Computers methods in Physics, a course for future teachers. A five years experience.

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We report on a course of "Computers Methods in Physics"; the course is held in the contest of a two years "Specialization School for secondary school Teacher" (SILSIS-MI) of the Milan University, in the branch "Fisica Matematica Informatica". Admission to this School is at closed numbers and requires a specific "laurea" (higher degree): for our course, the "laurea" in physics, mathematics, or engineering. We present, analyse and discuss data and written material collected in this yearly course from 2000 to 2004, in five successive activity cycles of the School. The course, which is highly interactive, favours work by groups and is based on the use and critical analysis of computerized tools on Physics topics: Internet sites and educational multimedia materials. Relevant part of the discussion deal with significant aspects arising from the reports, written by students' groups, as well as individual students' records and to their answers to the course evaluation feedback questionnaire. The trend of variation throughout the years is also interesting, in particular the raising students profile and competence, with improved course outcome in more recent years.

1. Specialization School for Teacher

The course "Computers Methods in Physics", object of this paper, is being held in Milan, part of the two years postgraduate University School, the Italian Specialization School for Secondary School Teacher ("SSIS", Scuola di Specializzazione per l'Insegnamento Secondario) run by Italian Universities since 1999.

Students attending "SSIS", obtain, after a final examination, the qualification of "abilitazione all'insegnamento", i. e. the official qualification to teach a particular set of subjects ("classe di abilitazione", e.g. Latin, Physics etc.) in the secondary Italian schools. Student are required to attend the School's Courses for a total number of 1000/1200 hours of collective activity corresponding to 120 "cfu", credits (cfu: crediti formativi universitari).

The School's topics include four main areas: Science of Education (for the 20% of the total amount of hours), subject contents Teaching (frontal lectures and training laboratories 50%), Experimental Teacher Training in a Secondary School, realised with a particular agreement between the two institutions (secondary School and University) (30%).

At present, only graduates from the old Italian University graduating System (which required a four/five year course) can access to the SSIS School, which is at limited access , with an admission written and oral test.[1]

The present SSIS include 8 different "Indirizzi" ("subject content" units according to subjects that show affinity i.e. languages, humanities, scientific subjects…) each of those associated to more "Classi di abilitazioni" mentioned above.

[1] In the next 3 – 4 years a new post degree system will take the place of the SSIS: it will be a "Laurea Magistrale" (post graduate qualification) for schoolteachers. Graduates from the new Italian University graduating System (with the new degree obtained after a tree-year course) can have access to this qualification, also in this case, after passing an admission test.
The new "Laurea Magistrale" will consist in a two year course plus a one year of training in a secondary school

The course "Computer Science applied to Physics", made in the Milan SSIS[2], belongs to the "Indirizzo" of scientific subjects: Computer, Physics, Science and Mathematics; it leads to the qualification ("Abilitazione") which is a title that allows to teach Physics in the Italian Secondary Schools.
At present 47 students are attending this course.
At the SILSIS-Mi there are, now, in total, 1600 students distributed in 29 different qualifications.
The postgraduates so far, in these 6 years, have been 2974.

2. Aims of the course "Computers Methods in Physics"

The aims of the course are:

1. to have post graduates to master key tools for their activity as teachers in the classroom as well as in their individual preparation
2. to update their general knowledge in the subject and teaching methodology.

This will also be relevant to enable students to keep up to date for the rest of their life of teacher and scholar.
Considering the large use of ready-made multimedia material downloadable from the net, it's highly necessary to be able to surf the net, to select relevant information and to connect and ponder facts and figures, analyse and evaluate computer software for its contents and technical characteristics.
Teachers shall acquire these skills as students and hand it over to their pupils who, on their turn, will use them both in their studies and future work.

3. Contents

The course is based on a critical use and analysis of Internet sites and software packages concerning Physics.
Graduate students are provided with a list of Internet sites and they are asked to choose one or a couple of them to be analysed. The sites have to be studied, examined in details from different points of view: see point 4.2.
A list of software packages is provided to the students. The majority of these software packages are produced by groups of researchers of didactics in Physics from Italian Universities; others are made by individual experts and are distributed free of charge or sold.
Most of the suggested sites and software refer to Modern Physics. This is, unfortunately, a neglected sector where, worldwide, it is particularly hard to train Physics teachers and to provide updating courses. Furthermore, this is a research field of special interest for researchers at Milan University, who are also lecturers of this course. Modern Physics is even more important for graduates in Mathematics who will be physics teachers, lacking the robust background that physics graduates have in this subject. The analysis criteria are dealt with at point 4.2

4. Summary of the course organisation

The course is lead by three lecturers who are also the authors of this article.
At the very beginning students are requested to fill in an anonymous questionnaire. Questions mean to collect information about students' knowledge of computer science, type of degree they hold, their skills in the use of a foreign language, and their teaching experience if any.
After that, the students are split into small groups (two or three people, better if with different degrees); they start analysing the sites and the software packages. We suggest that 4 hours on average have to be devoted to the sites analysis and other 4 hours are necessary for software packages.

[2] There are two SSIS in Milan, the our one is named "SILSIS-Mi" and has five Universities involved (Università Statale di Milano, Università Statale di Milano Bicocca, Politecnico, Università Bocconi, LIUCC-LIbera Università Carlo Cattaneo-) , while the Università Cattolica has its own SSIS.

Until the last year students were split into two categories: the first one being composed of students who will teach Mathematics and Physics at "Licei" (general secondary schools), working for 10 hours in our course. In the second one there were students who will teach at “Istituti tecnici” (technical and vocational secondary schools) working for 20 hours.
Now the general schedule of the course had changed: all students are expected to work for 24 hours.
At the end of the course a common and guided panel debate (2hrs) follows.
Finally all the students’ groups are asked to work out a report (see paragraph 4.2).

4.1 Profile of the post graduate students

In the past 6 years 236 post graduate students, coming from 3 different scientific faculties (Mathematics, Physics and Engineering), have attended the courses.
In Tab. 1 the post graduated students are grouped according to their degree. By “cycle” it is meant “a two year course”. The first cycle began in school-year 1999-2000. As to the 6th cycle, the present one, only data concerning the number of students presently attending the course and their distributions in the different degrees are reported.

Table 1 Number of students enrolled at the course per cycle, and per degree

Cycle	Enrolled students	Mathema-tics	Physics	Engineering
1°	23	11	9	3
2°	23	11	11	1
3°	38	23	13	2
4°	47	17	20	10
5°	58	35	15	8
6°	46	21	16	9
total	235	118	84	33

Further data about computer skills and knowledge came from the initial questionnaire given to 143 post graduated students from 3 cycles. From these data it turns out that averagely 72% has its own computer for unlimited number of hours; 25% uses computer for less than 25 hours per week and only 3% uses it never or just 1 hour per week. Over the course of time the use of computers has progressively increased; in particular until six years ago the use of a computer was not very frequent (information coming from a qualitative survey); three years ago the percentage of students using a computer raised to 62% and last year this percentage was 86%.

In Tab.2 the levels of knowledge relevant to the different informatics programmes and operating systems are listed.
The lowest levels of knowledge refer to Apple Mac operative system, a type of computer which is seldom used in the Italian schools.
More in detail, the data in the three cycles show a progressive increasing experience in the use of the computer.

Table 2 Average percentages, relative to the level of knowledge of some operating systems or informatics programmes (Data from the last three cycles).

LEVEL OF KNOWLEDGE	Null	Basic	Medium	Advanced
Operating systems for personal computer (Windows …)	1	12	81	6
Operating systems for Apple Macintosh	84	10	1	0
Word or other word processing informatics programme	0	9	69	22
Explorer or Netscape or analogous browser	3	15	68	14
Excel or other electronics sheets	3	30	57	10

4.2 Final evaluation

For the final evaluation every group of students prepare a report on the sites and types of software (one or two of each one) that have been previously explored and studied. The following items have been taken into account in the reports:

- their content: assessing completeness and correctness from the point of view of the declared subjects, their extensiveness and whether they provide important information;
- the didactic aspects (whether they may be used for a traditional lesson in a classroom of a secondary school, in the lab or for individual study) and the resulting level of user interest;
- computer-aided use (if they are easy to use, if one can surf the programme maintaining ownership of choices/options and control of resulting actions/outcomes).

It is useful for students to ascertain the cultural level of the material they are examining and to distinguish those sites with didactic and subject-related appropriateness from those merely informative/passive.

Each of the three course lecturers gives his own personal assessment with reference to the compliance with the suggested prompts, the correctness of the Physics contents and the logical coherence of the analysis. Then, from a proper discussion, emerges a final evaluation of the students' reports. The students' way of dealing with Physics contents as well as their critical skill/ability to appreciate the validity of Physics subjects dealt with the web-sites or the software, are particularly taken into consideration for the final assessment, together with the ability to see if the web-site or the software are suitable for teaching. The students are progressively trained to avoid both being superficial and underlining the popular aspects instead of the disciplinary or the educational ones.

The final assessment range is from 18 (minimum acceptable level) to "30 cum laude" (maximum level: pass with distinction). The results are listed in Tab.3.

Table 3 Students evaluation range per course/Year

Year/	18-23	24-26	27-29	30-30 cum laude
2000	1	3	12	2
2001			13	7
2002		8	25	7
2003		20	19	9
2004	10	8	13	2
Tot.	11	39	82	27

From the data of Tab.3 we can see that there is not a positive trend throughout the years in the students' final evaluation. These results, highly influenced by the students' ability of analysing multimedia materi-

als, do not seem to improve with time, notwithstanding students' improved familiarity with computers in more recent times, as it was already detailed in point 4.1.

5. Course validity

At the end of every course an anonym questionnaire is given to the students who are asked to express their personal opinion on specific aspects of the course. The answers of 83 students are summarised below. Fig. 1 shows the level of students satisfaction with the course. Fig. 2 shows the students assessment on the course contents with reference to the compliance of the course aims with the final targets, also considering the students' expectations.

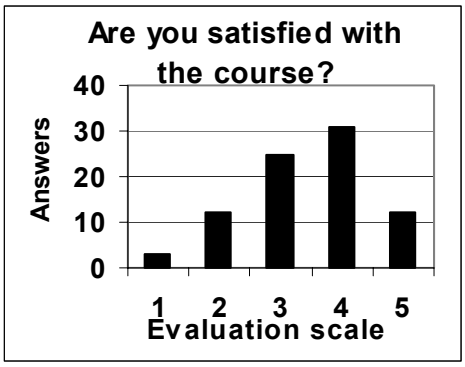

Fig. 1 Level of students satisfaction with the course.

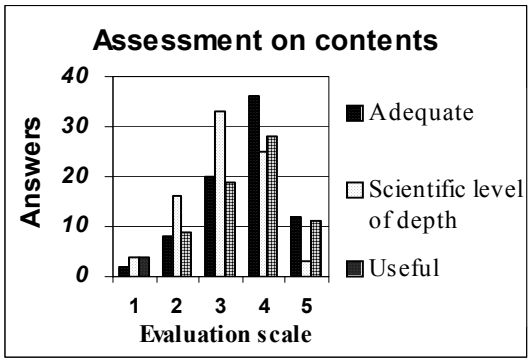

Fig. 2 Students assessment on the course contents with relevance to their adequacy, scientific level of depth and usefulness.

6. Conclusions

The results of these 5 years confirm that the course is useful to prepare the would-be teachers.
The organisation and content have been continuously enhanced on the basis of experience. In particular, in the latest years, we asked our alumni to give a feedback about the course. Once again the answers confirm the course's usefulness (many students said that the course was among the best attended at the School, and that completely fulfilled their expectations). We gathered some critical observations as well, and we took those into serious consideration, improving the course with time.
The data concerning students' records, coming from questionnaires, show that, throughout the years, the trainees have greatly improved their knowledge and their ability in computer science and in informatics technology. Five years ago most trainees were unable either to use computers or to appreciate its usefulness in teaching. Now, the majority of the students master it very well and often use it already for teaching (even if not always in the very best way). On the other hand, post-graduate students have not equally developed, at the same level, a critical capacity to analyse and to estimate the available material for Physics. We often observe a sort of superficial approach, permeated by "consumerist habits" set off by non scientific media influence on today's culture. It's necessary for us to dedicate more attention to it in the future and to try to transmit interest for real knowledge and culture.