Laboratory activities and the perception of the students

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The **perception** that students have **towards laboratory activities** has been analyzed on the basis of the results of a questionnaire distributed to:

- 99 students from High School
  - Liceo COCITO – Alba (Torino – Italia)
  - They had a laboratory experience before the questionnaire and only part of them had regular laboratory experience before
- about **270 university students** from the Physics Bachelor degree course at the University of Torino.

Objective of laboratory activities:

not only

- demonstration of **concepts**
- **laws** and
- **procedures**

but also

- greater **maturity**
- **autonomy** of thought
- increased **capacity of cooperation**
- increased **capacity of using instruments**

By laboratory activities is possible to **develop learning modalities**

"cooperative learning"
(groups of **students** that **collaborate/cooperate** in a work of in-depth analysis and learning that leads **to the building of new knowledge** in order to reach a common objective)

"learning by doing" (the action and experimentation of situations, duties and roles in which the subject, as an active **participant,** finds himself in a position in which he **must use his own resources and competences to elaborate and/or reorganize** theories and concepts in order to reach an objective)

- students can **investigate, identify problems** and **try to suggest solutions**
- **interpret** the results in the light of previous knowledge
- understand **how to initiate/inhibit a process** or vary the behavior of a system (Sassi & Vicentini, 2009)
- **express** results **in different languages** (natural and formal, both analytical and graphic)
- **depict** more aspects of their laboratory work **by Lab reports** (Haagen-Schuetzenhoefer, 2012)
- **Laboratory activities play an important role in growing inquiry capabilities and scientific understanding** (Hofstein, Shore & Kipnis, 2004).

- **objective** of our research was **to follow the temporal evolution of the approach to laboratory activities …..**

….starting **from** the students of the **IV and V years of High School** and going on **to** students in the **III year of the degree course in Physics**.

- We made the analyses during the 2011-12 academic/scholastic year and in particular **in the spring-summer of 2012.**

99 responses were obtained from High School and about 600 from University

- at the University of Torino are active **6 obligatory laboratories , 2 for each year of the course**
- Every student answered for the two laboratories of the year and some 3rd year students answered about I and II year laboratories also.
- So we have more than 600 responses divided into:
- few less than **350 for the first year** laboratories
- more than **150 for the second year** and
- about **100 for the third year** laboratories

The questionnaire was similar to that proposed to university students in Canada (Deacon & Hajek, 2011) :

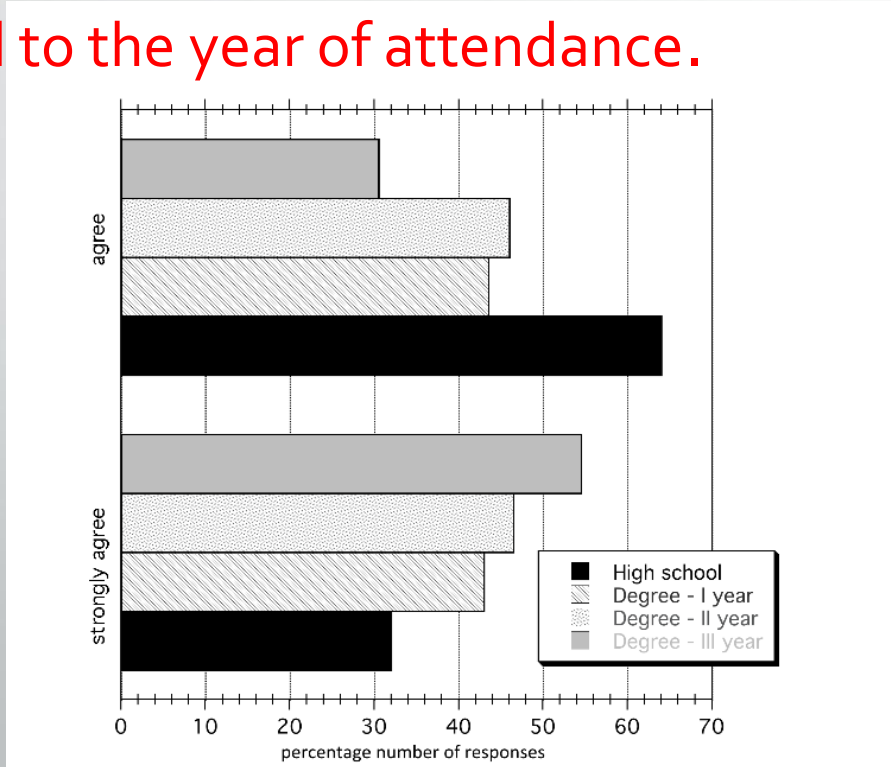
- **Usefulness** of the laboratory to attain a greater comprehension of Physics.
- **Interest** in laboratory activities and **complementary nature** of laboratory activities and classroom lessons.
- **Implementation in the capacity** to use other instruments (informatics or not informatics).
- Usefulness and ease of use of the **informatics instrumentation.**

The questionnaire also included two open questions on "What I like" , "What I do not like" in laboratory activities.

- The responses were proposed with **5 possible choices**
- from "***clearly yes***" → **complete agreement** with what was stated
- to **"*clearly no*"** → **complete disagreement** with what was proposed as the reference statement
- We did an analysis for each question throughout a **chi-square test** with the **null hypothesis** of **simple uniform statistical distribution**.
- Therefore, the non-acceptance of the null hypothesis shows the presence of a diversified response, which points out:
  - a change in opinion over the years
  - a more positive opinion (or more negative) than expected for a pure proportional distribution

"The laboratory activities contribute to the enlargement of my preparation in Physics"

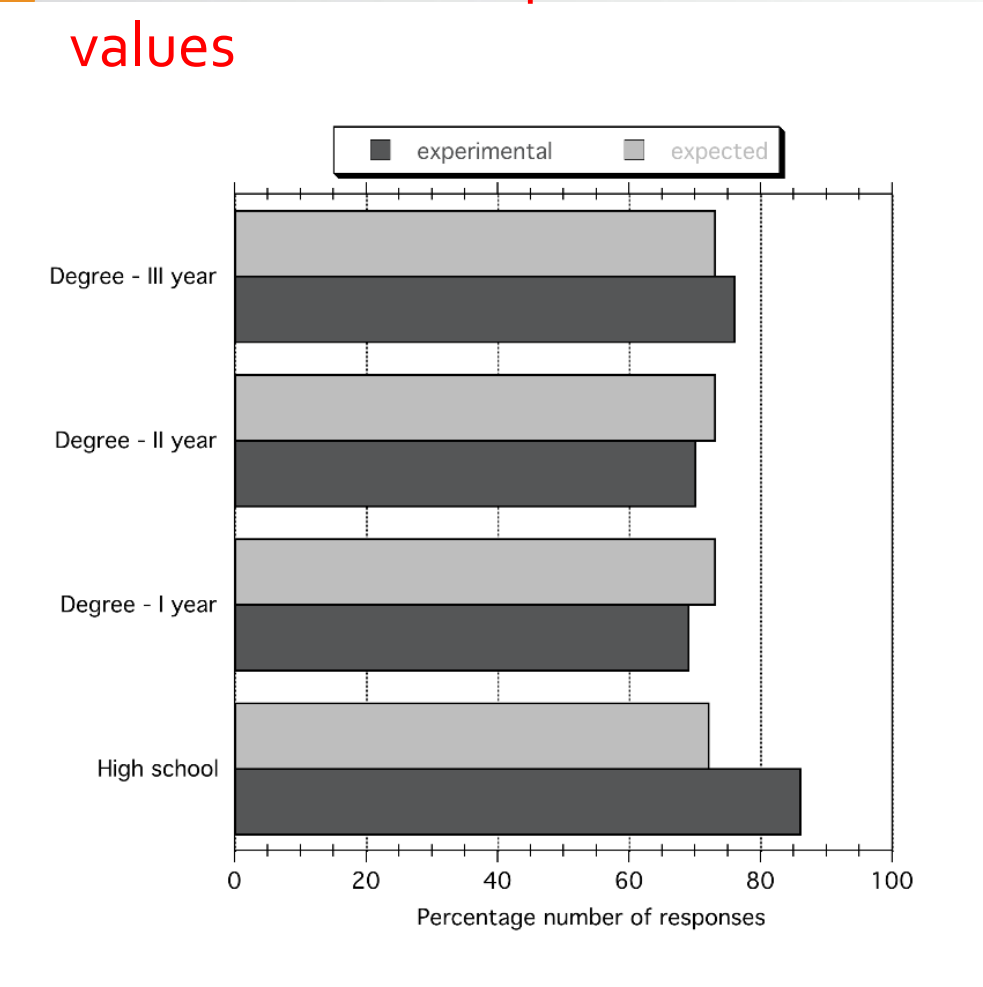
Trend of the percentage number of "clearly yes" and "yes" responses accord to the year of attendance.



- Students in **High School agree (64%)** and complete agree (32%) → sometimes the teacher does the experiments without the real active partecipation of the students.
- Students in the **third year of university** indicated the opposite trend (28% of "yes" against **55% of "clearly yes")** → their activities reveal the characteristics of experimental verification of what they acquire in the study in theoretical courses .
- The percentages of the two responses are more or less uniformly distributed for the first and second years of university (p=0.93).

“The conducted activities are interesting”

Comparison between the experimental “positive” values and the expected values



- we grouped responses into two categories:
  - positive: “clearly yes + yes “
  - not positive: “yes and no + no + clearly no”
- The following points emerged:
  - **Satisfaction** in the **High School** was a bit **greater** than expected. **For many students this activity was the first laboratory experience.**
  - **Less satisfaction** was expressed at the **University**, although the result was not far from the uniform distribution (p=0.16), and showed a **higher degree of dissatisfaction for the first year students, who perhaps do not appreciate the theoretical part of data analysis theory**

- **Laboratory activity** surely is considered by **all the students useful for a greater comprehension of Physics**.
- **Lack of time for analysis** (High School students, in particular)
- **Not complete satisfaction and low interest during university first year course**

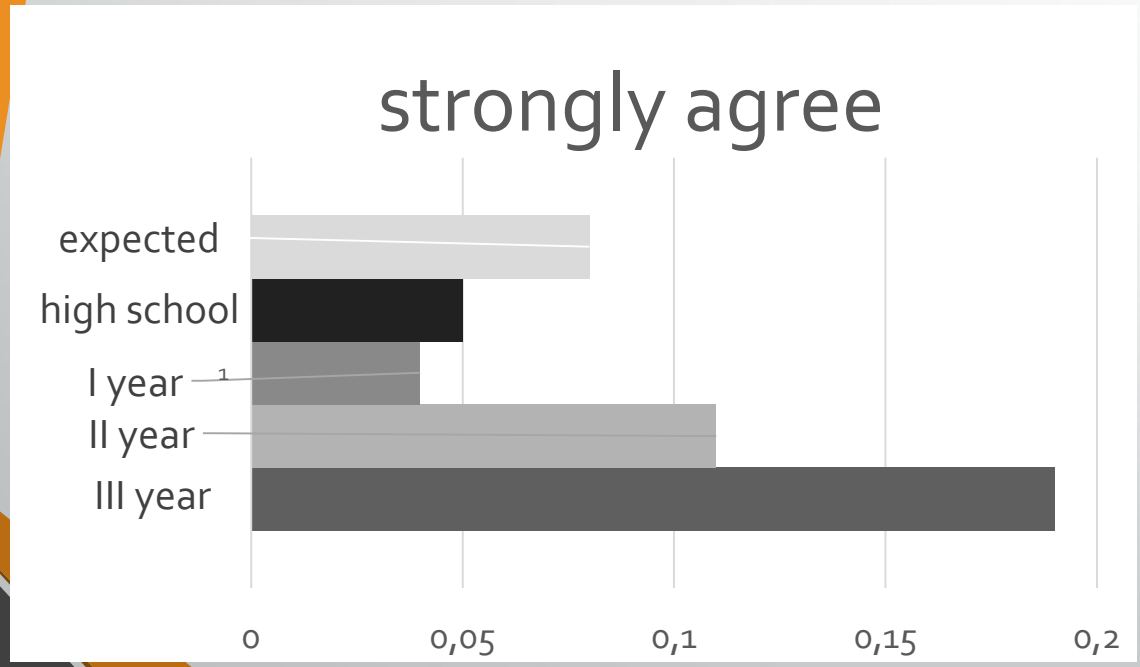
→ it is important that students **already at the High School acquire the concept of the experimental error in measurement operations** and that laboratory activity is not a simple collection of data, without a connected discussion.

→ they must understand that they can **obtain results only from the analysis of data** and not simply from the conduction of experiments, perhaps experienced in a passive manner.

→also many of **first university year students** were not aware that, in order to obtain information from experimental data, they must be able to **analyze** these data **according to methodologies acquired through** an inevitably partially **theoretical course**.

"The part carried out in the classroom and that conducted in the laboratory integrate each other in a harmonious manner"

Distribution of the percentage number of responses versus the year of attendance.



- we found in **High School** and in the **first year of university a lower value of "cleary yes" than expected;** the students **want a greater coordination** between the two didactic parts
- **In the third year**, students completely refused uniform hypothesis ($p=7\ 10^{-5}$), but in a positive sense: **they recognize a clear complementarity between the two parts,** which they consider to integrate and enlighten each other.

"Do the laboratory activities contribute to improving the capacities connected to experimental activities?"

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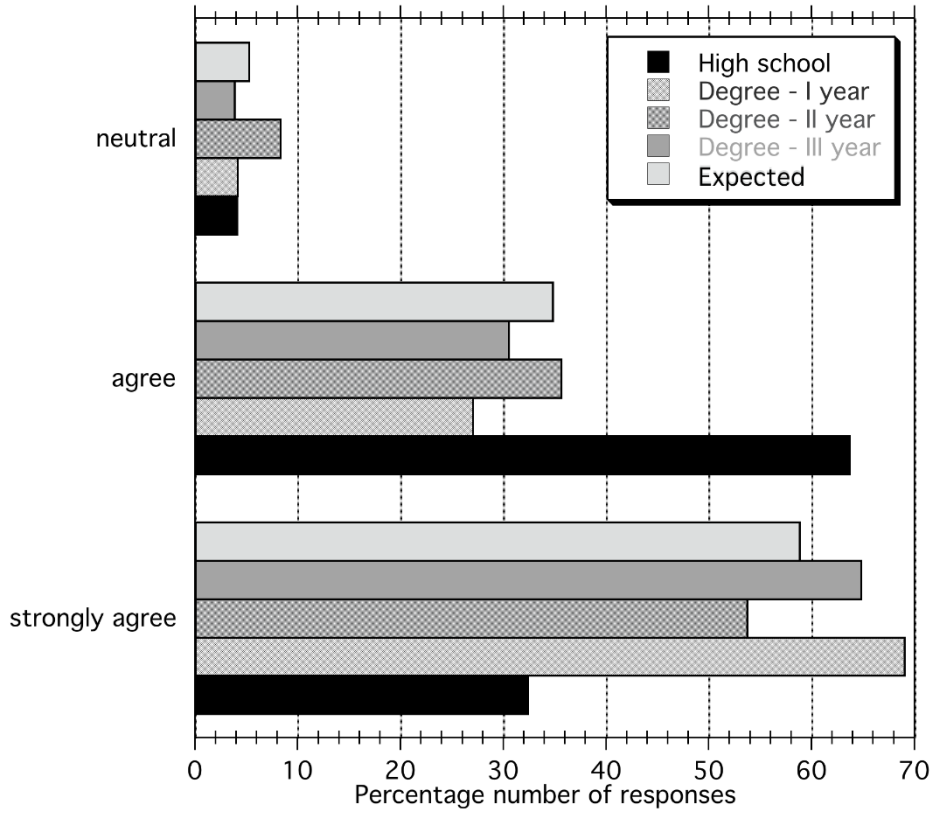


- in **High School "yes"** responses **are more numerous** and "clearly yes" are less numerous than expected
- A possible reason is the **low possibility for students of directly analyzing data**, because of their limited expertise. The other correlated activities (reports, presentation of results, discussions) also play a minor role in the High School, which favors the actual moment of collecting data.
- At **University**, the situation for first and third year students is **a bit more favorable to complete agreement** than expected
- In particular first year students for he first time face the responsibility of having to write a scientific report according to well-defined criteria and they have to use a software program (Mathematic) that they did not know before. **They therefore recognize a net improvement in their capacity to analyze and present results**.

What I like about the laboratory	What I do not like about the laboratory
To experiment and verify the theories studied during the lessons, to obtain a greater comprehension of Physics and manual skills.	The burden of the requested work (both for the measurements and for the analyses); physical and mental fatigue due to the 4 hour sessions; conflict with other courses
To understand the problematic nature of the experimental measurements and of their analyses	Lack of time for analysis ; **impossibility of conducting experiments in an autonomous manner** (first year)
Group work, acquisition of a critical mind, collaboration, contact and relationships with teachers/tutor, informal atmosphere	Boring practices, with **very complex data analyses:** or excessive number for the considered didactic period
Autonomy in the management of the practices, construction of apparatus; possibility of varying the parameters in order to increase comprehension; more modern and interesting practices (in the second and third years)	**The bad preparation of some tutors** lacking/obsolete/incomplete didactic material, **laboratory data sheets not complete;** obsolescence of the instruments
	Groups are too numerous or with non-collaborative members
	Adequacy of what is required in the laboratory with what is explained during the lessons; too many technical aspects are taken for granted
	Very short times for the handing in of reports for the examinations; different software programs used in the different laboratories

- Students often consider laboratory activities of secondary importance compared to theoretical courses and **excessive the work** required for the **analyses** of the data and **the drawing up of reports**

→ it would be useful **to leave them free to analyze data in an autonomous way**, according to their previously gained knowledge. Then discuss the results and guide them to the theory that underlies the correct analyses of the experimental data.

- The laboratory **data sheets** must guide students in the correct execution procedures.

→ It could be useful **to start from very simple laboratory activity** for **which only the strictly necessary information** should be supplied and then ask the students themselves to draw up a laboratory data sheet that contains the information they feel necessary for a correct conduction of the experimental steps.

- The aspect **of autonomy in the management of experimental activities**, which has resulted to be important for a great number of students, is difficult to realize in the first year of university.
- the **instrumentation** used in the first year laboratory **is delicate** and the students cannot manage it by themselves. They **have to follow codified operations** under control: this undoubtedly reduces the attractiveness of the activity itself.

→ **Electricity experiences offers** to students the possibility to **work autonomously** and makes the laboratory work more interesting and amusing.

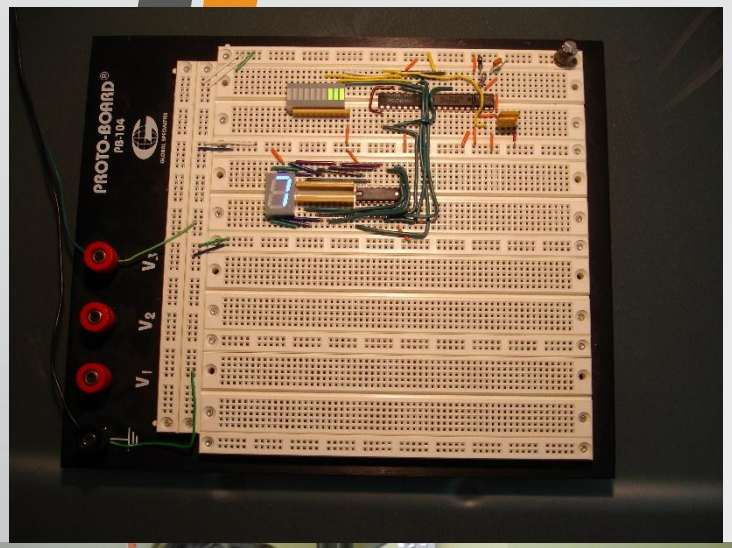
So those experiences can be the **occasion for students to plan** what they want to obtain and how, and **then to verify** if they have correctly reached the proposed objective.

- the use of delicate instruments makes **necessary the constant presence of technicians and tutors.**
- This is one aspect that the **students** find hard to appreciate, and often **complain about the tutors' preparation**.

→ It could be important **to valorize the activities of the tutors** and their preparation more carefully, not only in favor of younger students but also **as a moment of development of competences and ability**.

The preparation of the tutors could therefore go beyond a simple "training" and involve codified operations, thus **becoming an educational moment** with positive consequences on activities with their younger companions.

Thank you for attention!!



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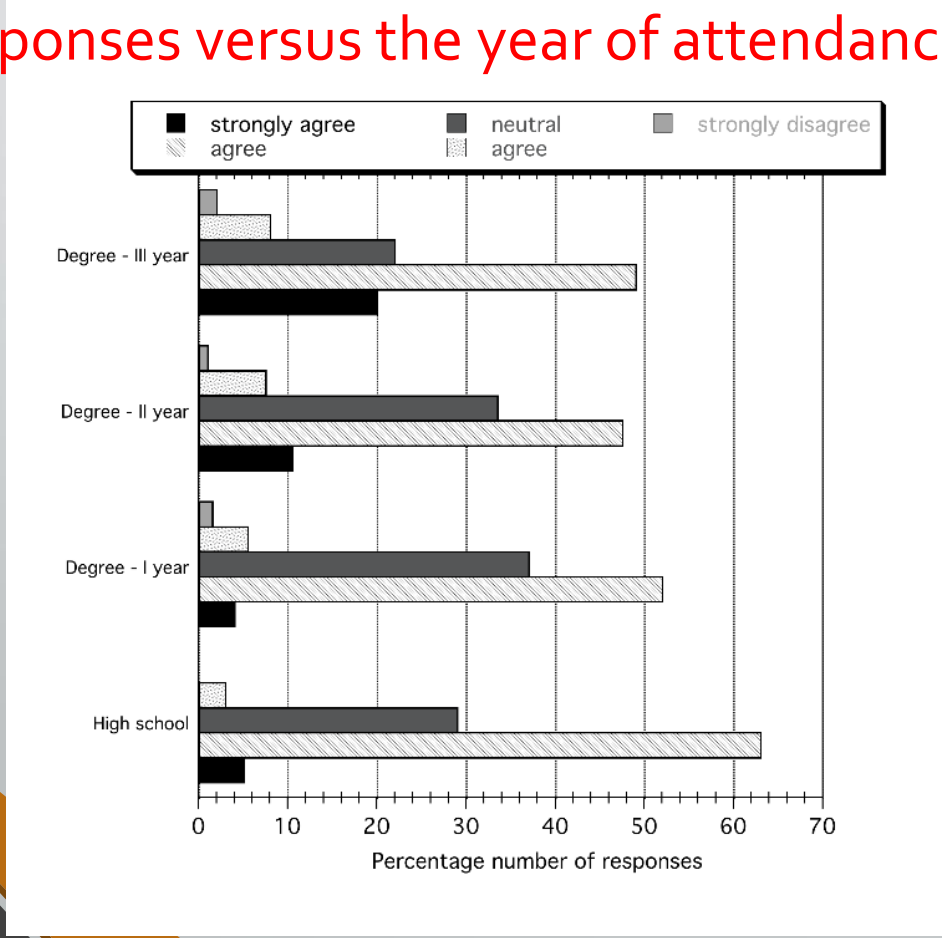

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