

THE IMPLEMENTATION OF THE BOLOGNA PROCESS REFORMS INTO PHYSICS PROGRAMMES IN EUROPE

A position paper of the EPS



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Submitted to the European Physical Society by

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- (1) The study on the implementation of the Bologna reforms into Physics programmes at European universities was carried out on behalf of and in close cooperation with the *European Physical Society* which had received funding for the project from the European Commission.
- (2) The aims of the first year of the project were to provide an *overview of the implementation of Bachelor and Master structures in Physics Programmes*, to analyse possible regional differences, to determine the extent of common standards, common quality assurance mechanisms, as well as the extent of modularisation in the new structures, to assess what professional qualifications can be obtained in the framework of Bachelor programmes in Physics, and to determine whether Bachelor curricula have a more standardised structure than Master curricula.
- (3) *The design of the study was a two-step approach.* In the first step curricula of Bachelor and Master Physics programmes were collected and analysed according to a list of criteria (two-cycle system and duration, use of credit point systems, student workload calculations, modularisation, and assessment of learning outcomes, use of Diploma Supplement, and opportunities for mobility). In a second step an *online questionnaire* was sent to the programme coordinators having submitted Physics curricula asking them to fill it in. Apart from questions addressing the criteria applied in the curriculum analysis, the questionnaire also addressed the following issues: degree of specialisation and internationalisation, assessment and examinations, transmission of key skills and competences to support employability, transitions preceding access into Physics programmes and succeeding graduation, and finally accreditation, evaluation and quality assurance mechanisms.
- (4) Early in the project the steering group decided to *focus on the Bachelor curricula in Physics programmes* and analyse the Master curricula in more detail in the envisaged second year of the project. Thus the results of the online questionnaire and the curriculum analysis presented in this report concentrate on Bachelor Physics curricula.
- (5) *Sample size and responses to the collection of curricula:* 152 Bachelor Physics curricula in all from universities in 24 Bologna signatory countries were collected, the largest clusters being from German universities (35 curricula) and from British universities (30 curricula). This constitutes a response rate of 67 percent. *Sample size and responses to the online questionnaire:* The questionnaire was sent to 223 programme coordinators at universities offering Physics programmes in 26 European countries. The response rate was 109 valid questionnaires from universities in 21 European countries constituting a response rate of 49 percent. Due to the fact that UK and Ireland did not have to make in-depth structural changes to their two-cycle systems as well as due to a somewhat different organisation of studies compared to continental Europe, a separate questionnaire was constructed for programme coordinators in these two countries. The results were later on integrated into the results to the other countries included in the study. Responses to the questionnaire show a slight bias towards older universities and large Physics Departments or Faculties.
- (6) *Duration of Bachelor programmes in Physics:* almost 90 percent of programmes included in the study have a duration of three years, slightly less than ten percent have a duration of four years. British and Irish universities vary between three or four years' duration. Four years can be found predominantly in Greece, Lithuania, Macedonia and Belarus. Belarus has not yet changed to the two-cycle structure and Spain is just beginning with its introduction. Actual duration of studies until completion of the degree is still unknown in half of the Physics Departments, but of the other half of respondents 22 percent stated that their students finished after 3.5 years, 16 percent stated that they finished after four years and 11 percent indicated that their students actually finished after three years.
- (7) *Credit points, modularisation, student workload, learning outcomes:* Apart from the use of credit point systems the other three dimensions of the Bologna reform agenda are the least homogeneous and obviously not well understood (cf. Appendix 1). ECTS is used in 75 percent of the curricula submitted, while national credit point systems, albeit compatible with ECTS, are used in 18 percent. A clear majority of Bachelor Physics curricula require between 150 and 180 ECTS. Modularisation is not applied in about 40 percent of the Physics curricula and where it is (about 60 percent) the time units on which a module is based differ greatly from each other. Furthermore, respondents from eleven (out of 21) countries stated that the concept of student workload is not applied in their Physics curricula. Although the majority of respondents indicated that one credit is earned by 25 to 30 hours of student workload, the overall numbers of hours indicated by respondents vary between 7.5 and 40. Module or course description as a rule includes a specification of expected learning outcomes (91 % of respondents) but there remain some doubts whether the use of the terminology is already "the real thing" because there continue to be vast differences in terms of how learning outcomes are defined.
- (8) Concerning the use of *Diploma Supplements*, the results are inconclusive. The vast majority of curricula which were analysed (more than 80 %) did not provide any information about it and a respective question was not included in the online questionnaire.

- (9) Two thirds of the Bachelor programmes in Physics are characterised by the respondents to the online questionnaire as being more general in their content, while one third indicate that the curriculum is a mixture of general and more specialised content. Frequently the last year of the study programme offers some opportunities for specialisation. The majority (87 %) of Bachelor programmes in Physics also include *interdisciplinary components* integrating contents from a broad variety of other subjects but having an emphasis on other natural sciences and engineering.
- (10) *Mobility and internationalisation:* At the Bachelor level there are mostly (93 % of responses to the question in the online survey) mobility opportunities (temporary study abroad of the ERASMUS type). The few programmes with compulsory study abroad can be found in Germany, France, and UK/Ireland. Typically, the third year of Bachelor programmes provides a time window (of three to five months in more than half of the programmes) for study or internships abroad. Joint or double degree programmes in Physics at the Bachelor level are rare. In one third of the programmes at least some of the teaching is provided in a foreign language (mostly English in the non-English speaking countries). High proportions of teaching in a foreign language can be found in Bachelor Physics programmes in Switzerland and the Netherlands. Apart from some of the Central and Eastern European countries Bachelor Physics programmes in many other countries have a proportion of international students between five and ten percent. Higher proportions (between 10 and 15 %) can be found in Austria, Germany, and France.
- (11) *Assessment and examinations:* Although the written thesis plus defence continues to be most frequent form of final examination. However, the weight of the final examination which used to determine the final grade exclusively in continental European universities has been somewhat reduced by also including the results of homework papers or tests submitted during the course of study in the grade of the final degree. No homogeneous picture emerges in this respect, however.
- (12) *Employability:* Considerable attention is being paid to equip Bachelor students in Physics with key skills and competences to ease transition onto the labour market. High emphasis is put on foreign language skills (mostly English), other communication skills and project management skills. Altogether 78 percent of the respondents to the online questionnaire stated that the acquisition of such key skills is part of the Bachelor programme in Physics.
- (13) *Transitions:* With regard to Bachelor programmes in Physics we have identified two points of transition: (a) getting access; (b) moving on after graduation. Concerning access there is a general trend towards a higher degree of selectivity, sometimes requiring participation in longer preparatory courses (e.g., cases in Croatia, Switzerland, Germany, and Italy). In an increasing number of countries the school leaving certificate from upper secondary school is no longer seen as being sufficient. These trends tend to be re-enforced by the growing competitiveness of European universities scouting for best talent. The transition after completion of the Bachelor degree can be onto the labour market (frequent so far only in the UK and in Ireland and after graduating from a 'professional Bachelor programme in France), into a Master's programme or directly into a PhD programme (1 % of respondents from UK/Ireland exclusively). 61 percent of all respondents to the online questionnaire stated that their Bachelor students in Physics were trained to continue studying in a Master's programme and 33 percent stated that it was a mixture of both, studying at Master's level and going onto the labour market. However, there are a number of countries from which all respondents stated that they trained their Bachelor Physics students predominantly for continuing their studies at Master's level: Belgium, Denmark, Finland, France, Lithuania, the Netherlands, and the Slovak Republic. Still, most universities included in our study have a considerable spectrum of services and activities geared towards supporting students in their transition onto the labour market.
- (14) *Accreditation, evaluation, quality assurance:* In most Bologna signatory countries accreditation procedures (either for new programmes or for institutions or both) have been established by now. 76 percent of the respondents to our online questionnaire stated that their programmes have to be accredited. Even more common than accreditation is course or module evaluation through student satisfaction surveys (92 %). A special instrument of quality assurance, namely monitoring of teacher preparation and teaching material, can be found especially in Denmark, Finland, the Netherlands, Sweden and the UK/Ireland (altogether 58 % of respondents stated that this is case in their Physics programme).
- (15) *Convergence or not?* The study shows that there is a trend towards *converging structures*, especially in terms of the implementation of two cycles and the use of credit points. *Curricular content, pedagogical approaches and forms of assessment* clearly show more heterogeneity and reflect to a larger extent differences in academic cultures, teaching and learning styles. Key skills and competences as well as support in the transition phases before entering and after graduating are receiving increased attention. Still there is a clear preference among the majority of Physics Departments included in the study to prepare their Bachelor students for transition into a Master's programme.

1. Introduction: Description of the Project

In 2007 the European Physical Society received funding from the European Commission to carry out a study of the implementation of the two-cycle (Bachelor/Master) study and degree structure into Physics programmes in European Universities. It was envisaged to cooperate with the National Physical Societies of at least 15 European countries to collect relevant Physics curricula for in-depth analysis and conduct an online survey addressed to coordinators of Physics programmes in a representative sample of universities in each of the countries involved in the study. The International Centre for Higher Education Research (INCHER-Kassel) at Kassel University was subcontracted as a partner in this project to analyse the curricula and administer the survey. Representatives of the European Physical Society acted as members of the steering group of the project as a whole and as contact persons to the national Physical Societies.

Originally it was envisaged to include both standard physics programmes and engineering physics programmes into the analysis, however, during a first meeting of project partners and steering group it was decided to concentrate in the first year of the project on Bachelor programmes only and exclude engineering physics and teacher training programmes in physics in order to arrive at a relatively homogeneous sample of programmes for the analysis. It is envisaged to focus on Master programmes in Physics in the second year of the project.

The aims of the project can be summarised as follows:

- to provide an overview of the state of implementation of Bachelor and Master structures in Physics Programmes in Europe;
- to analyse possible regional differences in the structures;
- to determine to what extent common standards and appropriate examinations have been introduced as an element of quality assurance;
- to provide information about the extent of modularisation that can be found in the new structures;
- to assess whether professional qualifications can be obtained within the framework of Bachelor programmes in Physics; and

- to determine whether Bachelor curricula have a more standardised structure while Master programmes offer a higher degree of specialisation and, thus, diversity.

Due to the specific character of Physics programmes in most European countries which have introduced the Bachelor/Master structure only in recent years, there will also be a special focus on the interfaces and transitions, *i.e.* the transition from school into university physics programmes and the transition either into the labour market or into Master programmes in Physics after successful completion of a Bachelor degree.

Overall, the study aims to provide a profile of the implementation of the Bachelor/Master structure in European Physics programmes and arrive at conclusions pertaining to the following issues:

- an assessment whether major goals of the Bologna Process have been addressed and whether the aims of the European Commission's "Education and Training 2010" Work Programme will be met;
- enabling Physics Departments involved in the study to recognise potential partners for exchange and cooperation;
- yielding the basis for advice to students interested in changing university;
- providing a basis for modifications and amendments which might become necessary to achieve the overall reform goals.

2. Design of the Study

The study is divided into two parts which will complement each other and be linked together in the concluding chapter.

After having determined the sample size – approximately 60 percent of all universities offering Physics programmes in the large countries involved in the study and as close as possible to 100 percent of all universities offering Physics programmes in the small countries – contact persons in the respective National Physical Societies were asked to select the respective number of universities and ask the local programme coordinators to send their Bachelor and Master Physics curricula to INCHER-Kassel. Where necessary they were also asked to help with translations into English. The curricular material was analysed according to a list of criteria (*cf.* chapter 4) which had been derived from

the main structural dimensions of the Bologna reform process.

In a second step an online questionnaire was designed focusing primarily on Bachelor programmes and covering altogether nine areas (*cf.* chapter 5):

personal details of the respondent (status and function),

- institutional details (type, size),
- implementation of the tiered (two-cycle) structure (accreditation status, duration, number of programmes on offer),
- implementation of complementary measures (ECTS, workload, modularisation, mobility opportunities),
- characteristics of the curriculum (generalised/specialised, use of foreign languages in teaching and learning, extent of interdisciplinarity),
- forms of student assessment and examinations,
- mechanisms of quality assurance,
- employability and acquisition of transferable skills,
- number of international students, completion rates and transition into Master programmes or into the labour market.

For the United Kingdom a separate online questionnaire was constructed due to the fact that the Bachelor and Master structure is the rule in British universities but differs to some extent from the meaning it has acquired in the framework of the Bologna process, *i.e.* three year Bachelor programmes possibly followed by a one year Master programme in England and Wales, four year Bachelor programmes in Scotland. Thus, many questions in the questionnaire sent to the other countries did not apply. However, for the final report the results of the British questionnaire are integrated as much as possible into the overall presentation of results.

Together with a cover letter explaining the project and including the link to the online questionnaire a sufficient number of personal identification numbers (PINs) generated by chance were then sent again to the contact persons in the National Physical Societies with the request to forward the letter and one PIN to the programme coordinators in the selected universities. Due to reasons of data protection all universities having submitted curricular material as well as all persons filling in the online questionnaire were assured of complete anonymity.

3. Bologna Reforms and Physics Programmes

3.1 The Bologna Process: Structures and Elements of Bachelor and Master Programmes

The overall goal of the Bologna Declaration and the resulting reform process (for short: Bologna Process), namely to create a European Higher Education Area (EHEA) by the year 2010 has been described as a “target on the move” (cf. Maassen/Olsen 2007, Kehm/Huisman/Stensaker 2009). And indeed, with every ministerial meeting after the one in Bologna in 1999 when the original Declaration was signed by 26 European countries goals were added to the agenda and targets refined increasingly moving from a mostly structural level to also include content related goals. Thus, for example, the “social dimension” was added at the 2001 ministerial meeting in Prague, doctoral education as the third cycle of studies was added at the 2003 ministerial meeting in Berlin, further details on specific targets, in particular on quality and a European qualifications framework were added at the 2005 ministerial meeting in Bergen. All the while more and more countries joined the process by signing the Declaration and committing themselves to the achievement of the goals by 2010. By now, 46 countries in all have signed and the Bologna Process is regarded as the biggest and most far reaching reform of curricula and study structures since possibly the period after World War II.

In addition to ever more countries joining the reform, stakeholder inclusion was extended as well. Starting as an intergovernmental initiative of ministers responsible for (higher) education, deliberations, follow-up and stocktakings now include the European Commission, the European University Association (EUA), the European Student Union (ESU, formerly ESIB), and a number of other actors (e.g. ENQUA, EURASHE, the Council of Europe). In fact, the process of coordinating this massive reform project has become so complex that a Bologna Follow-up Group has been established with its own Secretariat, a Stocktaking Group, and a number of other European organisations and consortia have become involved studying particular issues and working on the formulation of recommendations.

In addition to periodic national reports about the implementation of the Bologna reforms to be submitted by all signatory countries, the European Commission is currently funding an independent consortium (in which INCHER-Kassel is one of altogether three partners) analysing the state of implementation and the achievement of the Bologna goals for the ‘finale furioso’ which can be expected in 2010. Finally, the responsible ministers are currently in the process of designing and discussing a strategy for the future and sustainability of the Bologna Process 2010 to 2020 which will be decided at the upcoming ministerial meeting in Leuven in April 2009 (cf. Kehm/Huisman/Stensaker 2008).

Despite the growing complexity of the reform agenda, there are a few core issues which can be said to constitute the main targets for 2010:

- the adoption of a system of easily readable and comparable degrees, also through the implementation of the Diploma Supplement (Bologna Declaration 1999);
- the adoption of a system essentially based on two main cycles, undergraduate and graduate, the first cycle lasting a minimum of three years and being relevant to the European labour market as an appropriate level of qualification (Bologna Declaration 1999);
- the establishment of a system of credits (such as in the ECTS system) to promote student mobility (Bologna Declaration 1999);
- the promotion of mobility of students, teachers, researchers and administrative staff including recognition and valorisation of periods abroad (Bologna Declaration 1999);
- the promotion of European cooperation in quality assurance to develop comparable criteria and methodologies (Bologna Declaration 1999) further refined in the Berlin Communiqué 2003);
- the promotion of the necessary European dimensions in higher education with regard to curriculum development, inter-institutional cooperation, mobility schemes, and integrated programmes of study, training and research (Bologna Declaration 1999);
- to promote lifelong learning as an essential element of the European Higher Education Area (Prague Communiqué 2001);

- involvement of higher education institutions and students as competent, active and constructive partners in the reform process (Prague Communiqué 2001);
- to promote the attractiveness of the European Higher Education Area to students from Europe and other parts of the world (Prague Communiqué 2001);
- the establishment of a link between the Bologna reforms and the Lisbon Strategy to create a European Research Area (Berlin Communiqué 2003);
- the adoption of an overall framework for qualifications comprising three cycles (Bergen Communiqué 2005);
- the inclusion of a social dimension in the Bologna Process (Bergen Communiqué 2005);
- the establishment of a European Register of Quality Assurance Agencies (London Communiqué 2007);
- to promote the attractiveness and competitiveness of the European Higher Education Area in a global context (London Communiqué 2007).

In order to be able to analyse the structures and elements of Bachelor and Master programmes (the third cycle, *i.e.* doctoral education, is not included in this study) we have concentrated on those Bologna reform goals that are targeting study programmes and have to be implemented at the institutional level. We have not dealt in detail with goals that have to be implemented at the national level and through policy. This basically leaves the two-cycle structure and their duration, the diploma supplement, the introduction of a credit point system, the issue of employability after successfully completing the first cycle, the promotion of mobility and a European dimension in the curricula, widening access or enabling equality of access (social dimension), and quality assurance. These are the items on which we have concentrated our analysis of Bachelor (and Master) curricula in Physics programmes in Europe.

3.2 Previous Analyses

In addition to the national reports submitted for the Bologna stocktaking exercise in 2005 and the Trends I – V reports prepared as background information about the state of implementation of the

► Bologna reforms for each of the ministerial meetings, the Bologna reform process has generated a plethora of studies and analyses so far. The majority of these studies and analyses are policy oriented and either focus on one country or a few countries for comparative reasons or on the European level. There are hardly any subject specific analyses available (*e.g.* one doctoral dissertation on history by a young French researcher).

Concerning Physics, we find the results of the Tuning Project (2007) for Physics providing a template for how it should be done and the study by Ulrich Nienhaus (2007) about the actual implementation of Bachelor and Master structures into Physics education at German universities. The work by Johanna Witte (Witte 2006) who took a comparative look at the Bologna reform process in four countries (Germany, Netherlands, France, England) included curricula and curricular governance. However, the analysis was focused on general structures and policy and did not include any subject specifics.

Most analyses show that policies are in place and that there is a certain amount of convergence on the level of macro structures while there is a clear trend towards considerable diversity and divergence at the level of the micro structures. In addition, policy makers of many Bologna signatory countries have attached national reform agendas to the Bologna reform process so that not everything subsumed under the “Bologna label” actually is part of the Bologna reform agenda.

This study is a first attempt of a comprehensive and comparative analysis of Bachelor Physics education at universities in 25 Bologna signatory countries and how it is implemented on the basis of the Bologna reform goals.

3.3 Sample Size, Responses, Specificities of the Curriculum Analysis

Basically through the promotion of the project by the European Physical Society the number of countries involved in the project could be extended from the envisaged 15 to 24. In particular a number National Physical Societies from smaller, often Central and Eastern European countries were keen to join, while some of the larger and more central countries have been lagging behind.

Through desk research we first tried to determine the total number of universities in each of the countries and assumed that these would be offering Physics Programmes. The figures were cross-checked and amended where necessary with the help of the European Physical Society and the national Physical Societies of the countries involved in the study. We then decided in cooperation with the steering group to have a sample of about 50 to 60 percent of these universities in the big countries and 100 percent in the small countries and ask the contact persons in the respective National Physical Societies to provide us with the Bachelor and Master Physics curricula of a given number of universities or approach a university contact person to submit them either in paper or in electronic form. This did not quite work out as expected. The following factors prevented us from having our ideal type sample:

- (a) the implementation of the Bachelor and Master structure in some countries had not yet started at all or was in its preparatory stages (*e.g.* Spain);
- (b) some countries had opted to implement Bachelor programmes first and Master programmes at a later stage (or vice versa);
- (c) implementation of the new structure does not happen at the same time in every university across some countries so that some universities have changed to the new structure already while others have not yet (*e.g.* Spain, Germany);
- (d) in two countries the Bologna reforms are being implemented by designing one national template for a curriculum which has to be implemented by all universities (Belarus, Ukraine);
- (e) in a few cases pure physics programmes are not offered at all universities but are concentrated in some institutions only (*e.g.* Czech Republic);
- (f) finally, there was and still is the problem that some of the curricula and related material have not been translated but were sent to us in the language of the country; and while we could deal with quite a number of languages, at least sufficiently to get an idea about the curriculum, other languages were simply beyond our capacity (*e.g.* Finnish, Albanian).

The following table contrasts what we ideally had hoped for and what we have actually received in terms of curricula submitted for analysis:

The table shows that there are altogether roughly 1,000 universities in the 24 countries involved in the study (Poland did not participate in the end; Denmark participated in the survey) of which 382 (37.9 %) offer physics programmes according to information of the European Physical Society and the national Physical Societies involved in the project. From among these we selected (as described above) a sample of about 60 percent. The response rate has been 66.4 percent, however we also should note the inherent bias in the sample. Somewhat more than two fifths (42.2%) of the curricula in the sample are from Germany and the UK. Two of the larger countries (Ukraine and Belarus) submitted only one curriculum each for Bachelor and Belarus also one Master programme curriculum due to the fact that a national curriculum template had been designed which must be implemented by all universities in the country offering Physics programmes. In Slovakia and in the Czech Republic pure Physics programmes are concentrated in just a few institutions while the others offer teacher training or applied Physics which we excluded from our analysis.

Altogether the analysis of Bachelor Programmes in Physics is based on 154 universities having submitted one or more Bachelor curricula until March 2009. To establish the exact number of Bachelor curricula in Physics included in this study presents a problem. The majority of institutions offer only one Bachelor Programme in Physics, however there is a sizable number of universities – especially in the UK, *i.e.* 25 out of 30 UK universities (83.3 percent) participating in the project – offering more than one and up to 10 or 12 different programmes at this level. In addition there are also a few universities offering different Physics degree programmes at the Bachelor level which are distinguished into one general Physics programme with a given number of variations in form of specialisations which are also named as part of the degree. These variations in the combination of general Physics education plus a chosen specialisation do not count as individual programmes everywhere. In order to deal with this potential bias we have

▼ Table 1: Countries involved in the study, number of universities, curricula received

Country	Total number of universities	Number of universities offering Physics programmes	Number of universities to be included in project	Number of universities having submitted curricula	Comments
Albania	15	4	4	2	
Austria	31	6	6	6	
Belarus	28	6	4	1	One curriculum for a one year Master; one curriculum for a (traditional) 5 year specialist education.
Belgium (nl)	6	5	3	3	
Belgium (fr)	9	5	3	3	
Croatia	5	4	4	4	One university submitted a Master programme only.
Czech Republic	24	12	7	3	80 to 90% of pure Physics programmes concentrated in a small number of universities.
Denmark	12	4	4	0	
Finland	13	11	8	8	
France	87	57	29	7	One university submitted a Master Programme only.
Germany	97	59	35	35	
Greece	23	5	5	3	
Hungary	25	5	5	5	
Ireland	21*	9	4	3	* 7 Universities; 14 Institutes Of Technology with equivalent programmes.
Italy	89	36	20	10	
Lithuania	15*	4	4	1	* 7 private Universities.
Macedonia	5	2	2	2	
Netherlands	14	9	5	5	
Poland	18	12	8	0	
Portugal	34	15	10	4	
Slovenia	4	3	2	2	
Slovakia	33	14	2	2	20 public, 10 private, 3 state universities. Standard Physics programmes concentrated in two universities.
Spain	73	21	12	5	Implementation of Bachelor and Master programmes just starting.
Sweden	21	9	6	2	
Switzerland	12	7	7	7	
Ukraine	81	10	3	1	One national curriculum for a 4-year Ba (Ma envisaged at a later stage.)
United Kingdom	212	48	30	30	
Total	1.007	382	232	154	
In Percent		37.9 % of the universities	60.7 % included in project	66.4 % of departments/faculties submitted one or more curricula	

► chosen Physics departments/faculties as our aggregate level for overall tables. For the time being we have established a number of 152 faculties/departments with Bachelor Physics curricula as a basis for our analysis. Finally, three departments submitted a Master curriculum only. This explains the difference between the number of universities (n=155) having submitted curricula (be it Bachelor curricula or be it Master curricula or both) provided in Table 1 and the number of departments/faculties having submitted Bachelor curricula in Physics (n=152) used as the basis for our analysis.

3.4 Sample Size, Responses and Specificities of the Online Survey

In mid-November 2008 a cover letter with a link to the online questionnaire and a number of PINs (generated by chance) were sent to the contact persons in the National Physical Societies with the request to send the cover letter and one PIN to each of the programme coordinators of study programmes in Physics in the universities selected for inclusion in

the project. Also countries were included from which no curricula had been received for analysis. For the UK and Ireland a special questionnaire was designed which went online a few days later. The deadline for submitting the filled in questionnaires was set for 28 November 2008. A week after that a reminder email was sent to all contact persons in the National Physical Society with the request to forward it to the programme coordinators in the universities. Eventually the deadline was extended until 23 December 2008.

Altogether 223 PINs were provided to programme coordinators at universities offering Physics programmes in 26 European countries. The response rate was 109 valid filled in questionnaires from 21 countries (48.9 percent) which are included in the analysis. We received no responses to the online questionnaire from universities in Albania, Croatia, Italy, Poland and Portugal. A further specificity is that the UK National Physical Society is also organising the Irish universities and since the PINs were generated to guarantee anonymity and confidentiality, we can not differentiate between responding UK universities and responding Irish universities.

The distribution of responding institutions or better Physics departments across the countries involved in the study is shown in Table 2:

The highest proportion (46%) of local contact persons or programme coordinators in the universities who filled in the questionnaire were senior teachers (professors, readers, lecturers) followed by deans, directors or heads of studies (43%). But there were also some junior academic (4%) and administrative staff (7%) dealing with the questionnaire as well as a number of persons in other functions ranging from vice dean and faculty manager to head of the examination board. In relation to the Physics Bachelor Programme or Programmes, the respondents had different functions, most of them being senior teachers (68%), followed by programme coordinators (61%), and administrative staff (16%). Other functions were indicated by 13 percent of the respondents.

Regarding the higher education institutions Physics Departments of which have participated in the survey the sample has a slight bias towards older universities, 43 percent are 100 years old or older, the oldest being 700 years old, the youngest 15 years. Among the Physics departments responding to our questionnaire 88 percent were part of a university and 12 percent part of a technical university. We also asked about the range of subjects offered by the institution as a whole and it tends to be rather broad. All of the institutions offer programmes in natural sciences, about three quarters offer humanities (75%) and social sciences (77%), two thirds offer law (66%), and slightly less than two thirds of them offer engineering (62%). Medicine is offered by 57 percent of the universities participating in the survey. Arts (including Design and Architecture) are offered by more than half of the institutions (53%) and agriculture by only 21 percent. We can conclude that a clear majority of universities in which participating Physics Departments are located offer the full or at least a very broad spectrum of subjects. This is supported by the overall number of students studying at the respective universities as Table 3 shows.

The smallest higher education institution in our sample has slightly less than 1,000 students and the biggest has 72,000 students.

Country	Number of respondents	In Percent
Austria	3	2.8
Belgium	6	5.5
Belarus	3	2.8
Czech Republic	3	2.8
Denmark	3	2.8
Finland	8	7.3
France	5	4.6
Germany	27	24.8
Greece	1	0.9
Hungary	5	4.6
Lithuania	1	0.9
Macedonia	1	0.9
Netherlands	4	3.7
Slovenia	3	2.8
Slovakia	2	1.8
Spain	8	7.3
Sweden	4	3.7
Switzerland	5	4.6
Ukraine	1	0.9
UK/Ireland	16	14.7
Total	109	100.0

▲ Table 2: Respondents to the Online Questionnaire according to Country

Number of students	Percent of institutions
Up to 5,000	9
5,001 – 10,000	15
10,001 – 15,000	17
15,001 – 20,000	19
20,001 – 30,000	20
More than 30,000	19
Total	100

▲ **Table 3:** Size of institutions participating in the survey by number of students

Overall our sample of universities tends to have a slight dominance of large and older institutions offering a broad range of subjects and study programmes.

The Physics departments or faculties which have filled in the online questionnaires also tend to be larger ones with 43 departments/faculties having up to 300 Physics students and 57 departments/faculties having between more than 300 and up to more than 1,000 Physics students (*cf.* Table 4). Another indicator for size can be the number of academic staff within the Physics departments/faculties. Among the 100 responses we received to the respective question, 16 universities said that the number of academic staff in their Physics department/faculty was less than 25, a number of staff between 26 and 50 was provided by 37 respondents, 14 departments/faculties each indicated staff numbers between 51 and 75 and between 76 and 100. Finally 19 departments/faculties said their academic staff numbers in Physics were more than 100.

The types of Physics programmes currently offered by the departments/faculties providing valid responses to the question show a considerable range as well. Slightly less than one fifth of the departments (18%) offer (degree) programmes other than Bachelor or Master indicating either that traditional programmes are still offered or that programmes other than degree programmes in Physics are also provided (*cf.* Table 5). Furthermore it can be safely assumed that some of the respondents included their traditional long cycle programmes either into the category of “consecutive/integrated Master programmes” or into the category “stand alone Master programmes”. As this report focuses on the Bachelor programmes in Physics some more information on these will be provided in the following.

In quite a number of countries universities typically offer one Bachelor programme in Physics. This is the case for Austria, Belgium, Switzerland, Spain, the Netherlands, and Sweden. However, the average number of Bachelor programmes offered by a university is more than one on average in the rest of the countries. Especially high figures can be found for Greece (5), Lithuania (7), the Ukraine (10) and the UK/Ireland (6). However, only one university each from Greece, Lithuania, and the Ukraine answered to this particular question.

Apart from the UK and Ireland where Bachelor programmes are the traditional degree programmes, the change to the new structure in the other countries happened mostly between 2002 and 2005. Concerning Physics, only the Spanish universities responding to the questionnaire indicated that the introduction of the tiered structure has not yet taken place but is envisaged to happen soon. 65 percent of the institutions answering to the questionnaire said that their Bachelor programme in physics was accredited, while 35 percent said that it was not. However, among these 35 percent are all institutions from three countries (Austria, Belarus, Spain) in which accreditation is not implemented. Rather curricula are approved either by the responsible Ministry

or by the institutions themselves (Austria). Other countries typically have a mixture of government bodies, institutional autonomy and agencies for the approval of new curricula.

4. Results of the Curriculum Analysis and the Survey

4.1 Duration of Bachelor Programmes in Physics

The majority of Bachelor programmes in Physics which have been submitted for analysis have a duration of three years. Exceptions are found in Greek and Irish universities as well as in Lithuania and Macedonia where they have a duration of four years. The one curriculum we received from Belarus which is the same for all universities in the country is a traditional five year programme.

What has to be kept in mind when talking about duration of studies are two things:

- The Bologna Declaration only talks about a first cycle which should have a duration of at least three years, thus longer programmes are possible as long as the combined duration of first and second cycle studies is not longer than five years.
- The transition phase from school into Physics programmes at universities increasingly tends to be extended through preparatory courses which may last up to one year. In addition, some programmes (*esp.* in the UK) offer a year of study abroad which might also extend the duration until completion of the degree.

Table 6 provides an overview of the regular duration of Bachelor programmes in Physics as established in the curricula. It does not inform about the actual duration until successful completion of the

Number of students	Number of Physics Departments/Faculties
Less than 100 students	13
101 – 300 students	30
301 – 500 students	20
501 – 700 students	13
701 – 1,000 students	12
More than 1,000 students	12
Total (n)	100

▲ **Table 4:** Size of Physics Departments according to number of students.

Type of programme(s)	Percent of Institutions
Bachelor progr.	95
Stand alone Master progr.	63
Consecutive/integrated Master progr.	65
Other (degree) progr.	18

▲ Table 5: Types of Physics programmes currently offered (multiple replies possible)

► degree. The majority of four year Bachelor programmes can be found in Greece, Ireland, Spain, Lithuania and Macedonia. The five year “specialist” programme is from Belarus.

Looking at the countries in which those universities are located having responded to the online questionnaire we find that in the majority of countries (85 percent) Bachelor programmes in Physics have a duration of 3 years. Exceptions are Spain, Greece, Lithuania, Macedonia and Ukraine where Bachelor programmes in Physics have a duration of four years. In Belarus the average duration of what is being termed “specialist programme” is five years. The regular duration of Bachelor programmes in Physics is somewhat mixed in the British and Irish universities, although the majority of respondents (73 Percent) indicated a duration of 3 years while 27 percent said that it was 4 years. In the online questionnaire we had an opportunity to ask how long it actually takes students to successfully finish their Bachelor programme in Physics. Although almost half (45 percent) of the respondents indicated that no information was as yet available concerning this question, 11 percent said that students actually finished after 3 years, 22 percent said that students finished after 3.5 years, 16 percent had an average completion rate after 4 years, 2 percent after 4.5 years, and 4 percent said that their students on average took 5 years or longer. The latter is the case in Spain, Greece, and Macedonia and it can be safely assumed that Physics programmes in these countries either have not made the actual change to the new structure or were referring to integrated programmes in which the Bachelor and the Master phase of study are not clearly separated.

Countries in which the new tiered structure has obviously been implemented only recently, so that there is a high proportion of respondents indicating that there is as yet no information available about actual duration of studies are: Austria (67%), Germany (72%), Spain (83%), Hungary (100%), Sweden (67%), and Slovenia (100%). Countries with a high percentage of students finishing after 3 years are Switzerland (40%) and Slovakia (100%); and countries with a high percentage of Bachelor Physics students finishing after 3.5 years are Belgium (50%), Switzerland (60%), and the Czech Republic (67%).

4.2 Use of Credit Point Systems, Student Workload Calculations, and Modularisation

A number of European countries had introduced credit point systems long before the beginning of the Bologna Process, some even before the advent of the European Credit Transfer Scheme (ECTS) as a pilot scheme (in 5 subjects and 145 universities) in the academic year 1989/90. While ECTS gradually became more popular in the course of the 1990s as a formal instrument of recognition, it experienced its final breakthrough at the beginning of the Bologna Process. The Bologna Declaration and subsequent Communiqués of the responsible Ministers do not prescribe the use of ECTS but accept other credit point systems as well as long as they are compatible with ECTS. Most of those countries operating their own credit point systems (in particular UK, Ireland, the Netherlands, some of the Central and Eastern European countries within our sample, but also some of the Scandinavian

countries) have by now found means and ways to make them compatible with ECTS. The curricula from Belarusian, Slovak and Spanish universities in our sample did not provide information about the use of a credit point system, although all respondents to the questionnaire from Spain and Slovakia stated that the ECTS credit point system is used in their Bachelor Physics programmes.

The idea of basing credit points on a calculation of student workload crept into the reform agenda during the 2003 ministerial meeting in Berlin at which the establishment of an overarching framework of qualifications for the European Higher Education Area was introduced. Establishing such a framework of comparable and compatible qualifications (at first implemented by the Dublin Descriptors¹ which were then further developed into a European Qualifications Framework) entailed the description of “qualifications in terms of workload, level, learning outcomes, competences and profile” (cf. Berlin Communiqué 2003, p. 4) and marked the shift from a teacher centred to a learner centred organisation of studies. The student workload is calculated on the basis of the number of hours which a student has to spend for earning one credit. The workload is composed of self-study, participation in classroom teaching and doing the homework or prepare for and participate in an examination. The general idea that one ECTS credit point equals approximately 25 to 30 hours of student workload is based on an estimate of how long an average student might need to fulfil certain tasks, acquire certain competences, or successfully acquire knowledge, skills and competences of a certain type. The latter is defined as learning outcome. According to these parameters students acquire 60 ECTS credit points in a given academic year and accumulate altogether about 180 ECTS credit points in the framework of a 3 year Bachelor programme (between 4,500 and 5,400 hours of student workload).

The vast majority of Physics Bachelor curricula in our sample indicated the number of national or ECTS credit points that

Duration in years	3 years	4 years	5 years	Total
Number of curricula	136	15	1	152
In percent	89.5	9.9	0.7	100

▲ Table 6: Regular Duration of Bachelor programmes in years

¹ The Dublin Descriptors were developed in 2004 by an informal working group to differentiate key competencies which can be expected from graduates in each of the three cycles (bachelor, Master and doctorate).

have to be earned for a Bachelor degree, however it frequently remains unclear how many hours of student workload are necessary to earn one credit point or whether credit point calculations are based on student workload at all.

Table 7 provides an overview of the number of curricula based on national and ECTS credit points. National credit point systems are dominantly used in Italy and the UK. Just as the concept of learning outcomes, the definition of modules or ideas about the meaning of modularisation are vastly diverse. Despite the fact that the Tuning Project has tried to provide guidelines and even templates for respective curriculum development, the information provided in the Physics Bachelor curricula shows that proper definitions of learning outcomes and appropriate calculation of credit points based on student workload are available in only few countries. Here are a few examples:

(a) Modularisation (curricula of 5 countries do not make a reference to modularisation)

Belgium: Modules consist of different teaching formats as well as independent study. Teaching material is listed, credit points take level of content into account.

France: Various topics of the curricular content are associated with a different number of hours of student workload per week which includes contact hours and independent study.

Germany: Similar to Belgium.

Hungary: Reference only to curricular content, differentiation according to types of teaching, no definition of learning outcomes.

Lithuania: Reference to curricular content, number of contact hours is calculated as student workload.

Switzerland: Credit points include all study related activities; learning outcomes are envisaged but often not listed in the module descriptions. Workload and credit points are related.

United Kingdom: Clear definition of modules and learning outcomes with a number of national and ECTS credit points associated to each module.

(b) Workload (curricula of three countries do not provide information on student workload)

Belgium: Workload calculations consist of time for theory, exercises, training and project, and independent study by students. Credit points are calculated on the basis of the sum of working hours.

Italy: Broad variety of definitions, ranging from associating a fixed number of credit points to a particular course provision to differentiating credit points according to type of class (e.g. lecture, seminar, laboratory etc.).

Netherlands: Student workload is expressed in credit points.

Spain: Level and content of course provision are associated with a number of credit points.

Slovenia: Types of teaching plus number of required work hours by students for a particular module result in a given number of credit points.

(c) Learning Outcomes (curricula of nine countries are not based on learning outcomes, curricula of five countries do not provide information on learning outcomes)

Belgium: Modules are differentiated according to learning goals, content, and level. Learning outcomes are achieved through various forms of teaching and independent study.

Croatia: Definition of learning outcomes and competences which can be acquired for every course. ECTS is a combination of contact hours and independent study.

France: No definition of learning outcomes. Topics are studied in the framework of a number of hours per week and with different methodologies. Independent study is included in the calculations.

Germany: Broad variety of approaches ranging from a simple list of themes or topics with credit points associated to each topic to highly differentiated models with defined learning outcomes.

Questions about the extent of modularisation and calculation of credits based on student workload were also included in the online questionnaire. 69 percent of the respondents said that their Bachelor Physics programmes were modularised while 31 percent answered negatively to the respective question. Interestingly, in seven countries (Belarus, Germany, Denmark, France, Greece, Lithuania, and Ukraine) all responding universities (100%) had modularised their programmes while universities in the other countries gave a mixed response, i.e. some had modularised programmes, some had not. A similarly mixed picture emerges from the question whether modules or other time units used are calculated on the basis of student workload. 87 percent of responding universities said that modules (or other time units) are calculated on the basis of student workload, while 13 percent said they were not. To this question 100 percent of all responding universities from eleven countries answered positive, responding universities from Greece and Ukraine answered negative (only one response from each of the two countries to this question) while universities from the other countries (Belgium, Switzerland, Finland, Hungary, United Kingdom) provided a mixed answer.

The majority of responding universities indicated that one credit is earned by either 25 hours (21%) or 30 hours (35%) of student workload. Other respondents provided a large variety of workload hours ranging from 7.5 to 40, furthermore all respondents from Belarus, the Czech Republic, Greece, and Macedonia indicated that the question was not applicable so that it can be assumed that student workload is not used as a criterion for credit points in these countries. Asked however, whether their module

▼ **Table 7: Physics Bachelor curricula based on credit points**

	ECTS	National Credit Point System	Student Workload/Hours*	No Information	Total
Number of curricula	114	28	1	9	152
In percent	75.0	18.4	0.7	5.9	100

* Belarus submitted a five year curriculum requiring a workload of 9,744 hours but does not use a credit point system. This is most likely a traditional "specialist" degree.

► or course description included expected learning outcomes, the picture changes considerably. 91 percent of respondents to the questionnaire answered positively to this question, including the respondents from Belarus (2), Greece (1), and Macedonia (1), while of the two respondents from the Czech Republic one answered with “yes” and the other with “no”. Answers from the other countries again provide a mixed picture; it is, however, interesting that all 25 German respondents to this question said that their module description included expected learning outcomes. This positive result for Germany is related to the recommendations of the KFP (Conference of the Physics Faculties) which were fully adopted by the German universities.

4.3 Diploma Supplement

Despite the fact that the Diploma Supplement is becoming increasingly more widespread, the majority of curricula included in our analysis does not provide information about its implementation or mode of its use. Not finding any mention of it does, however, not necessarily imply it is not issued or available. It might also be that the issue of the Diploma Supplement is stated in different documents which we did not collect. We therefore created three categories (automatically issued, issued upon request and no information available).

Of the 152 curricula which we have analysed 124 (81.6%) did not provide any information concerning the Diploma Supplement, 27 (17.8%) stated that it was issued automatically, and one (0.7%) stated that the Diploma Supplement was issued upon request.

A question concerning the issue of a Diploma Supplement was not included in the online questionnaire.

4.4 Degree of Specialisation

Two thirds (63%) of the respondents to the online questionnaire state that their Bachelor Physics programmes are more general, two percent characterise them as more specialised and one third (35%) state that there is a mix of general and more specialised content. Typically Bachelor Physics curricula are more general in the first two years while the third year offers opportunities for specialisation. In the analysis of curricula from the United Kingdom we found that the first two years of standard Physics programmes (the so-called F 300 programmes) at Bachelor level are basically very similar while the third year is used for specialisation as well. The specialisations which are offered cover a broad range of fields within Physics or constitute particular combinations of Physics programmes plus another subject. These specialisations usually form an individual programme of study. This is the reason for the high number of Physics degree programmes at Bachelor level offered by British universities (up to 15). The majority of Bachelor Physics programmes (87 %) responding to the online questionnaire also include interdisciplinary components. Most of these components (75 %) are integrated parts of the curriculum. The subjects to which these components are related or linked show a broad range of fields (*cf.* Table 8).

4.5 Time Windows for Mobility and Degree of Internationalisation

It is well known that easing and increasing mobility of students (and staff) is an important goal in the Bologna reform process. When the actual process of implementing the tiered structure of study programmes and degrees had taken off, there was first a widespread concern that the way of implementing the reform would create a problem for mobility because curricula showed a high level of density of subject matter and the more formalised structure of studies in many programmes seemed to close rather than open up time windows for mobility. In addition, figures tended to support this concern. Intra-European, ERASMUS-type mobility was stagnating or even decreasing. However, gradually another picture is emerging. Temporary periods

of study abroad (à la ERASMUS), now being termed “credit mobility”, are beginning to be complemented by what has been called “degree mobility”, *i.e.* more and more students opt to study abroad for a whole degree programme. In addition, there is an increasing number of students from outside Europe seeking to get a degree at a European university. The latter is also related to the fact that the number of English taught degree programmes has increased in the non-English speaking countries. Finally, there also seems to be a slight increase in the number of double or joint degree programmes which – together with the ERASMUS Mundus programme – offer further opportunities for study abroad which are integrated into the curricular structure of a given programme and thus, constitute the rule rather than an exception. Only a minority of our Bachelor Physics curricula (2 %) which are included in the study have an obligatory phase of study abroad. In a number of programmes study abroad is possible – most likely within the framework of ERASMUS agreements – and the majority of curricula (almost 80 %) do not provide information on this issue. Here the same arguments are valid as provided for the “no information” category with regard to the Diploma Supplement. An overview is provided in the following table (Table 9). The online questionnaire was used to ask about mobility opportunities and the extent of internationalisation of Physics programmes in more detail. Compulsory phases of study abroad are rare (7 %), however, 93 percent of the respondents state that elective phases of international student mobility are part of their Bachelor curriculum in Physics. Compulsory phases of study abroad can be found in particular in German, French und UK/Irish Physics programmes. Furthermore, in the vast majority of countries included in our study universities offer a broad range of opportunities for mobility in the framework of internships or laboratory work. In two fifths of the programmes (41%) students can go abroad for a temporary period of time at any point in time during their programme of studies but there is a clear trend (46%) that the third year of studies is the preferred time window to go abroad. More than half of the respondents (57%) state that mobile students

Subjects/subject groups	In percent
Other natural sciences	89
Engineering	49
Medical sciences	24
Humanities	26
Social sciences	36
Other subjects	26

▲ Table 8: Other subjects or subject groups being part of the Bachelor Physics curriculum (multiple replies possible).

spend between three and 5 months abroad, 35 percent spend more than five months abroad, and seven percent indicated that students spend between one and two months abroad. These shorter periods are most common in Belarus, Finland, and the Netherlands.

Joint or double degree programmes are rare at the Bachelor level in Physics. Only 2 percent (two programmes out of 98 about which information was provided) of the respondents stated that their programme is a joint or double degree programme.

Another factor typically adding to the extent of internationalisation of a given programme is its provision in a foreign language (mostly English in the non-English speaking countries). 34 percent of responding Physics Departments stated that in their Bachelor programme teaching is offered in a foreign language. Particular high percentages of foreign language teaching in Bachelor Physics programmes can be found in Switzerland and the Netherlands. However, it is unusual at the Bachelor level to teach the complete programme in a foreign language, this is more typical for the Master level. At the Bachelor level typically some courses, modules or classes are offered in English or another foreign language. Teaching in English ranks highest in non-English speaking countries, followed by French, German, Italian and Spanish.

The indicator “proportion of international students among overall student population” is also typically used to assess the degree of internationalisation within a given higher education institution. To a respective question in the online questionnaire (“please indicate the percentage of international students enrolling in your Bachelor Programme in Physics”) only Physics Departments from Belarus, Lithuania, Macedonia, and the Ukraine stated that there were no international students in their Bachelor Programmes in Physics. The majority of respondents indicated proportions of international students between one and five percent (32 percent of all respondents to this question said that the proportion of international students was five percent). High proportions of international students (between ten and 15 percent) can be found in Physics Departments in Austria (not last due to many students from the German speaking minority from South Tyrol in Italy), Germany, and France. Swiss Physics De-

	Mobility possible	Mobility obligatory	No Information	Total
No. of Curricula	28	3	121	152
In percent	18.4	2.0	79.6	100

▲ **Table 9: Mobility within the Physics Bachelor curricula**

partments participating in the online questionnaire indicated the highest proportions of international students in the Bachelor Physics programmes, namely between 25 and up to 42 percent. This surprisingly high level of international students can be explained to the fact that in Switzerland three languages (German, Italian, French) are spoken and many students from the neighbouring regions of Italy, France, Germany and Austria come to study in Switzerland.

4.6 Assessment and Examinations

Modularisation and continuous assessment of learning outcomes is linked to the reduction of the dominant weight of the final examination which used to be typical for university studies in continental Europe. 84 percent of the respondents to the online questionnaire stated that student performance in terms of learning outcomes is assessed after each module or unit of teaching and learning. Still, the final examination continues to have considerable weight and is often composed of several aspects or parts. The written thesis plus defence was the most frequently stated form of final examination (51 %), followed by an oral examination (38%). 28 percent of the respondents stated that in their Bachelor examination for a Physics degree a written thesis is required, 26 percent of Physics Departments included in this study have project presentations as part of the final examination for a Bachelor degree, 19 percent stated that there are written tests, four percent required the demonstration of a project, a mathematical formula or similar, and twelve percent named further forms of assessment in the final examination. Furthermore, 40 percent of the respondents indicated that only subject knowledge is assessed, while 60 percent also included transferable skills in the assessments.

During the course of study the following types of assessment are used:

- written tests (99 %)
- oral examinations (78 %)

- homework papers (71 %)
- interviews by the teachers (30 %)
- multiple choice tests (26 %)
- other forms of assessment (27 %).

The forms of marking or grading which are used in Bachelor Physics programmes tend to be rather varied as well. Only 16 percent of the respondents stated that the student performance is not marked but stated as passed or failed only, though the pass degree might be additionally qualified, *i.e.* by ‘with honours’ or ‘with distinction’. Markings during the course of the programme and for the final examination show a clear preference (79 %) for absolute marking, assessing the degree of fulfilment of established criteria. 31 percent of the respondents stated that the marks refer to individually acquired knowledge during a module (or a class), in 15 percent of the cases a relative marking (*i.e.* the performance of an individual student in relation to the group) is used, and 22 percent stated that individually acquired competences and skills are marked. Practical parts (*e.g.* laboratory work, demonstrations etc.) are not marked in 33 percent of the cases. In these cases they are just assessed as pass or fail. However, in 66 percent of the cases the practical parts have a certain weight and count for the final mark. Mostly (33 %) the weight accorded to the practical parts is between 11 and 20 percent, in 14 percent of the cases the weight is between 5 and 10 percent, in 13 percent it is between 21 and 30 percent and in six percent it is more than 30 percent.

4.7 Employability: Key Skills and Competences

The shift towards a student centred organisation of studies and the related assessment of learning outcomes together with the emphasis on labour market relevance of the first cycle degrees (employability) has led to more attention being paid to the acquisition of key skills and competences by students. ▶

► By now a considerable number of key skills and competences for Physics graduates have been identified, first and foremost – in the non-English speaking Bologna signatory countries – a good command of the English language. This holds true also for those countries with Romanic languages (*i.e.* France, Italy, Spain). Another particularity, dominant in the Central and Eastern European countries (*e.g.* Ukraine, Hungary, Croatia, Lithuania) is the idea of “mens sana in corpore sano” – originating in antiquity – so that many curricula include sports or gymnastics as part of the qualification. Other key skills or competencies have been derived from modern forms of research organisation with an emphasis on project management skills which include time management and team work.

According to the results of the online questionnaire 78 percent of the respondents stated that the acquisition of transferable skills is part of their Bachelor programme in Physics while 22 percent stated it is not. A high proportion of respondents (50 percent or more) stating that transferable skills were not part of their Bachelor curriculum in Physics are located in Belgium, Belarus, Switzerland, Denmark, Greece, and Sweden.

Table 10 provides an overview of the key skills and competencies which have been mentioned in the curricula analysed in the framework of this study and the frequency with which they were stated.

Another issue to be mentioned here is that previous studies about learning outcomes came to the conclusion that key skills and competences are more easily acquired if they are integrated with the subject matter. However, we do see a certain trend to “outsource” at least parts of them to other departments or service centres for the support of teaching and learning. This practice can be found in subjects other than Physics as well and is most probably related to either lack of competences among the regular teaching staff in Physics or capacity problems in terms of teaching load.

4.8 Transitions

The issue of transitions comes up the beginning of entering into Physics programmes, *i.e.* what are the access requirements and what are criteria for selection of students

Skill / Competence	Count and (Percentage) of Statement Occurrence
Foreign (English) language skills	134 (88.2 %)
Communication skills	109 (71.7 %)
Project management skills	55 (36.2 %)
Knowledge about society	33 (21.7 %)
Teamwork	31 (20.4 %)
IT skills	29 (19.1 %)
Knowledge about business administration and economics	18 (11.8 %)
Keeping fit (sports)	8 (5.3 %)
Knowledge of other natural sciences	6 (3.9 %)
Self management	6 (3.9 %)
Total	429

▲ Table 10: Key skills and competencies and frequency of statement (multiple replies possible)

wanting to study Physics, and after graduation, *i.e.* what next after having been awarded a Bachelor’s degree in Physics.

Two factors tend to increase the actual duration of studies for a Bachelor degree: mobility and access regulation.

Examples for the first factor are provided by UK universities. Bachelor programmes in Physics at universities in England and Wales normally have a duration of 3 years (Scottish Bachelor programmes in Physics are generally four year programmes). However, a number of Bachelor degree programmes are offered with an obligatory (and integrated) year of study abroad which often increases the number of years until completion to four. Typically students would spend their third year of studies in another country and return to their home university for the final year. These arrangements are not necessarily in the framework of an ERASMUS partnership or a joint or double degree programme. They can also exist within the framework of institutional or departmental arrangements and then do not necessarily include an exchange. Another variant is that since the 1990s an increasing number of four year programmes which are called “integrated Master programmes” have been introduced to deal with the growing subject matter and also allow more time for the acquisition of soft skills.

The second factor is only indirectly related to the Bologna reform goals. Due to shifts towards formula or performance based funding of universities in many countries, a frequently used indicator is “number of students successfully completing their study programmes within

the regular period of time”. This indicator puts pressure on universities to take over responsibility for getting as many students as possible through the programme in the prescribed period of time in order to secure their funding. This in turn has led to the fact that universities become increasingly selective in their admission to Physics programmes. It is further re-enforced by the growing competitiveness of European universities among each other for the best talent.

Many curricula which have been analysed in the framework of this study do no longer accept the upper secondary school leaving certificate at face value but have established further conditions which have to be met by students who are seeking access into Physics programmes. In some countries (*e.g.* Germany, Italy and Croatia) universities have established entrance examinations, in other countries additional requirements are defined, like outstanding marks in particular school subjects like mathematics, physics or chemistry, or participation in longer preparatory courses is recommended before enrolment (this is the case in some universities in Croatia, Switzerland, Germany, and Italy).

Bachelor Physics curricula (as other Bachelor curricula as well) are also shaped by the transition phase starting after completion of the degree. Here the issue is whether transition onto the labour market or transition into a Master programme is sought. In many countries, persons responsible for the curriculum of a given Bachelor programme continue to find it difficult to prepare students for both options within three years. In

addition, universities which are competing for best talent tend to be more interested in preparing their students for transition into a Master programme or possibly turn them into early career researchers than preparing them for the labour market. The Bachelor degree then tends to become an 'honourable way out' for those students who are deemed to have insufficient potential for getting a higher level degree, *i.e.* the Bachelor award becomes an implicit 'weeding out' procedure. An interesting exception from this general picture can be found in France. Trying to deal with the same problem, the French government created so-called professional Bachelor programmes which are particularly geared towards enabling transition onto the labour market after three years. All new entrant students starting to study Physics at Bachelor level can now decide at the end of their second year of students whether they will continue with general Bachelor studies enabling transition into a Master programme after successful completion of the third year or whether they continue their third year studies in the framework of a professional Bachelor programme and move into jobs after successful completion. Currently the proportion of Physics students moving into a professional programme after their second year is about 10 percent of all Bachelor students in Physics.

Again, the cases of UK and Ireland are different in this respect because the labour market is used to absorb Bachelor graduates while this is not the case for those countries in which the Bachelor degree is new and potential employers are used to recruit Physics graduates after five or more years of studies.

It is still somewhat early for a stable picture of actual completion rates. To a respective question in the online questionnaire 60 percent of the respondents stated that completion rates are not known yet, indicating that the tiered structure has been introduced within the last three or four years. An exception to this pattern are British and Irish universities where completion rates for Bachelor programmes in Physics are mostly between 90 and 95 percent.

In many of those countries having newly introduced the tiered structure of study programmes and degrees it currently remains unclear what a Bachelor graduate in Physics can actually do on the labour market. There continues to be a widespread view that a 'proper' Physicist can not be

produced within three years of study. This of course is different in those countries (namely UK and Ireland) which have always had the tiered structure of study programmes and degrees. Therefore, the online questionnaire included a question whether Bachelor students in Physics were predominantly educated and trained for the labour market or for transition into a Master's programme. Only four percent of the respondents stated that Bachelor students in Physics were trained for transition into the labour market (the one response from Belarus and some of the UK/Irish respondents). 61 percent of respondents said that their Bachelor Physics students were predominantly educated and trained to continue studying in a Master's programme, 33 percent of the respondents said it was a mixture of both, labour market and Master level programmes and one percent (from the UK/Ireland exclusively) stated that their Bachelor Physics students were trained to progress into a PhD programme. Countries in which all institutions (100 %) responding to the respective question in the online questionnaire indicated that their Bachelor Physics students were predominantly trained to continue at Master level programmes are: Belgium, Denmark, Finland, Lithuania, the Netherlands, and Slovakia. The majority of respondents indicated that those students who continue to study at Master's level stay at the same university from which they received their Bachelor degree. 41 percent of the respondents stated that about 5 percent of their Bachelor graduates in Physics continue to study at the Master's level in another university of the same country and 32 percent of the respondents said that about 5 percent of their Bachelor graduates continued to study for a Master degree abroad.

In the meantime higher education institutions have established a broad range of services and activities to support students in their transition onto the labour market. Still 26 percent of respondents (especially from the Czech Republic, Denmark, Greece, and the Slovak Republic) stated that no such services are available at their institution. Where services exist they can also be used by Bachelor Physics students and graduates. Respondents listed the following services and activities available to students in this respect (*cf.* Table 11):

4.9 Accreditation, Evaluation, and Quality Assurance

Over the last 10 to 15 years quality assurance of teaching and learning has become increasingly important. Regular evaluations of study or degree programmes have become the rule. Originally such evaluations mostly consisted of student satisfaction questionnaires. However, increasingly other mechanisms of quality assessment and assurance are being applied. We therefore provided a range of options with regard to quality assurance activities in the online questionnaire and asked what types of quality assurance activities were carried out with regard to the Physics Bachelor programmes in the institutions of the respondents (*cf.* Table 12). Multiple replies were possible.

Table 12 shows that the student satisfaction questionnaire is still the most frequently used form of quality assurance (92%), followed by accreditation and periodic re-accreditation (76%). In the majority of countries included in this study both of these forms of quality assurance are applied. It is somewhat surprising that

▼ **Table 11: Services/activities to ease transition of students/graduates into the labour market (in percent; multiple replies possible)**

Service/activity	In percent of respondents
Career service and advice	55
Interviews with potential employers	27
Internships	18
Lectures by alumni or potential employers	40
Training for job applications and job interviews	22
Information brochures about potential job areas	44
Other activities/services	13
No particular activities/services on offer	25

► 58 percent of the respondents indicated that teaching material and teacher preparation is monitored. This form of quality assurance can be found especially in Denmark, Finland, the Netherlands, Sweden, and the UK/Ireland. The use of external examiners is also concentrated in only some of the countries included in this study, especially in Denmark and the UK/Ireland. It should be noted that in the UK and Ireland accreditation means the accreditation of a degree by an external professional body (for Physics this is the IOP) while other quality assurance mechanisms are university based. One of the reasons for the similarity of study programmes in Physics in the UK and Ireland is the role of accreditation.

5. Conclusions: Physics Studies in Europe Today

In most countries included in this study on the implementation of Bachelor programmes in Physics policies are in place and the reform process to implement the new study structures and degrees is ongoing. Some countries (esp. Belgium, Switzerland, the Netherlands) seem to have the reform process more or less completed, while other countries (e.g. Spain) have just started with it. A third group of countries (esp. Ukraine, Belarus, Greece) seem to be seriously lagging behind in the implementation process. The United Kingdom is an exception because it basically kept its traditional Bachelor and Master degree structure which differs from the emerging European mainstream by enabling Bachelor graduates (typically three years of study in England and Wales, four years of study in Scotland) to continue directly into doctoral programmes or getting a Master's degree after an additional year (*i.e.* a 3 + 1 structure).

Concerning the two-cycle structure as well as the use of ECTS or a compatible national system of credit points we found a rather high level of convergence across Europe. However, the understanding of and ideas about modularisation of studies, basing credit points on student workload and assessing learning outcomes continue to be vastly heterogeneous in interpretation and application. This does not only hold true for Physics programmes. Generally, curricular reforms seem to be easier when focused on structures. Curricular content, pedagogical approaches and forms of assessment are very people dependent and teachers have to endorse the new approaches and take time to familiarise themselves with them. Our analysis showed that there is no common understanding of the concepts of modularisation, student workload, and learning outcomes. Concerning the issue of a Diploma Supplement at the end of a programme of studies our data remain inconclusive for the time being.

The majority of Bachelor programmes in Physics tend to be more general with some international and interdisciplinary dimensions. There is a clear indication that the first two years of a Bachelor programme in Physics tend to be rather similar everywhere because students have to be familiarised with the tools of the trade and the subject matter of the discipline. The third year of the programme (in some cases the fourth year) is typically used for project work giving the opportunity for a certain degree of specialisation or following individual interests and writing the Bachelor thesis.

Study abroad (mostly of the ERASMUS type) is possible in the majority of the programmes but only rarely compulsory. In some countries (esp. Switzerland, Aus-

tria, Germany, and France) a considerable proportion of international students can be found in the Bachelor programmes in Physics.

What clearly has changed in the majority of the continental European countries is the reduced emphasis on the final examination in order to determine successful completion of a degree. Students now are more often continuously assessed and these results have a weight in the final grade, despite the fact that in more than half of the Bachelor programmes in Physics the written thesis plus defence continues to be the typical form of final examination.

The Bologna reforms put a great emphasis on students' employability after obtaining a Bachelor degree. In order to contribute to a smooth transition into the labour market the integration of key skills or key competences into the curriculum is required. Our respondents to the online questionnaire as well as the curriculum analysis resulted in a broad spectrum of key skills being part of the Bachelor curricula in Physics, especially foreign (English) language skills, communication skills, and project management skills, the latter also including competences in time management and team work.

Also the two transition phases preceding and succeeding Bachelor level studies in Physics have received more attention. Increasingly access into Physics programmes is more regulated and selective requiring the fulfilment of certain criteria or success in an additional entrance examination. Some countries also require longer preparatory courses – mostly in mathematics – before enrolment (e.g. some universities in Croatia, Switzerland, Germany, and Italy). Despite the fact that universities have increased their services and activities to help students with the transition onto the labour market, most of our respondents (61 %) to the online questionnaire stated that they predominantly trained their students for continuation of studies at the Master's level. Marked exceptions in this respect are British and Irish universities where Bachelor degrees are not new and the labour market is used to absorb graduates with a Bachelor degree, as well as France offering professional Bachelor programmes geared towards transition onto the labour market. In most European countries new forms of quality assurance have been established in the framework of the Bologna reforms.

Quality assurance activity	In percent of respondents
Periodic accreditation/re-accreditation	76
Evaluation of courses/modules by student questionnaire	92
Evaluation of programme by external evaluators	31
Inclusion of external examiners	20
Monitoring of teacher preparation and teaching material	58
Obligatory participation of teaching staff in pedagogical training	16
Other activities	15

▲ Table 12: Quality assurance activities in Physics Bachelor programmes

In the majority of Bologna signatory countries a change from curriculum approval by the ministry to the establishment of (more or less) independent accreditation agencies can be observed. The agencies evaluate the curricula on the basis of a set of standards and criteria. They approve of the new degree programmes and undertake periodic re-accreditation and/or evaluation procedures. Experts have called this development the “agencification of quality assurance”. In our sample of respondents to the online questionnaire 76 percent indicated that accreditation is in place in their country and 92 percent stated that evaluation of courses or modules by student satisfaction questionnaire takes place as well. Surprisingly 58 percent also said that teacher preparation and teaching material is being monitored. Overall, it can be expected that with time the general structures of Bachelor level Physics programmes in Europe will converge more and more, while at the “shop floor” level a considerable amount of heterogeneity and diversity will continue. This diversity will reflect the differences in national academic cultures as well as teaching and learning styles and is a European added value.

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1. Definitions of Key Terms

1.1 Modularisation

Modularisation means the structuring of a degree programme in units (modules) with each unit having its own defined content. Each unit finishes with an examination the result of which counts for the final degree. Modularisation is also the basis for the introduction of credit points. Credit points facilitate the recognition of examination results achieved at various higher education institutions (at home or abroad) and can be accumulated over various periods of time. An example: if 60 credit points have to be earned in the framework of an academic year by a full-time student, one module would typically consist of six (or twelve) credit points so that ten (or six or any mixture thereof) modules have to be studied per academic year. When designing a curriculum on the basis of a modular structure it is not only important to create academic coherence within units but also provide a sufficient amount of choice for students so that they can design their own tailor-made course profiles. (Source: http://www.ba-ma.bayern.de/en_innovations.html)

1.2 Student Workload

Credit points are based on calculations of student workload to indicate the shift from a teaching centred to a learning centred form of studying. One credit point is typically associated to 25 to 30 hours of student workload (e.g. one module = 6 credit points = 180 hours of student workload). The student workload is composed of hours of classroom teaching/learning, plus hours of preparation with reading material or other forms of learning, plus studying for the examination and taking the examination.

1.3 Learning Outcomes

Learning outcomes are the specific intentions of a programme or a module. They describe what a student should know, understand, and be able to do at the end of the programme or module. Apart from subject specific knowledge, learning outcomes also include a description of key

competencies or skills (see Dublin Descriptors, national and/or European Qualification Frameworks) a student is supposed to acquire. Thus, learning outcomes can be defined in terms of knowledge and understanding, intellectual skills, practical skills, and key or transferable skills. There should be a clear link between the learning outcomes and the assessment criteria. Learning outcomes should specify the minimum acceptable standard for a student to pass a module or a programme. Learning outcomes of a module should start with the phrase: "on successful completion of the module, students will be able to ...". Learning outcomes can

help to guide students in their learning by explaining what is expected of them and thus, helping them to succeed in their studies.

Help staff to focus on exactly what they want students to achieve in terms of both knowledge and skills.

Provide a useful guide to inform potential candidates and employers about the general knowledge and understanding that a graduate will possess.

(Source: www.ssdd.bcu.ac.uk/outcomes/)

2. Template for a Model Curriculum (Bachelor in Physics)

Typically the documentation and information material consists of three key elements:

- General description of the programme and admission requirements;
- Structure of the programme;
- Module handbook and/or syllabus.

These three elements will be described in the following.

(a) General Description of the Programme and Admission Requirements

As a rule this is treated as an official document and part of the curriculum. It is composed of the following elements:

- **Admission requirements:** for example, school leaving certificate, possibly preparatory courses or entrance examinations, costs/tuition fees, insurance, deadlines for application;

- **Objectives of the programme:** for example, to attain a solid command of the relevant subjects and associated skills; to understand the general physical principles and methods as they are applied in the analysis of concrete physical issues; to develop a capacity for abstraction and to stimulate problem-solving and reasoning skills; to appreciate the value of experimentation when compiling and testing physics theories.

- **Learning outcomes:** for example, to have a due command of the foundations of physics and astronomy and to have acquired a full grasp of the required mathematical tools; to be acquainted with scientific research; to be capable of putting forward oral and written communications on scientific results; to have a full command of those ICT skills related to physics and astronomy; to be able to operate as a member of a team; to have acquired a mindset focused on learning and understanding boosted by an eagerness to embrace lifelong learning.

(b) Structure of the Programme

Typically the first two years of bachelor programmes in Physics are rather similar, i.e. learning the tools of the trade and getting familiar with the subject matter (e.g. astronomy, optics, energy, etc.), while the third year is more often characterised by project and thesis work. Elements of the structure are:

- **Duration of the Programme:** for example, 3 years or six semesters.
- **Number of credit points:** for example, 60 credit points per year or 30 credit points per semester.
- **Workload:** for example expressed in credit points (180) or in hours (5,400).
- **Distribution of workload over programme content:** for example, 130 credit points have to be earned in the framework of general courses, 40 credit points have to be earned in elective courses, 10 credit points have to be earned with the Bachelor thesis.

(c) Module Handbook and/or Syllabus

The Module handbook and or syllabus informs students about the content of the

courses (possibly including relevant literature), the approaches to teaching and learning, and the key competences to be acquired.

A module description includes the following information:

- access requirements (if any),
- teaching language,
- workload (including study time and credit points),
- theory,
- exercises,
- projects,
- teaching and learning material,
- teaching methods,
- examination and evaluation methods.

Knowledge of the subject matter as well as key competences or key skills to be acquired by the students have to be defined for the programme as a whole (cf. general description of programme) and for each module. They can be divided into four components:

- (a) **Subject related knowledge** can be divided into knowledge (e.g. theories, models, boundaries, methods, techniques, processes and applications in physics) and abilities (e.g. to be able to analyse, to have problem solving abilities and abilities for critical reflection).
- (b) **Intellectual competences** are defined, for example, as systematic and critical reflection, professional attitude, ability for logical and analytical reasoning, and ability to formulate problems at the proper level of abstraction.
- (c) **Teamwork and communication skills** are defined, for example, appropriate written and oral presentation skills, ability to communicate new developments and underlying basic ideas within the discipline and neighbouring sciences to experts and non-experts, communication skills in the native tongue and in English, ability to communicate, cooperate and act depending on the situation in a supportive, inspiring and/or authoritative manner.
- (d) **Societal/civic competences** are defined, for example, as the ability to connect subject matter issues with public debates and concerns, to act in a responsible way in terms of ethics and society, to integrate social responsibility and commitment in one's professional activities.

APPENDIX 2

Selected information on country specificities

1. Austria

The introduction of the Bologna structure is a stated national goal; the timing, however, is left to the individual universities. In Physics, all universities have started the introduction, but in some other fields old style degree programmes are still offered. A number of items on the Bologna agenda are implemented via national legislation, such as the universal adoption of ECTS, based on a student workload of 25 hours per credit point. The formulation of learning outcomes is a legal obligation for programmes as a whole, but not for individual courses, though several universities have adopted regulations requiring the formulation of learning outcomes for subunits as well. Modularisation is not legally required and used unevenly. There is no grade for a programme as a whole, but grades are given for subunits (subject areas); based on these grades the predicate “passed with distinction” may be given; the rules for bestowing this distinction encourage the use of “subject areas” larger than modules.

Austrian law obliges universities to admit all applicants who have obtained one of a broad class of high school diplomas, and to admit bachelor graduates to consecutive master programmes without further selection. For graduates of master programmes, especially in technical fields (including physics at technical universities or faculties), pre-Bologna titles like “Diplom-Ingenieur” are used as an alternative to M.Sc. There is no requirement for accreditation of study programmes, and no institutional accreditation is required for state universities.

The high proportion of foreign students in Austria is explained in part by the fact that many students from the German speaking minority in Italy (South Tyrol) attend Austrian universities.

2. Italy

The Bologna process was imposed by law in 2001 on all the Italian universities. Between 2004 and 2007 changes of the original act were proposed by the government. These changes are implemented in the academic year 2008/09 in about half of the universities and will be implemented effect starting from the academic year 2009/10 in the other half. The academic structures are strongly involved in the changes, but they are not yet in a position to provide clear results on the effects of the initial reform. In other words the Bologna reforms have been applied in all the universities, but the achievements in each of the universities are still under study.

3. United Kingdom

Until the 1990s, it was the normal route for everyone in England, Wales and Northern Ireland to have a 3-year Bachelor degree in Physics as with most other subjects. There were a few longer programmes, such as medicine and architecture, but essentially all the main sciences were three years. Graduates from these courses most certainly did become physicists, either progressing to a PhD, taking a one year Master of Science degree or by starting a job in a private company – there was no other route. The vast majority of current academics in the UK followed this route and obtained their PhD six years after entry to university. In Scotland, all courses were and are one year longer because entry is at a lower level.

In the early 1990s, four year integrated Master degrees were introduced, usually called MPhys or MSci. The reason for their introduction was that universities were putting more and more material into their degree programmes, so it was felt that there should be more time to give the students a better chance to understand the subject matter and also to allow time for developing soft skills, such as communication skills and teamwork. ►

► Since then, it is certainly the case that the majority of professional physicists have the four year degrees but there is still a substantial number who the three year degree. It is still possible, though less common, for example, to enter a PhD programme directly from a Bachelor of Science. It also important to note that the majority of the other courses at universities, *i.e.* all the arts and humanities and the biological sciences, do not have the integrated Master programmes and progression to PhD is directly from the Bachelor degree. Engineering, Chemistry and Mathematics are similar to Physics. Inevitably history plays a large part in these matters. Employers in the UK are familiar with graduates from three year Bachelor courses and not really expect anything else. Even after 15 years, they are still not totally familiar with the integrated Master programmes. In addition, in England, students have to pay for their education and the majority of them do not receive grants. Therefore, any extra time spent at university can be costly, with debts accumulating at more than 10,000 pounds a year, to be repaid out of tax later. Thus, even the four year integrated Master programmes are under threat for that reason. Discussions have started in England on the possibility of 3 + 2 integrated Master programmes but not all university physics departments think it is a good idea.

4. Sweden

Sweden is in the middle of the process of implementing the new Bachelor and Master programmes. The kinds of degrees that can be offered at Swedish universities are decided by the government. Starting from 1 July 2007 all general programmes must be 3-year Bachelor programmes or 2-year Master programmes. Therefore, the first students that follow the new Bachelor programmes will graduate in June 2010. Physics programmes used to be 4-year integrated Masters and still some special vocational programmes can be integrated Masters. Since there are almost no Swedish students with a Bachelor degree yet, there are very few Swedish students in the new Master programmes. There are mainly exchange students in these programmes. However, students in the final year of the old integrated Masters take the same courses as are offered in the new Master programmes.

In this report it is observed that many respondents from Sweden have stated that teaching material and teacher preparation are monitored as part of the quality assurance activities. This is mainly due to the national regulation that text books and other literature that are used in a course must be listed in the course syllabus which is decided by the faculty board at the university.

5. Switzerland

The Swiss higher education system currently consists of ten cantonal universities, the two Federal Institutes of Technology, as well as other university level institutions. In addition there are eight *Fachhochschulen* (universities of applied sciences), among which there are also teacher training institutions, all recognised by the state. A few non-integrated teacher training institutions are listed as a special category. The majority of cantonal universities offer a broad variety of study programmes. Only three of them (St. Gallen, Luzern, and Svizzera italiana) have a more narrow and subject specific range of programmes. The Federal Institutes of Technology (Lausanne and Zürich) offer higher education in the subject areas exact sciences, natural sciences, and technical sciences. The universities of applied sciences differ from the universities by offering more practically oriented study programmes which are regulated by the federal government. An exception is the teacher training being the responsibility of the cantons.

Swiss higher education is currently undergoing considerable change. Higher education was diversified by the establishment of universities of applied sciences and of teacher training institutions. This complemented the already existing provisions of universities. The Bologna Declaration also implied a deep reaching change of the higher education landscape in order to implement the goal of establishing a European higher education area until the year 2010.

At the beginning of the academic year 2008/09 it is estimated that slightly less than 85 percent of all students (around 130,000) are enrolled in Bachelor and Master programmes according to the Bologna model. Practically all new entrant students start in a Bachelor programme. The implementation of the Bologna re-

forms was carried out in all subjects and is basically finished. In 2005, the proportion of students being enrolled in a Bologna reform compatible study programme was only 40 percent in both cycles of studies. In general, it can be observed that the reform has progressed less at universities than at universities of applied sciences and teacher training institutions. 18 percent of students studying at universities are still enrolled in a 'traditional' programme, while this is the case with only 13 percent of students studying at universities of applied sciences and teacher training institutions. The latter types of higher education institutions began the reform in a coordinated manner in 2005. In addition, the duration of studies at these institutions is shorter than at universities so that the implementation of the Bologna reforms happened faster. In 2008, altogether around 7,500 Bachelor degrees were awarded by universities; the number of Bachelor degrees awarded by universities of applied sciences and teacher training institutions can not yet be stated currently.

In the fall of 2009, a further step will be taken in the implementation of the Bologna reforms by introducing Master programmes at all universities of applied sciences. The prognosis is that there will be between 4,500 and 6,000 Master students in universities of applied sciences and teacher training institutions.

6. Slovenia

Slovenia is a small country with only 4 universities three of which offer Physics studies (at both Bachelor and Master level). However, the majority of Physics students (more than 75%) are enrolled at one of the three universities. The study reforms according to the Bologna Declaration and the subsequent communiqués was prescribed by law setting 2010 as the year by which all new programmes should be in place. All universities opted for the 3+2 scheme. The programmes are accredited by the Accreditation Senate of the Council of Higher Education. In 2009 the new programmes according to the Bachelor Master scheme are running between one and three years so that there is no experience as yet concerning the quality of the programmes, employability and transfer into labour market.

7. France

This short report by Nathalie Lebrun (representative of the French Physical Society) gives an overview of the state of the art of the implementation of the Bologna Process in Physics studies. The second part is dedicated to some recommendations. The report will be complemented in 2010 with specificities regarding Master level study programmes.

State of the Art

In France, each university has a four year contract with the Ministry of Higher Education and Research (MESR). Thus, the Ministry ensures that the Bologna process is implemented. The fulfilment of the contract of each university is controlled by an evaluation agency (AERES). Currently, France has no national working group on the Bologna Process which could develop policy proposals for its implementation. However, a national group of Bologna promoters exists supporting the universities in the implementation of the Bologna reforms. Since September 2006, all French universities adopted the “LMD” scheme (Licence, Maitrise, Doctorate) which is a reflection of the European award structure based on Ba/Ma/D (Bachelor, Master, Doctorate). Only the medical subjects and engineering are not yet included in this scheme. Negotiations about this are in progress.

Among 87 universities, 57 offer Bachelor programmes in Physics. The Bachelor programmes impart a broad and general knowledge of physics and ensure a fundamental professional qualification. Significant variations are noted for the experimental physics in terms of the number of hours allocated to this type of studies. The ratio between the physics courses and the non physics courses is not homogeneous and strongly depends on the local situation in each university. In most of the Physics courses the essential fields are: mechanics, optics, fluid mechanics, thermodynamics, physics statistics, molecular physics, physics of condensed matter, and quantum mechanics. In addition, some special physics courses might be taught in universities which are strongly related to research domains in laboratories. These special courses are mostly offered during the

third year of Bachelor degree studies and are compulsory courses directly linked to the specialisations of Master programmes offered at the local level. Mathematical tools are well integrated into the curricula as well as transversal courses as communication tools, foreign languages and discovery of scientific jobs. A comparison of Bachelor programmes allows the conclusion that a similar body of knowledge is offered in all university Physics Departments, however, with some small differences. These essentially concern the position of the courses mentioned throughout the three years of the Bachelor programme. In 2005, the French Physical Society and the Ministry of Education and Research worked together and established recommendations regarding the content of the Bachelor programmes in Physics: which knowledge should a student have acquired after three years of Bachelor studies in Physics? The recommendations were spread to the French universities.

To improve student success in the first year of Bachelor degree studies, the Ministry of Education and Research launched in September 2008 a “Plan for success in first degree courses” for the following four years. Its aim is to encourage project based forms of study which allow universities to develop student support schemes, assistance with guidance and the strengthening of knowledge in preparation for employment or further studies. This plan enhances student-teacher ratio and introduces a progressive specialisation of studies. During the first year, students clarify their choices of study domain and the teaching staff obtains a better understanding of the student profiles in order to adapt their teaching accordingly. The plan involves:

- circulating objective information for students;
- giving advice to students about the chances of success and employment prospects in the planned speciality;
- the creation of support systems for students such as pre-term, skills assessments, upgrading, establishment of a methodological framework for university studies, interviews, etc.

The plan is essentially applied in science studies as mathematics, physics, chemistry, biology.

Access to Bachelor and Master Programmes

No selection exists of newly entering students at universities while the other higher education institutions (offering short studies: BTS, DUT; offering long studies: Classes préparatoires, engineering schools) select the best students.

Entry to the second cycle is quasi-automatic with a Bachelor degree in a subject compatible with that of national Master diploma. A selection takes place subsequently between the first and the second year of the Master programme.

Employability

A regular survey of employment of young graduates three years after the end of their initial studies is undertaken by CEREQ (Qualifications Study and Research Centre). After the Bachelor degree most of the graduates continue their studies at the Master’s level. Regarding the Bachelor in general Physics, only five percent of Bachelor graduates decided to stop their studies and enter professional life. The employability rate is very low (a few percent) with generally low qualified jobs (below the Bachelor level). Most of these Bachelor graduates applied for the civil service competitive examination (management staff). In order to increase the employability of graduates with a Bachelor degree, the French Ministry of Education created in 1999 the professional Bachelor (“licence professionnelle”). The Professional Bachelor (“licence professionnelle”) is classified at ISCED level 5B and is specially designed to give access to the labour market. However, it offers only restricted possibilities to study at the Master’s level, except in a lifelong learning context. Staff from private companies are frequently involved in these professional Bachelors with a participating rate of 50%. The employability of graduates from Professional Bachelor programmes in the Physics domains (electronics, electricity, acoustics, materials, etc) is around 85%.

National Qualification Network, Learning Outcomes, Competences

In 2002, the Ministry of Education established a National Directory of Professional Qualifications (RNCP) which is the framework for qualifications in France. All general and professional Bachelors have ►

- ▶ now to be registered with the RNCP. The RNCP formula is attached to the degree certificate and highlights learning outcomes, especially in terms of skills. It also sets out the field of activities and specialities as well as the level of qualification. For the professional Bachelor the employment rate over the past three years is also included. The implementation of this national qualifications framework is in progress regarding the general Bachelor degrees, for example Physics Bachelors. To be registered with the RNCP, degree certificates must have received the approval of the National Commission for Professional Qualification (CNCP). The self-certification of compatibility with the Bologna framework has started but it is not yet completed.

European Credit System ECTS, Learning Outcomes and Workload

Any degree at the level of “Licence” (Bachelor) represents 180 ECTS credits and those at the level of “Maitrise” (Master) correspond to 120 credits, making it a total of 300 ECTS credits after finishing a Master’s degree. Exceptions are the medical and engineering studies. Their change to the Bologna structure is now underway. Regarding doctoral level studies it is not planned to quantify the study programme and doctoral degree according to ECTS.

Contact hours are no longer the reference to define ECTS credit points and have been replaced by student workload. Nevertheless, learning outcomes have not yet become the usual reference points for the system. ECTS credit points are linked with learning outcomes in some Physics programmes. The generalisation is in progress. There are no other credit point systems than ECTS since France adopted the principle of generalising the European ECTS credit system for higher education studies, except at doctoral level.

Diploma Supplement

The diploma supplement (or descriptive appendix to the diploma) is still being gradually introduced. The main difficulty resides in the new approach of the assessment of skills and the definition of learning outcomes. This diploma supplement concerns the Bachelor and Master levels. It is organised centrally through the RNCP. It is available in the language of instruction, mainly in

French. When required, the diploma supplement is available in other official languages of the European Union depending on the wishes of the student and the choices offered by the university. This supplement is free of charge and is automatically delivered to students. It corresponds to the EU/CoE/ UNESCO diploma supplement format. At the current stage, the diploma supplement is not a standard reference document supporting a diploma presented by a foreign candidate since it is drafted in a variety of ways making interpretation difficult.

Lifelong Learning

An accreditation of prior learning (VAE) is available at Bachelor and Master levels. It takes into account professional experiences or higher studies undertaken in France or other countries. It constitutes an individual right open to all upon obtaining all or part of a degree. Furthermore it is possible to get accreditation by the VAE alone without a course of studies. The VAE is a means of access to accreditation in the same way as initial training, apprenticeships or ongoing vocational training. The modular organisation of Bachelor and Master Programmes combined with the accreditation of prior experience or learning (VAE) allows greater participation in higher education programmes by students from wider variety of backgrounds. This flexibility for diverse groups of learners was made possible thanks to the principle of modularity and of the wider application of the ECTS.

Mobility

The apparent high level of incoming mobility in French higher education institutions is combined with seemingly low level of outgoing mobility. The situation is mainly due to the low amount of grant offered to students and the fulfilment of many conditions is required to get access to a grant. In November 2008, the Council of Ministers decided the establishment of a High Level Group on Mobility. A reform of financial aids for students has been undertaken to develop opportunities for financial support of study abroad for a larger number of students. Higher education grants based on social criteria allow students to pursue studies abroad. Their value has been by 2.5 percent to

allow for the cost of living and the field of application has been extended to the middle class. The amount of the international mobility grant is 400 € per month for students who follow their studies abroad for a period of 2 to 9 months. This international grant may supplement the support normally received by holders of student grants.

Recommendations

- To pursue actions in order to improve the understanding of learning outcomes and to implement them. Meetings should involve teaching staff and not only the persons in charge of the degree certificates. Learning outcomes have to be defined for each module (or unit) and not only at the degree level including the three years of the Bachelor programmes.
- To improve measurement and control of student workload. Until now, the National Bologna Experts Team informs and advises the higher education institutions about the implementation of ECTS in line with students’ workloads. Contacts with the teaching staff have to be generalised to help in introducing calculation of students’ workloads. A homogenisation at national level is needed. It could be the role of the National Physics Society to recommend some ratio between the academic studies and the students’ workloads depending on the physics domain. The European Physical Society could have also the same role at the European level in order to establish a European framework.
- To increase the amount of the grants for mobility for students at Bachelor level. Despite the increase of 2.5 percent by the French government, this amount is still too low, especially for students who are moving around the western parts of Europe.
- To translate all study programmes into the English language and make them available on the websites of each university. Only few universities propose the double translation French / English. This has to be improved in order to facilitate the comparison of academic programmes between European countries and to increase the student mobility.

1. Questionnaire for All Countries except UK

The Implementation of the Bologna Reforms into Physics Studies in Europe

Dear Madam or Sir,

On behalf of the European Physical Society the International Centre for Higher Education Research at Kassel University (Germany) is carrying out an analysis of the implementation of the Bachelor and Master structure into Physics Studies in European universities. In this context we are also looking into the realisation of other reform goals of the Bologna Process, *e.g.* modularisation, application of ECTS or compatible credit point systems, student workload orientation, transmission of generic skills to enhance employability etc.

Approximately 25 European countries and 260 universities are involved as partners in this project.

The first step of the project consisted in collecting the actual Physics curricula focusing on classical Physics studies (i.e. Physics programmes for teacher education and engineering students are not included) and analysing them in detail. The second step is this online questionnaire to complement the curricular analysis with statistical data. Please note that we use the term "institution" as a generic term covering universities and other higher education institutions. It does not mean faculty or department or institute.

This questionnaire focuses on Bachelor programmes in Physics but also intends to gather some information about Master programmes. Master programmes will be mostly a focus in 2009. This splitting has only practical reasons to allow those countries which have changed to the new structure only recently to collect more information about their progress in implementing the reforms. We would be grateful if you could fill in the questionnaire electronically and send it **back** to us by **Friday, 19 December 2008**. We assure confidentiality of the data and information you are providing. No university will be identified by name and the report will present only aggregate data. The report will be available in spring 2009 from the European Physical Society.

The electronic questionnaire is available through the following link:

<http://www.hochschulforschung.uni-kassel.de/qtafi/projects/physics/>

Our contact person in the National Physical Society has been asked to forward this letter to you together with a PIN in order to access the link to the questionnaire.

Should you have problems in filling in the questionnaire please contact:

Mr. Ahmed Tubail

International Centre for Higher Education Research Kassel (INCHER-Kassel)

Tubail@incher.uni-kassel.de

Prof. Barbara M. Kehm

INCHER-Kassel
University of Kassel

Moenchebergstr. 17

34109 Kassel

kehm@incher.uni-kassel.de

Thank you for your cooperation.

Please insert your PIN:

General Questions

1. Personal Details

1.1 What is your status in the Department/Faculty?

Dean/Director/Head of Studies

Professor/lecturer/reader

Junior teacher/researcher

Member of administrative staff

Other, please indicate

1.2 What is your function in relation to the Physics Programme(s)?

Multiple replies possible

Programme coordinator

Teacher (professor/lecturer/reader)

Administrative staff

Other, please indicate

2. Institutional Details

2.1 Please provide the name of the country in which your institution is located:

2.2 How old is your institution counting from date of establishment?

years.

2.3 Please indicate the type of your institution:

University

Technical University

Other, please indicate

2.4 In what subject groups does your institution provide study/degree programmes?

Multiple replies possible

Natural Sciences

Engineering

Humanities

Social Sciences

Arts (incl. Design and Architecture)

Medicine

Law

Agriculture

Other, please indicate

2.5 Please indicate the size of your institution in terms of numbers of students and numbers of academic staff:

students (incl. doctoral students)

academic staff (teaching and research)

2.6 Please indicate the size of your Physics Department/Faculty in terms of student and academic staff members:

students (without doctoral students/candidates)

academic staff (teaching and research)

doctoral students/candidates

2.7 What types of Physics degree programmes did your institution offer BEFORE changing to the new model of Bachelor and Master (if applicable, also name traditional degree programmes currently still running parallel to Bachelor and Master programmes)?

Name of programme

Av. duration

in years

Av. No. of

students

Not applicable

2.8 What types of Physics programmes (and degrees) does your institution currently offer?

(Please take only approved/accredited programmes that are already running into account)

How many

Programmes?

Bachelor Programme(s) in Physics

Stand alone Master Programme(s) in Physics

Consecutive/integrated Master Programme(s) in Physics

Other (degree) programmes in Physics

Doctoral Programme(s) in Physics ▶

- **3. Implementation of the tiered structure**
- 3.1 When did you introduce first-cycle or Bachelor degree programmes in your institution as a whole?**
 Bachelor programmes are the traditional degree programmes in my institution
 Before the year 2000; please indicate in which year:
 In the year 2000
 In the year 2001
 In the year 2002
 In the year 2003
 In the year 2004
 In the year 2005
 In the year 2006
 In the year 2007
 In the year 2008
 Introduction of first-cycle or Bachelor degree programme(s) is envisaged for the year:
- 3.2 When did you introduce first-cycle or Bachelor degree programme(s) in Physics in your institution?**
 Bachelor programmes are the traditional degree programmes in my institution
 Before the year 2000; please indicate in which year:
 In the year 2000
 In the year 2001
 In the year 2002
 In the year 2003
 In the year 2004
 In the year 2005
 In the year 2006
 In the year 2007
 In the year 2008
 Introduction of first-cycle or Bachelor degree programme(s) in Physics is envisaged for the year:
- 3.3 Please state the name of the Bachelor Programme(s) in Physics offered at your Institution (in English translation):**
 Programme 1:
 Programme 2:
 Programme 3:
 Programme 4:
 Programme 5:
 Programme 6:
 Programme 7:
 Programme 8:
 Programme 9:
- 3.4 Is there a system of accreditation/approval of Bachelor study programmes in place?**
 Multiple replies possible
 Yes, national accreditation system
 Yes, institutional accreditation system
- Yes, other, please indicate:
 No, Bachelor programmes are approved by Ministry
 No, Bachelor Programmes are approved by institutional bodies
 No, the institution is accredited and autonomous to establish its own programmes
 No, other, please indicate:
- 3.5 Is your Bachelor Physics Programme accredited and if yes, until when?**
 Yes, until:
 No
- 3.6 What is the scheduled duration of a Bachelor programme in Physics at your institution?**
 3.0 years
 3.5 years
 4.0 years
 Longer than 4.0 years, please indicate:
 Other, please indicate:
- 3.7 How long does it actually take on average for Bachelor students in Physics (incl. final examinations) to complete their studies successfully at your institution?**
 3.0 years
 3.5 years
 4.0 years
 4.5 years
 5.0 years
 Longer than 5 years
 No information available (yet)
- 4. Implementation of Complementary Measures**
- 4.1 Do you apply ECTS Credit Points in the framework of your Bachelor Programme in Physics?**
 Yes
 No
- 4.2 If not, do you apply other forms of Credit Points?**
 Yes
 No
- 4.3 If yes, are these Credit Points compatible with ECTS?**
 Yes Please indicate conversion: ECTS = Credit Points
 No
- 4.4 Have you modularised your Bachelor Physics Programme(s); i.e. are the time units based on modules?**
 Yes
 No
- 4.5 Are your modules (or other time units) calculated on the basis of student workload ?**
 Yes
 No
- 4.6 How many hours of student workload are required to earn one credit point?**
 10 hours
 15 hours
 20 hours
 25 hours
 30 hours
 Other, please indicate:
 Not applicable
- 4.7 What does one module (or other time unit) consist of as a rule? (Multiple replies possible)**
 Number of hours of student workload, please indicate:
 Number of ECTS Credit Points, please indicate:
 Number of other Credit Points (if applicable):
 Number of teaching hours in class, please indicate:
- 4.8 Are compulsory phases or elective phases of study abroad (international mobility) part of the Bachelor curriculum?**
 Compulsory
 Elective
- 4.9 Are there other opportunities for mobility (internship abroad, work or lab work abroad) provided?**
 No
 Yes, please indicate which ones:
- 4.10 At what point in time during the course of study do students go abroad?**
 Bachelor Programme:
 2nd year
 3rd year
 4th year
 Any point in time
- 4.11 For how long do students go abroad on average?**
 1-2 months
 3-5 months
 longer than 5 months
- 4.12 Please indicate the percentage of Bachelor Physics students who use such opportunities to go abroad:**
 percent on average
 no information available yet

4.13 Is your Bachelor Programme in Physics a joint or double degree programme?

(Note: a double degree programme is programme offered jointly by two institutions located in different countries; a joint degree programme is a programme offered jointly by more than two institutions from different countries.)

Yes

No

4.14 If yes, is it a

Joint degree programme. How many partner institutions

Double degree programme. Partner from which country

5. Curriculum**5.1 How would you characterise your Physics Bachelor curriculum?**

More generalised

More specialised

A mix of both

5.2 Does your module (or course) description include expected learning outcomes?

Yes

No

5.3 What is the language of teaching in your institution?

Please indicate:

5.4 Is teaching offered in a foreign language in your Bachelor Programme in Physics?

Yes

No

5.5 If yes, please indicate the (foreign) language or languages and rank them according to the frequency of use (with Rank 1 being the highest):

English

French

German

Italian

Spanish

Other foreign language(s), please indicate:

5.6 Is the whole Programme taught in a foreign language or just parts of it?

Whole Programme

Just parts

5.7 If teaching takes place in a foreign language (or more than one foreign language), please estimate the proportion:

Language ranked 1: percent

Language ranked 2: percent

Language ranked 3: percent

5.8 Does teaching in your Bachelor Physics Programme include interdisciplinary components?

Yes

No; please go to question 6.1

5.9 If yes, does it include classes/courses/modules from other disciplines?

Yes

No

5.10 If yes, please indicate which subjects/subject groups other than Physics (including Mathematics and Computing) are included in the curriculum:

Multiple replies possible

Other natural sciences, please indicate:

Engineering Sciences

Medical Sciences

Humanities

Social Sciences

Other, please indicate:

5.11 Are interdisciplinary contents an integrated part of the Bachelor Physics classes?

Yes

No

6. Assessment and Examinations**6.1 How many ECTS credit points must be earned for a Bachelor degree in Physics?**

180

Other, please indicate:

6.2 How are the credit points distributed in your Bachelor Physics curriculum over the various types of delivery (provide number of credit points)?

credit points for modules/courses/other units of time

credit points for lab work/practicals

credit points for Bachelor thesis/project work and defence

credit points for other forms of delivery, please indicate:

Total credit points

Not applicable, no credit points in use

6.3 What are the final steps for the award of a Bachelor degree in Physics?

Multiple replies possible

Written thesis

Written thesis plus defence

Written test(s)

Oral examination

Demonstration of an experiment, mathematical formula (or similar)

Project presentation

Other, please indicate

6.4 Are the marks awarded during the course of study included when calculating the final mark of the degree (please indicate percentages)?

No mark given for final degree (just pass/fail/passed with distinction or honours)

Percent from modules

Percent from lab work/practical exercises

Percent from thesis and defence (if applicable)

From final oral examination

From final written examination test(s)

From other form(s) of assessment, please indicate:

6.5 Do you assess student performance in terms of learning outcomes after each module or unit of teaching/learning?

Yes

No

6.6 Do you assess subject knowledge only or also transferable skills?

Please note: The term "transferable skills" is frequently used synonymous with the following terms: soft skills, generic skills, key competences, key qualifications. It denotes a combination of cognitive, motivational, moral, and social skills needed to fulfil tasks, solve problems, cope with demands, and cooperate in teams.

Subject knowledge only

Also transferable skills

6.7 What types of assessment are being used during the course of study?

Multiple replies possible

Written tests

Multiple choice questions

Homework papers

Interview with teacher

Oral examination

Other forms of assessment, please indicate:

6.8 What forms of marking are used in your Bachelor Physics Programme?

Multiple replies possible

No marking given for final degree (just pass/fail/passed with distinction or honours)

Relative marking (performance of individual student in relation to the group)

Absolute marking (degree of fulfilment of established criteria)

Individually acquired knowledge during a module/class

- Individually acquired competences (incl. transferable skills) during a module/class
Other forms, please indicate:
- 6.9 To what extent do practical parts (demonstrations, lab work results, etc.) count for the final mark?
Not applicable, just pass or fail
Between 5 and 10 percent
Between 11 and 20 percent
Between 21 and 30 percent
More than 30 percent
- 7. Quality Assurance**
7.1 What types of quality assurance activities are carried out for your Bachelor programmes in Physics?
Multiple replies possible
Periodic accreditation/re-accreditation of the programme
Evaluation of courses/modules by student questionnaire
Evaluation of the programme by external evaluators
Inclusion of external examiners
Monitoring of teaching material and preparation of teachers
Obligatory participation of teaching staff in pedagogical/didactic courses
Other, please indicate:
- 8. Employability and Transferable Skills**
Please note: The term "transferable skills" is frequently used synonymous with the following terms: soft skills, generic skills, key competences, key qualifications. It denotes a combination of cognitive, motivational, moral, and social skills needed to fulfil tasks, solve problems, cope with demands, and cooperate in teams.
- 8.1 Is the acquisition of transferable skills part of the Bachelor curriculum in Physics ?
Yes
No; please go to question 8.3
- 8.2 If yes, is the acquisition of transferable skills integrated into the Bachelor Physics curriculum or is it separated from it (e.g. in special courses)?
Integrated
Separated in special courses
Mixed
- 8.3 Do you prepare your Bachelor students dominantly for transition into the labour market or for transition into a Master Programme?
Dominantly for labour market
Dominantly for Master Programme(s)
Mixture of both
- 8.4 What activities/services does your institution offer to ease transition of Bachelor Physics graduates into the labour market?
Multiple replies possible
Career services and advice
Organisation of interviews with potential employers
Internships during the course of study
Lectures by alumni or potential employers about labour market and career opportunities
Training for job applications and job interviews
Information brochures about potential job areas
Other activities/services, please indicate:
No particular activities/services on offer
- 9. Composition, Completion and Transition Rates**
9.1 Please estimate completion rates in your Bachelor Programme:
percent of students successfully complete their programme.
Not known yet.
- 9.2 Please indicate the percentage of international students enrolling in your Bachelor Programme in Physics:
percent
- 9.3 Please estimate the composition of Bachelor Physics graduates going into a Master Physics Programme offered by your own or by another institution:
percent of own Bachelor Physics graduates enrol in a Master Physics Programme at own institution
percent of own Bachelor Physics graduates enrol in a Master Physics Programme at another institution in the country
percent of own Bachelor Physics graduates enrol in a Master Physics Programme at an institution in another country
Not known yet.
- 9.4 Please estimate the proportion of Bachelor Physics graduates going into the labour market:
percent
Not known yet.

2. Questionnaire for UK Universities

General Questions

1. Personal Details

1.1 What is your status in the Department/Faculty?

Dean/Director/Head of Studies

Professor/lecturer/reader

Junior teacher/researcher

Member of administrative staff

Other, please indicate:

1.2 What is your function in relation to the Physics Programme(s)?

Multiple replies possible

Programme coordinator

Teacher (professor/lecturer/reader)

Administrative staff

Other, please indicate:

2. Institutional Details

2.1 Please provide the name of the country in which your institution is located:

2.2 For how many years has your institution been a university?
years.

2.3 In what subject groups does your institution provide study/degree programmes?

Multiple replies possible

Sciences

Engineering

Humanities

Social Sciences

Arts (incl. Design and Architecture)

Medicine

Law

Agriculture

Other, please indicate:

2.4 Please indicate the size of your institution in terms of numbers of students and numbers of academic staff:

students (incl. doctoral students)

academic staff (teaching and research)

2.5 Please indicate the size of your Physics Department in terms of student and academic staff members in full time equivalents

(FTE):

students (incl. Master's degree students

doctoral students

academic staff

Postdocs

2.6 If you have recently changed the structure of your programmes and degrees, what types of Physics degree programmes did your institution offer BEFORE changing to Bachelor and Master programmes (if applicable, also name traditional degree programmes currently still running parallel to Bachelor and Master programmes)?

Name of programme

Av. duration

in years

Av. No. of

students

Not applicable

2.7 What types of Physics programmes (and degrees) does your institution currently offer?

online.QTAFI - physics_UK

How many Programmes?

Bachelor Programme(s) in Physics

Integrated Master Programme(s) in Physics

Stand alone Master Programme(s) in Physics

Other (degree) programmes in Physics

Doctoral Programme(s) in Physics

First-Cycle or Bachelor Programmes in Physics

3. Implementation of the tiered structure

3.1 When did you introduce first-cycle or Bachelor degree programmes in your institution as a whole?

Bachelor programmes are the traditional degree programmes in my institution

Before the year 2000; please indicate in which year:

In the year 2000

In the year 2001

In the year 2002

In the year 2003

In the year 2004

In the year 2005

In the year 2006

In the year 2007

In the year 2008

Introduction of first-cycle or Bachelor degree programme(s) is envisaged for the year:

3.2 When did you introduce first-cycle or Bachelor degree programme(s) in Physics in your institution?

Bachelor programmes are the traditional degree programmes in my institution

Before the year 2000; please indicate in which year:

In the year 2000

In the year 2001

In the year 2002

In the year 2003

In the year 2004

In the year 2005

In the year 2006

In the year 2007

In the year 2008

Introduction of first-cycle or Bachelor degree programme(s) in Physics is envisaged for the year:

3.3 Please state the name of the Bachelor Programme(s) in Physics offered at your Institution

(Please note: for subsequent answers please refer to number(s) of programme(s) listed here from 1 to 15 to reflect variation.)

Programme 1:

Programme 2:

Programme 3:

Programme 4:

Programme 5:

Programme 6:

Programme 7:

Programme 8:

Programme 9:

Programme 10:

Programme 11:

Programme 12:

Programme 13:

Programme 14:

Programme 15:

3.4 Is there a system of accreditation/ approval of Bachelor study programmes in place?

Multiple replies possible

National accreditation system through agency

Institutional approval system

Approval by Ministry

Other form, please indicate:

3.5 Are your Bachelor Physics Programme(s) accredited and/or approved and if yes, until when?

Yes, accredited Until:

Yes, approved Until:

No, neither accredited nor approved

3.6 What is the scheduled duration of a Bachelor programme in Physics at your institution?

3.0 years Programme

3.5 years Programme

4.0 years Programme

Longer than 4.0 years, please indicate:

Programme

Other, please indicate: Programme

3.7 How long does it actually take on average for Bachelor students in Physics (incl. final examinations) to complete their studies successfully at your institution?

3.0 years Programme

3.5 years Programme

4.0 years Programme

4.5 years Programme

5.0 years Programme

Longer than 5.0 years, please indicate: Programme

No information available (yet) Programme

4. Implementation of Complementary Measures

4.1 Do you apply ECTS Credit Points in the framework of your Bachelor Programme in Physics?

Yes

No

4.2 If not, do you apply other forms of Credit Points?

Yes

No

4.3 If yes, are these Credit Points compatible with ECTS?

Yes Please indicate conversion: ECTS = Credit Points

No

4.4 Have you modularised your Bachelor Physics Programme(s)?

Yes

No

4.5 If yes, is the credit rating of your modules calculated on the basis of student workload?

Yes

No

4.6 If yes, how many hours of student workload are required to earn one credit point?

10 hours

15 hours

20 hours

25 hours

30 hours

Other, please indicate:

4.7 What does one module consist of as a rule?

Number of hours of student workload, please indicate:

Number of ECTS Credit Points, please indicate:

Number of other Credit Points (if applicable):

Number of teaching hours in class, please indicate:

Other numeric elements, please indicate: ►

- **4.8 Are compulsory phases or elective phases of study abroad (international mobility) part of the Bachelor curriculum?**
Compulsory Programme
Elective Programme
- 4.9 Are there other opportunities for mobility (internship abroad, work or lab work abroad) provided?**
No Programme
Yes, please indicate which ones: Programme
- 4.10 At what point in time during the course of study do students go abroad?**
2nd year Programme
3rd year Programme
4th year Programme
Any Point in time Programme
- 4.11 For how long do students go abroad on average? Please differentiate according to compulsory and elective mobility phases.**
Compulsory Elective
Less than one month Less than one month
1-2 months 1-2 months
3-5 months 3-5 months
longer than 5 months longer than 5 months
- 4.12 Please indicate the percentage of Bachelor Physics students who use such opportunities to go abroad:**
Percent on average No information
Programme 1
Programme 2
Programme 3
Programme 4
Programme 5
Programme 6
Programme 7
Programme 8
Programme 9
Programme 10
Programme 11
Programme 12
Programme 13
Programme 14
Programme 15
- 4.13 Is your Bachelor Programme in Physics a joint or double degree programme? (Note: a double degree programme is programme offered jointly by two institutions located in different countries; a joint degree programme is a programme offered jointly by more than two institutions from different countries.)**
Yes
No
- 4.14 If yes, is it a**
Joint degree programme. How many partner institutions
Double degree programme. Partner from which country
- 5. Curriculum**
- 5.1 Do your module descriptions include expected learning outcomes?**
Yes
No
- 5.2 What is the primary language of teaching in your institution?**
Please indicate:
- 5.3 Is teaching offered in a foreign language in Physics Bachelor Programmes in your institution?**
No
Yes, in some programmes
Yes, in all programmes
- 5.4 If yes, please indicate the (foreign) language or languages and rank them according to the frequency of use (with Rank 1 being the highest):**
French
German
Italian
Spanish
Other foreign language(s), please indicate:
- 5.5 Are whole Programmes taught in a foreign language or just parts of Programmes?**
Whole Programme
Just parts of Programmes
- 5.6 If teaching takes place in a foreign language (or more than one foreign language), please estimate the proportion:**
Language ranked 1: percent
Language ranked 2: percent
Language ranked 3: percent
- 5.7 Does teaching in your Bachelor Physics Programme(s) include multidisciplinary or interdisciplinary components?**
multidisciplinary interdisciplinary No
Programme 1
Programme 2
Programme 3
Programme 4
Programme 5
Programme 6
Programme 7
Programme 8
Programme 9
Programme 10
- 5.8 If yes, please indicate which subjects/subject groups other than Physics (including Mathematics and Computing) are included in the curriculum:**
Other natural sciences, please indicate: Programme
Engineering Sciences Programme
Medical Sciences Programme
Humanities Programme
Social Sciences Programme
Other, please indicate: Programme
- 5.9 Does your institution offer joint honours programmes in Physics?**
No
Yes, please indicate Programmes
- 6. Assessment and Examinations**
- 6.1 How many ECTS credit points (or ECTS equivalent credit points) must be earned for a Bachelor degree in Physics?**
180
Other, please indicate:
- 6.2 How are the credit points distributed in your Bachelor Physics curriculum over the various types of delivery (provide number of credit points)?**
credit points for lectures/theory modules
credit points for lab work/practicals
credit points for Bachelor thesis/project work and defence
for other forms of delivery, please indicate:
Total: credit points
Not applicable, no credit points in use
- 6.3 Does the award of a Bachelor degree in Physics include a final examination which is separate from/in addition to the modules?**
Yes
No
- 6.4 If yes, what does the final examination consist of?**
Multiple replies possible
Written thesis
Written thesis plus defence
Unseen examination
Oral examination
Demonstration of an experiment, mathematical formula (or similar)

Project presentation
Other, please indicate:

6.5 Are the marks awarded during the course of study included when calculating the final mark of the degree (please indicate percentages)?

Mark of degree emerges from the marks of the modules

No mark given for final degree (just pass/fail/passed with distinction or honours)

Percent from modules

Percent from lab work/practical exercises

Percent from thesis and defence (if applicable)

Percent from final oral examination (if applicable)

Percent from final unseen examination (if applicable)

Percent from other form(s) of assessment, please indicate:

6.6 Is each module assessed?

Yes

No

6.7 Do you assess learning outcomes after each module or unit of teaching/learning?

Yes

No

6.8 Do you assess subject knowledge only or also transferable skills?

Subject knowledge only

Also transferable skills

6.9 What types of assessment are being used during the course of study?

Multiple replies possible

Unseen examinations

Multiple choice questions

Homework papers

Interview with teacher

Oral examination

Other forms of assessment, please indicate:

6.10 What forms of marking are used in your Bachelor Physics Programme?

Multiple replies possible

No marking (just pass/fail)

Relative marks (performance of individual student in relation to the group)

Absolute marks (degree of fulfilment of established criteria)

Individually acquired knowledge during a module/class

Individually acquired competences (incl. transferable skills) during a module/class

Other forms, please indicate:

6.11 To what extent do practical parts in the modules (demonstrations, lab work results, etc.) count for the final mark?

Not at all

Between 5 and 10 percent

Between 11 and 20 percent

Between 21 and 30 percent

More than 30 percent

7. Quality Assurance

7.1 What types of quality assurance activities are carried out for your Bachelor programmes in Physics?

Multiple replies possible

Periodic approval by your institution

Periodic accreditation/re-accreditation of the programme

Evaluation of courses/modules by student questionnaire

Evaluation of the programme by external evaluators

Inclusion of external examiners

Monitoring of teaching material and preparation of teachers

Obligatory participation of teaching staff in pedagogical/didactic courses

Other, please indicate:

8. Employability and Transferable Skills

8.1 Is the acquisition of transferable skills part of the Bachelor in Physics curriculum?

Yes

No; please go to question 8.3

8.2 If yes, is the acquisition of transferable skills integrated into the Bachelor Physics curriculum or is it separated from it (e.g. in special courses)?

Integrated

Separated in special courses

Mixed

8.3 Do you prepare your Bachelor students predominantly for transition into the labour market or for transition into a Master Programme?

Predominantly for labour market

Predominantly for stand alone Master Programme(s)

Mixture of both

For a PhD programme

8.4 What activities/services does your institution offer to ease transition of Bachelor Physics graduates into the labour market?

Multiple replies possible

Career services and advice

Organisation of interviews with potential employers

Internships during the course of study

Lectures by alumni or potential employers about labour market and career opportunities

Training for job applications and job interviews

Information brochures about potential job areas

Other activities/services, please indicate:

9. Composition, Completion and Transition Rates

9.1 Please estimate completion rates in your Bachelor Programme:

percent of students successfully complete their programme.

Not known yet.

9.2 Please indicate the percentage of international students enrolling in your Bachelor Programme in Physics:
percent

9.3 How many newly enrolling students on average enrol in a Bachelor Physics Programme, a joint honours programme in Physics and an integrated Master Programme in Physics?

percent of new students in a Bachelor programme in Physics

percent of new students in a joint honours programme in Physics

percent of new students in an integrated Physics Master Programme

9.4 Please estimate the composition of Bachelor Physics graduates going into a stand alone Master Physics Programme offered by your own or by another institution:

percent of own Bachelor Physics graduates enrol in a stand alone Master Physics Programme at own institution

percent of own Bachelor Physics graduates enrol in a (stand alone) Master Physics Programme at another institution

percent of Bachelor Physics graduates enrol in a (stand alone) Master Physics Programme at an institution in another country

percent of Bachelor Physics graduates enrol in a (stand alone) Master Physics Programme at an institution in another country

percent of Bachelor Physics graduates enrol in a (stand alone) Master Physics Programme at an institution in another country

Not known yet.

9.5 Please estimate the proportion of Bachelor Physics graduates going into the labour market:

percent

Not known yet

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