internships

facilitating learning moduls for pupils in need of special support

individualised, tailor-made moduls

consultany, advisory and matching of pupils and companies

gender sensitive approach

To keep up with these aims the Federal Ministry of Education and Research lauched e.g.:

action programmes, including schools and e.g.municipalaties as well

learn-feasts at schools or in regional networks

days of... e.g. Chemistry, Girls-day

years of e.g. Chemistry year in 2003

MINT initiatives (Maths, Informationtechnology,Natural sciences, Techncl fields)

Technicum. (The Technicum is a sort of internship with a mentoring system. Pupils after their final secondary school exminations and before the start of their studies or vocational training can attend it for 5 6 months.

National contract for women in MINT Jobs

competitions/prizes for young researchers and special issues,  
special programs for young people e.g. : Maths –Olympic games  
special programs for excellence  
conferences on every level from local to national  
workshops and seminars.

As an abstract it can be stated that nowadays this sort of initiatives and programmes reaches a level of nearly 1000 nation wide.

#### **Institutional reaction**

The developments on the institutional side can be seen as the reaction to the problems mentioned above and as an attempt to convince more young. people to decide for the study or vocational training in natural sciences / chemistry

But there are more problems because, due to the demographic developments in Germany, there will be an undersupply of teachers even if taken into account the decreasing numbers of students.

The “Standing Conference of the Federal Ministers of Culture” published a study concerning the need for teachers in Germany in the years 2002 – 2015.

In the coming years an undersupply of almost 3,200 teachers (particularly in the teaching careers in secondary education (vocational subjects) or for vocational schools with an average of nearly 2,300 teachers is expected.

There is an initiative of the Federal Government of Germany to train and hire more teachers, especially for natural sciences, but there must be a wide expanded network of support and facilitation consisting out of economy, institution, public bodies ,regional/local companies and initiatives as well as federal policy to support the developments of academics as well as highly skilled workers in the area of chemistry from Kindergarten to university.

#### **4. Special strategies for Lifelong Learning in the Chemistry and Pharmaceutical Sector**

The European Chemical Industry is the second largest industrial sector in Europe, providing 2 Mill. jobs.

In the years to come the developments and innovations in Chemistry as a cross-sectoral science and versatile industrial sector will play a key role. The most important questions of the future e.g. health, nutrition, building. living, mobility and communication as well as clothes will acquire solutions based on chemical and technical developments.

These facts collide dramatically with the shown developments in schools and Universities.

To counter act this trend the Federal Ministry of Education and Research supports initiatives to facilitate the decisions of people to participate in vocational and continuing vocational training programs to get a job in the chemical/technical sector.

This is shared and promoted by the Society of German Chemists. This society promotes chemistry teaching in Germany in primary as well as in secondary schools.

One of the initiatives is a fond, another one the web-site: "Chemistry4you" (with a profiling test as a vocational preparation) and the initiative: "Educational strategy Chemistry" with a consortium of the social partners and stakeholders in this sector.

There are some good practice examples to support the decisions of students and pupils to go for a chemical or technical discipline:

"Blue Genes". A kit which enables high school teachers to perform basic experiments of gene analysis and cloning at school. With the equipment and the reagents provided in the kit the class can perform a restriction analysis, cloning, and expression experiments of a bacterial gene.

"Experimentierkasten Kuno". This kit has been developed for children of classes 2-4 in primary schools. Properties and applications of plastics are presented in a non-fiction book for children. Experiments can be carried out by children by themselves

"Experimentierkasten Tini und Toni" has been created for children of classes 2-6 in primary schools. ". Simple chemical experiments are presented in a booklet for children The experiments can be carried out by children by themselves.

-Weekend seminars and congresses for chemistry teachers are organised by the regional associations of the VCI. (The German alliance of the chemical industry)

A "Newsletter" for chemistry teachers is published three times a year The newsletter contains information from the chemical industry and other sources.

"Schulpartnerschaft Chemie". A brochure for chemistry teachers. It contains best practice examples from the school promotion programme "

-"Kuchen, Flirt und Nanowelten". A brochure which shows the important role of chemistry in our everyday life. Examples: health, textiles, energy, communication

"Chemie im Fokus". A website for career opportunities and information about study of chemistry This site is a joined activity between VCI and the German association of chemists (

For additional information concerning the formation in Chemistry and related fields (description of jobs, information on firms regarding formation, etc.) please have a look at the website of "Chemie 4you" , a joint initiative of the German chemistry employers association.

"Mentoring-projects". Financial support of partnerships between schools and institutions, such as chemistry departments of universities or chemical firms, for their establishment of e.g. permanent labs for pupils, science camps and other co-operations or activities intended to give children/pupils a realistic picture of the various job outlines in Chemistry and the requirements necessary for these jobs.

-"International Olympics in Chemistry". Financial support of the 2004 Chemistry Contest in which especially talented pupils of schools for general-education solve scientific problems, investigate independently and develop new ideas.

"Informationsserien". Transparency series dealing with special topics of interest out of sectors, such as chemistry, environment, biotechnology, etc. The folios can be ordered free of charge by teachers/schools.

For additional information concerning German activities please have a look at the website of "Bildungsinitiative Chemie" ), a joint initiative of the German chemistry trade union, the German chemistry employers association, the German association of chemists and the VCI.

## **5. Initiatives and Programmes in Berlin**

Following the aims of the Federal Ministry of Education and Research, Berlin has presented a “Masterplan Qualification” underlining the given topics and strategies shown above. Berlin is participating in the programm “ Local Learning networks.

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