La visió d'un investigador 2.0
VII Workshop BiblioUdG

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Outline of the presentation

- Research topics.
- How I conduct my research.
- Tools of the trade.
- Case 1: scientist and policy makers.
- Case 2: a window into the past.
- Case 3: how much is much?

Research Topics

- Water quality modeling in lakes and reservoirs:
  - Water clarity
  - Climate change
- Complex systems:
  - Neolithic dispersion
- Educational research:
  - Tracking performance

How I Conduct my Research

- Each research project is different: goals, scope, procedures and structure.
- Each project requires a different perspective.
- Some projects are big and complex, involving many people. Some research is conducted in solitary.
- Field work, lab work and intellectual work.
- Common tools and specific tools.
- But all have one thing in common: CREATIVITY

How I Conduct my Research: CREATIVITY

- Free association of ideas, brain storming, no structured, no constrained (sweet).
- Information from multiple channels (but avoid saturation!)
- Diversity: concepts, ideas coming from seemingly unrelated fields.

Tools of the Trade: Explore Ideas

- Newsletters.
  - Journals: Physics Letters, Science, Nature,..
- Newsalerts
  - Scoopit
- Podcasts & webcasts
  - BBC
  - TED conferences
- Science Blogs
  - Esmateria,...
- Journals and media outlets
  - Nytimes science section
  - BBC science

Tools of the Trade: Hands-on

- Reference management
  - Mendeley
- Searching tools
  - Web of Science
  - Google Scholar
- Apps (Android)
  - Whatsup
  - Camscan (pdf)
- Databases
  - WAALS, UPSID,...
- Visualization tools
  - Mathematica
- Live long learner
  - COURSERA
  - UDACITY
  - Santa Fe Institute
  - MIT

#1: Scientists and Policy Makers

- Goal: Keep Tahoe Blue (but with sound science).

#1: Scientists and Policy Makers

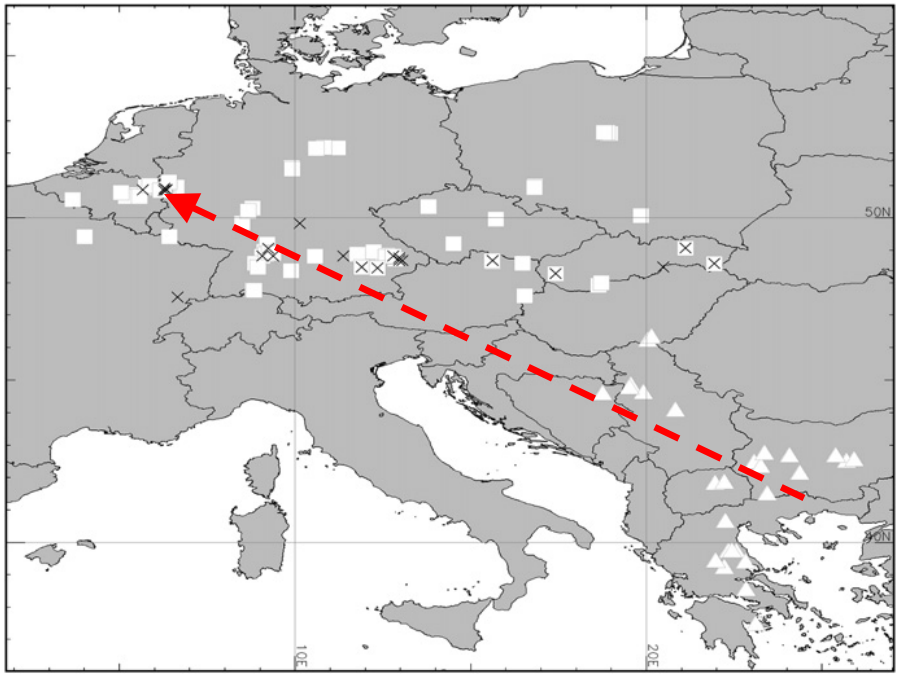
- Understand the dynamics of the lake: mathematical model
- Predictive Tool
- Team work involving: biologists, physicists, chemists, engineers,…
- High social impact
  - Change gamer
  - Affect the life of communities, involmvement of grassroots associations, developers, policy makers.
  - Political debate
  - Press coverage

#1: From Powerpoint to Augmented Reality

- How to effectively convey the need for an environmental policy.
- Long term goal: create a new sensibility.
- Science could be cool.
- Kids love to game (and some adults too).
- Take advantage of Augmented Reality Tools.
- http://www.youtube.com/watch?v=j9JXtTj0mzE

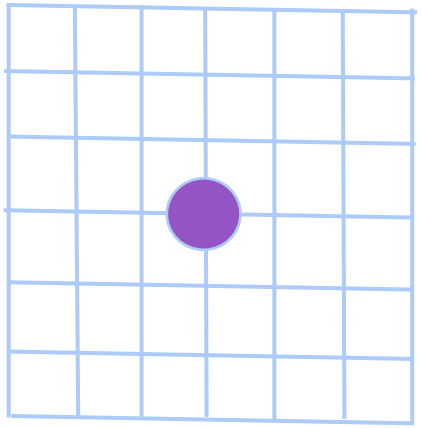
2: A Window into the Past

- Data: loss of crop diversity during the LBK Neolithic range expansion.
- Goal: Evolution of cultural diversity in Neolithic Europe can be explained by spatial drift.
- Idea: coupling of two existing models (drift and space) into a new concept, makes it possible to simulate the expansion of the LBK.



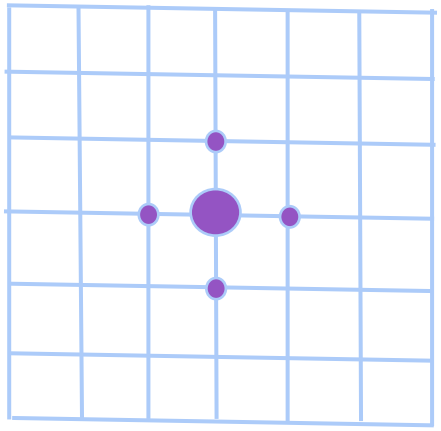
2: A Window into the Past

(1) Initial Population



P(t)

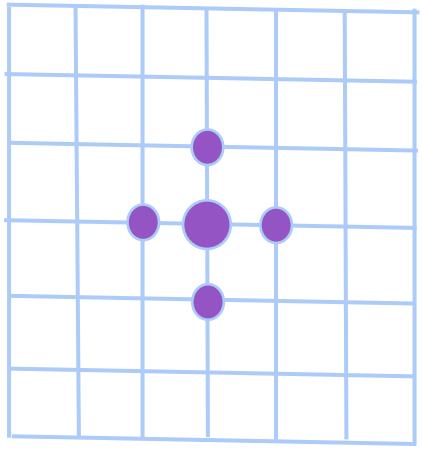
(2) Dispersion



P(t) (1-pe) (1/4)

P(t) pe

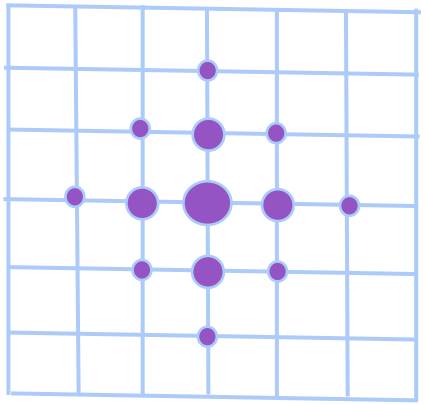
(3) Reproduction



P(t) R_o(1-pe)/4

P(t) R_o pe

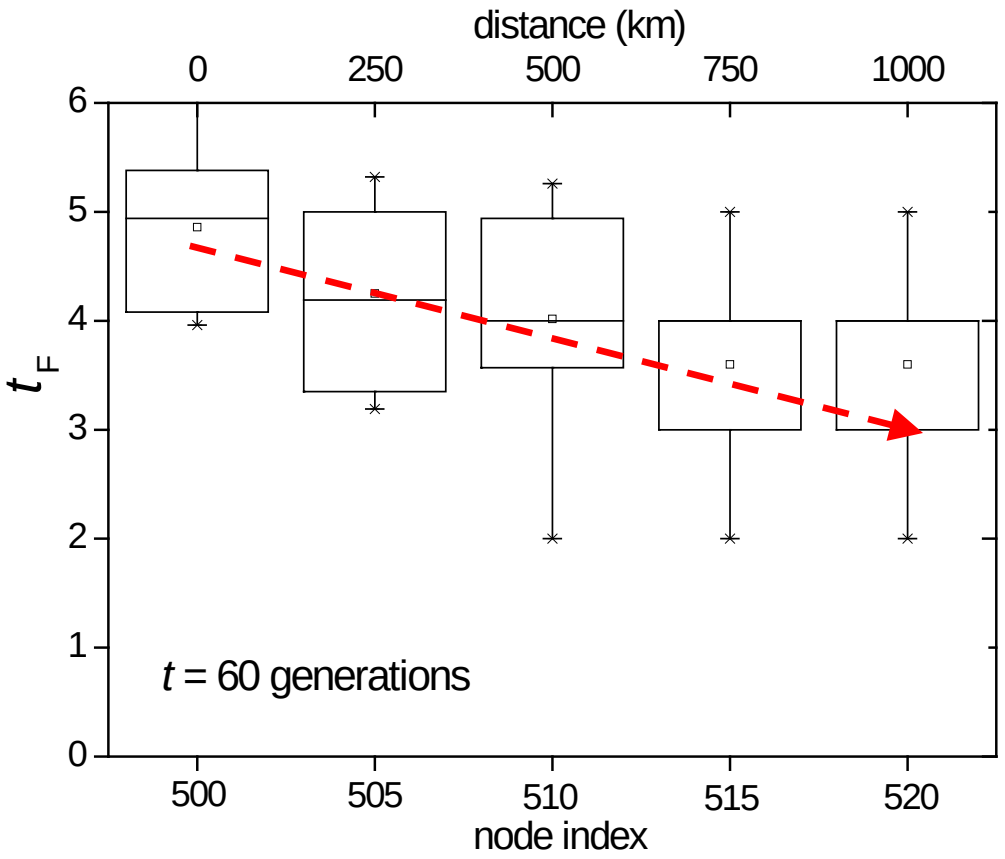
(4) Dispersion



- P(t) is the density population
- pe is the persistency
- R_o is the reproductive rate

2: A Window into the Past

- Novel approach. Interdisciplinary project integrating archaeological data and mathematical models.
- Relatively minor social impact (specialists and academia). However, **blogs and social media** can greatly enhance its visibility.



3: How much is much? Using smartphones to assess student (and course) performance

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Research questions

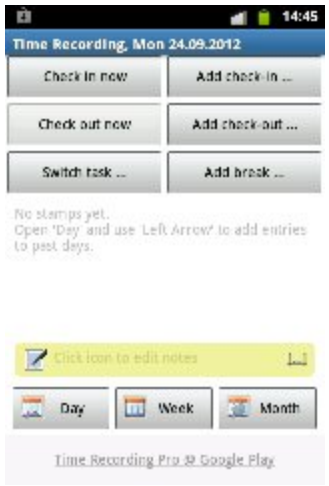
- How can we quantify the student performance?
- Can we reveal any pattern of learning?
- How can we improve the course design?

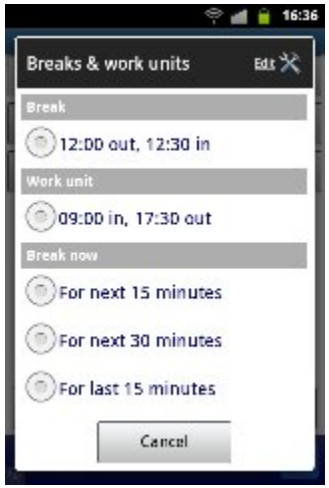
Outline of the course

- Physics 101 course for engineering students.
- 14 weeks, 3.5 hours of lecturing per week.
- Applying the Bolonia criterion yields 5.5 hours of work per week, 4410 minutes per semester.
- At the beginning of the semester, students were required to download and install a free app Time Recording Timesheet.
- Tracking method was compulsory. Alternatives were offered.
- 33 students completed the course.

Time Recording Timesheet app (Android)

- List of problems for each topic covered during the course
- Each problem was treated as if it were a task
  - Label
  - Date
  - Total amount of time
  - Degree of completion (non-completed, partially completed, fully completed)
- https://play.google.com/store/apps/details?id=com.dynamicg.timerecording&hl=en





Credit: sonomaorganics.com

Removing spurious correlations

- To remove any spurious correlation, students must complete a questionnaire at the beginning of the course

Survey of the class (1)

- path of entry: 65% come from high school, 29% from technical schools, and 6% were taken the course for second time
- To account for possible inequalities in their education, they were asked if they attended a private (19%) or public (81%) high school
- if students have taken Physics courses at high school (76%) or this was going to be their first contact with Physics (24%)

Survey of the class (2)

- Another source of variability could be when students were admitted to the University, 71% were admitted in July, while 29% in September.
- if they have taken extra lessons of Physics during the vacation time (thus providing them with a boost not accounted for): only 7% did while 93% did not.
- if the study they were enrolled on was their first choice (79%), as we hypothesized that the motivation could be higher for students who are supposed to pursue their goals.

Survey of the class (3)

- The level of education of their parents (college educated (24%), high school (21%) or elementary education (55%) of both parents) was also enquired on the grounds that students of a family with a higher level of education could be better equipped to face the changes.
- if they were working during the semester (33% have taken jobs, 77% were full time students), as performance could be resented by the mere fact that these students will have less time available and of poor quality, as fatigue may take its toll on the learning capabilities.

What we found

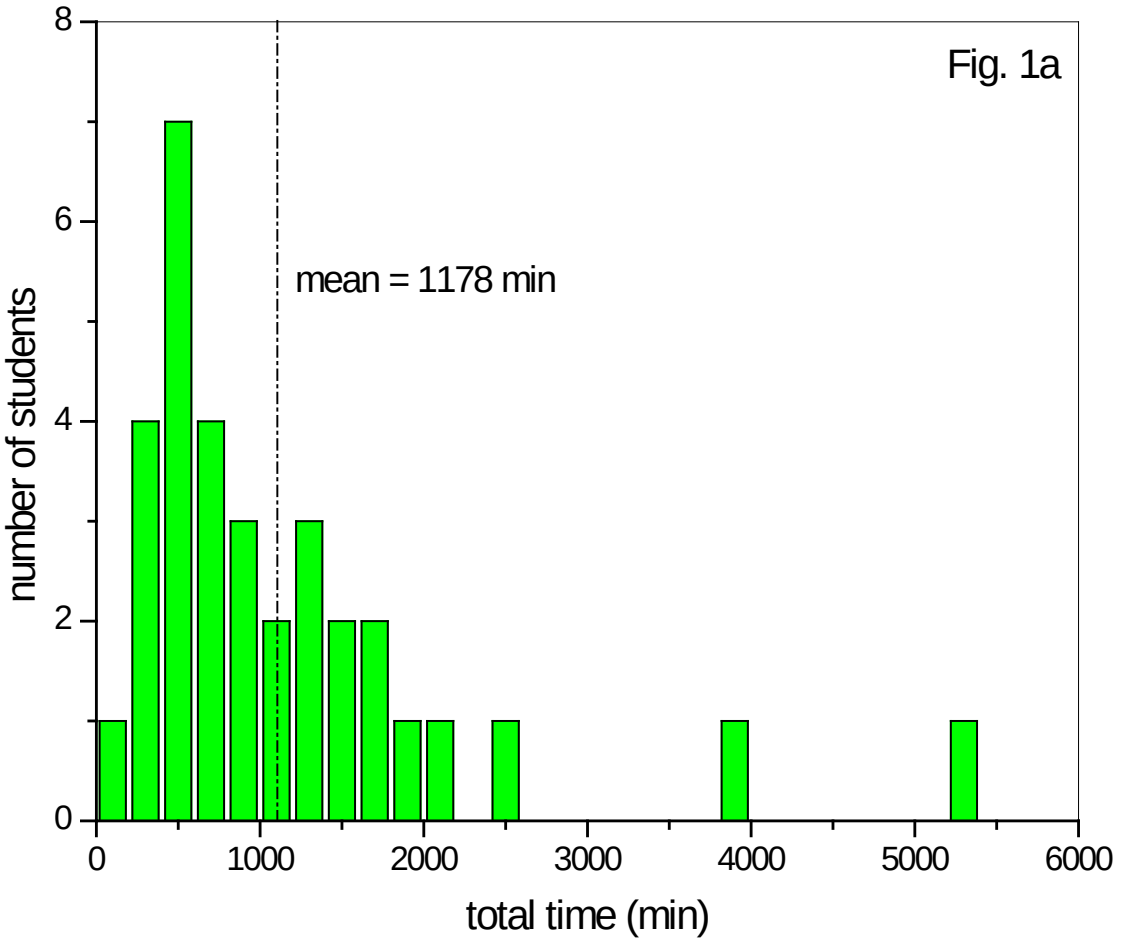
- None of the sociological tested variables have shown any significant correlation against grades.

What we expected

- We were expecting a correlation between the total time devoted to study and the final grade.
- We were expecting a correlation between the number of problems solved for each student and the final grade.
- We were expecting a correlation between efficiency for each student and the final grade.

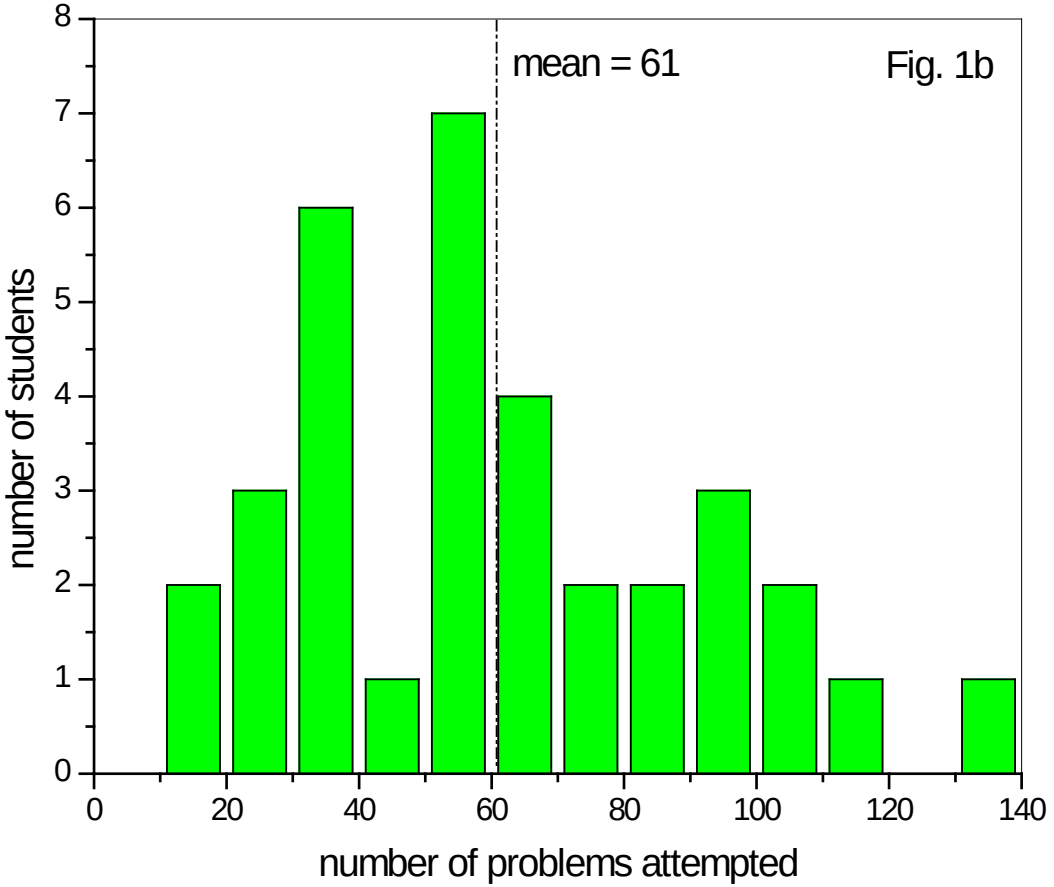
Distribution of the total time of study of each student

- Total time of study shows a wide dispersion.
- Biased towards the left.
- There is no significant correlation between the grade and the total time devoted to study.



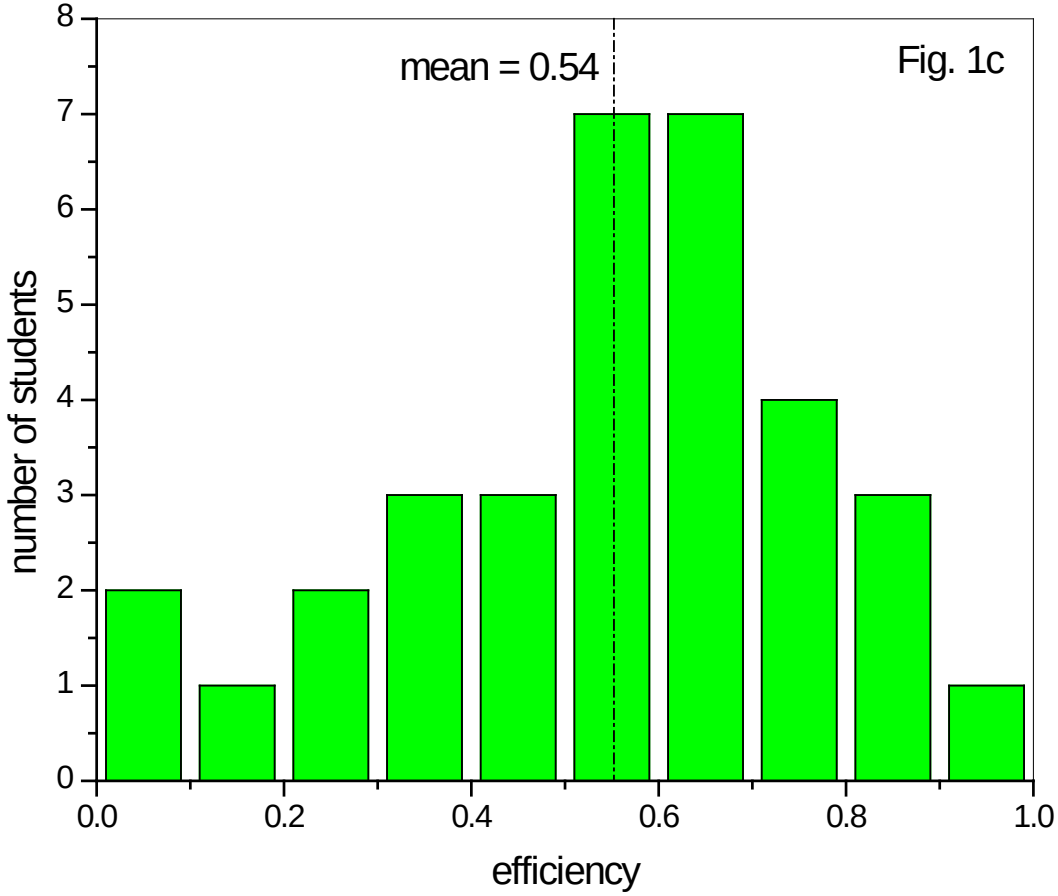
Number of tried problems

- We believe that trying to solve a problem does have a learning value, thus we expected that the higher the number of problems tried, the better the grade.
- The number of problems solved for each student did not show a significant correlation with their grades either.



Distribution of efficiency of each student

- We believed that only students that consistently and successfully complete tried problems will interiorize the required skills and knowledge, thus obtaining better grades.
- Efficiency is measured as a ratio of number of problems tried and completely solved to the total number of problems attempted
- Efficiency did not show any significant correlation with the grade.

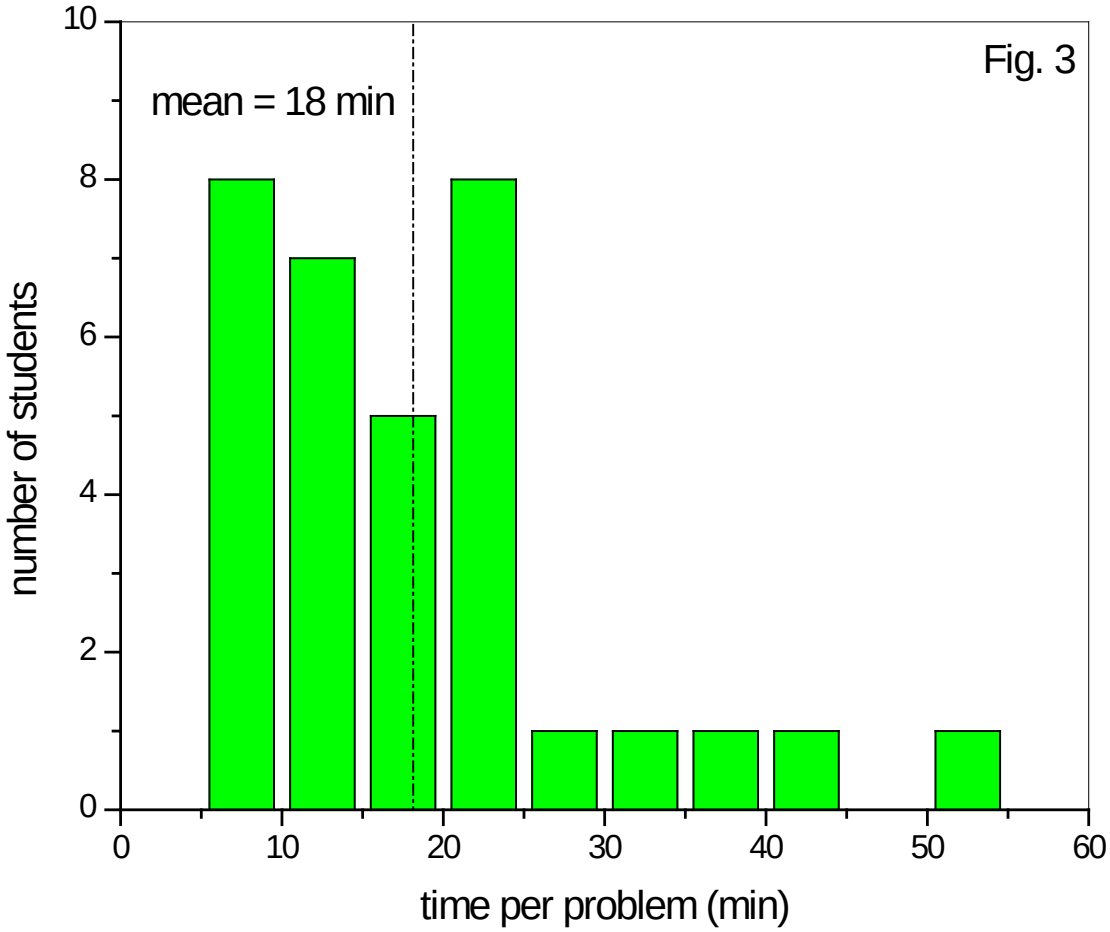


Recap. Why not?

- None of the tested variables have shown a significant correlation with grades.
- A more detailed analysis of the student performance casts some light on this lack of correlation between total time and grade.

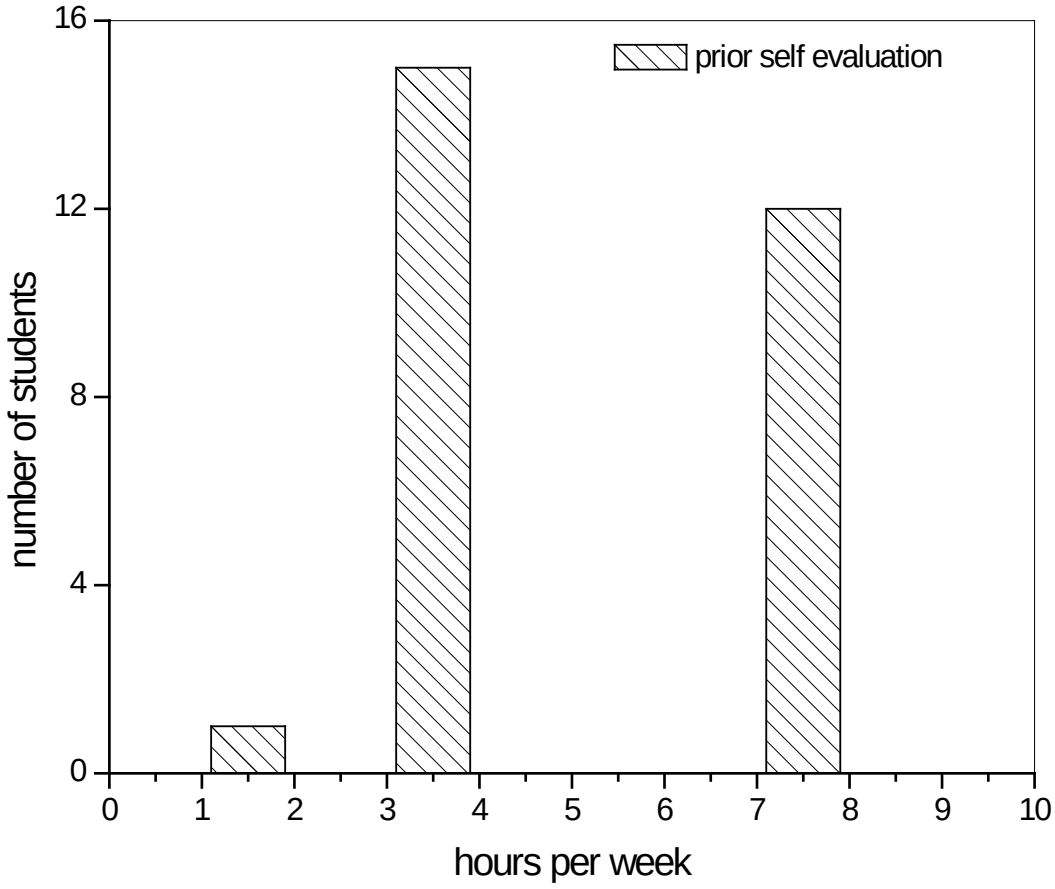
Time per problem: persistency

- The time per problem is defined as the total time of study divided by the total number of problems tried. It is a measure of the average time used to attempt a problem.
- It measures the degree of persistency while trying a demanding task (solving a problem).
- Most of the students gave up before satisfactorily completing the tried problem.
- The presence of a handful of students to the right could indicate the presence of slow or very persistent learners



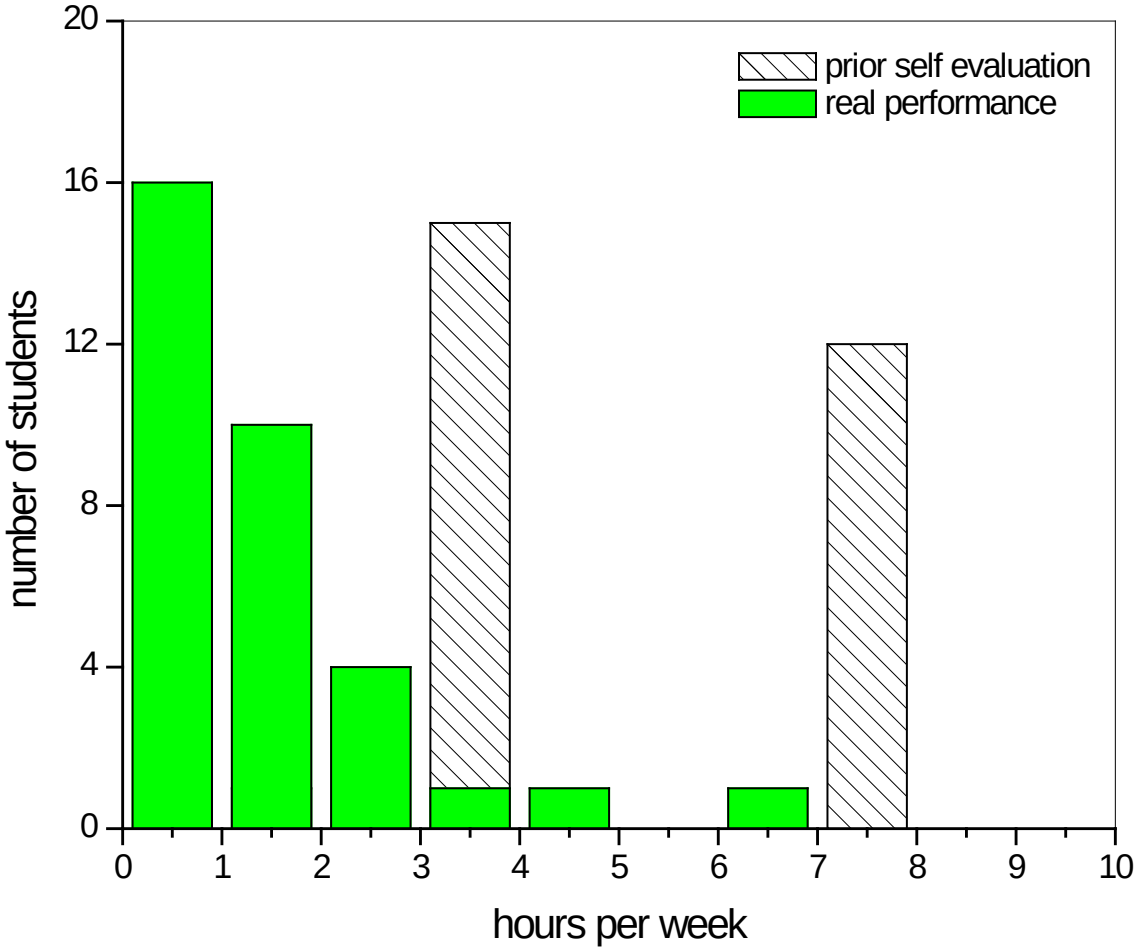
How much time per week will you work?

- At the beginning of the semester, students were asked how much time per week they think they will honestly work.
- The question targets the degree of maturity and self-perception of the student capabilities
- Mean of 6 hours per week.



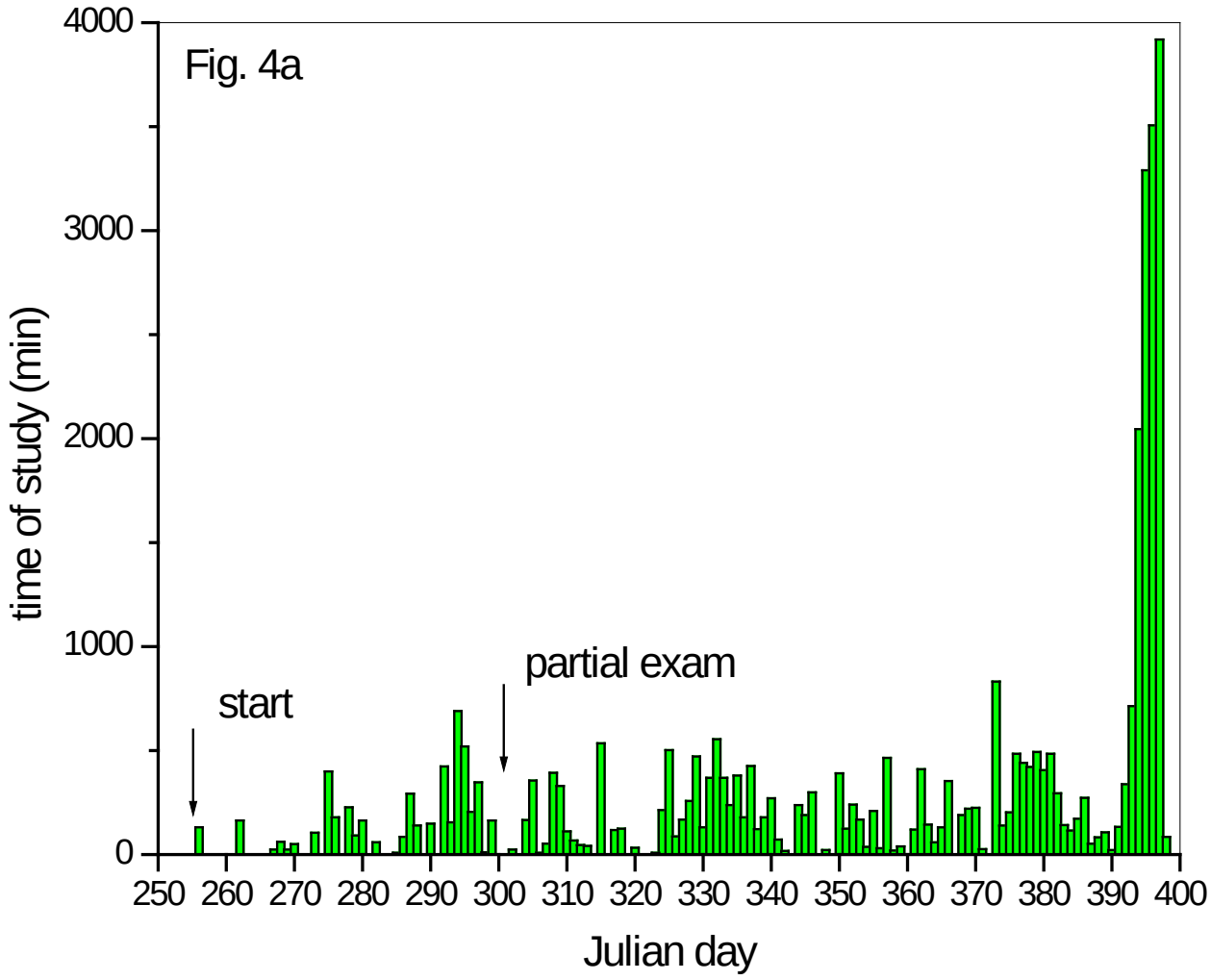
How much time did you work?

- The perception of their capacities is over estimated.
- The distribution of their actual performance is biased towards the left on the lower end.
- Mean of 1.4 hours per week.
- Bolonia criterion 5.25 hours per week.



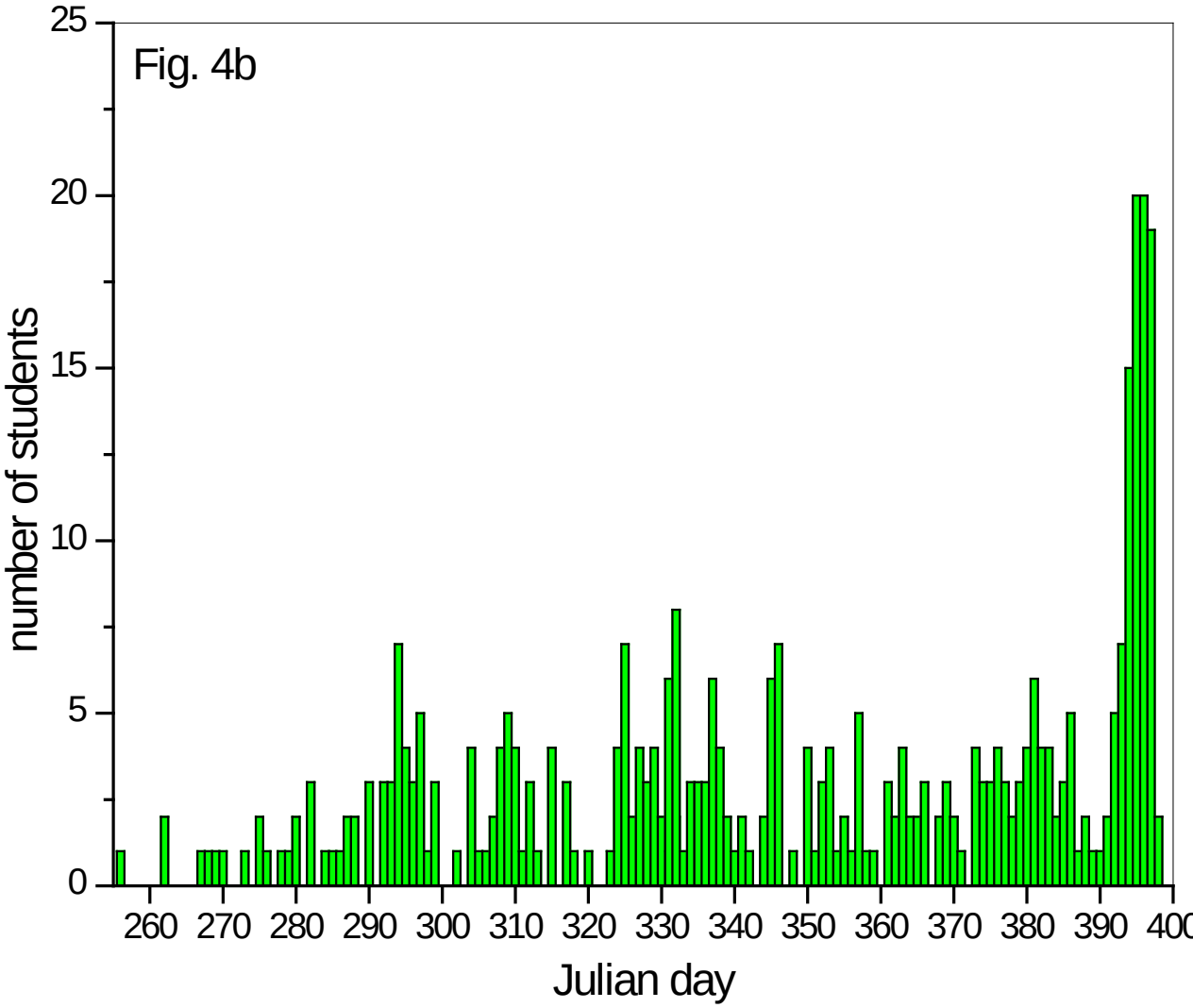
Distribution of time of study per day: last-minute effort!!

- Students postponed their study until the last days. Massive peak at the end of the semester.
- A sluggish start of 30 days without any appreciable work .
- Christmas holidays did not contributed significantly to the total amount of time of study.



Number of students per day: last-minute peak!!

- Only a handful of students consistently work during the entire semester.
- Intermittent effort, with burst of two or three days was the norm.
- Massive peak, last-minute effort at the end of the semester.

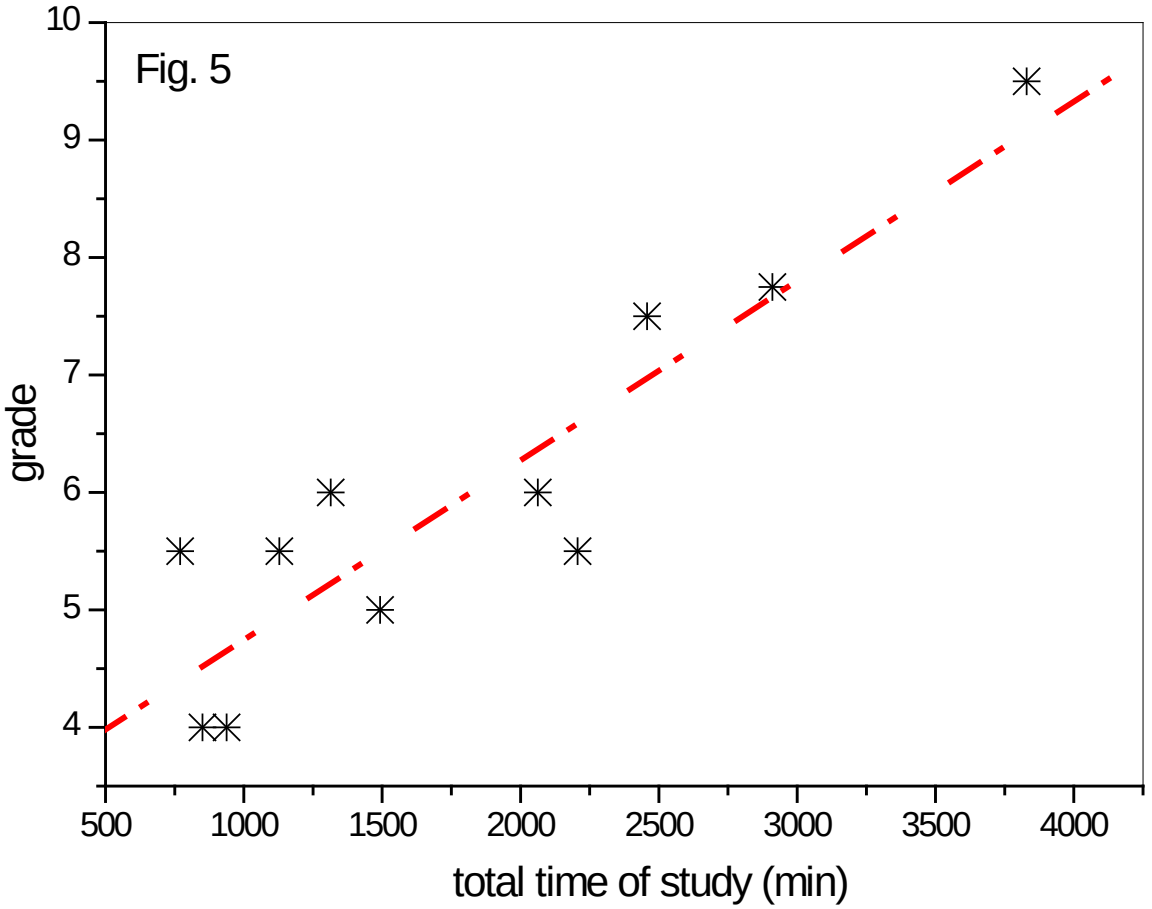


What happened?

- The temporal pattern of study forced students to choose among topics, concentrating their efforts into a few topics deemed to be the most likely to be tested on the final exam.
- A probabilistic factor was added to the equation of success.
- The final exam was composed of five problems, each one specifically designed to survey the knowledge of a given topic and accounting for 20% of the grade. A five points on a scale of ten points is the minimum required to pass the exam.
- These students that scored in less than three problems may selectively choose among which topics to study in a last-minute effort to pass the exam.
- To check this hypothesis, we removed from the original dataset all students that scored on less than three questions (regardless their score on each problem and the total time of study).

Total time of study versus grade for high-performance students

- The key variable to explain the success of the students is the total time of study (for high-performance students).
- Equation that describes the required amount of time of study to successfully pass the course (R=0.903)



$$Grade = 3.22 + 0.00153 \cdot Total\ Time\ of\ Study\ (min)$$

Course equation

- Only valid for high-performing students
- y-intercept: the grade by serendipity (or by previous knowledge)
- As a final check of validity of the equation, setting the total time to 4410 minutes, the estimated workload for the course applying the Bolonia' criterion, yields a grade of 9.9, virtually a perfect score.
- The amount of 4410 minutes of study is equivalent to 9 days of 8 hours of continuous hard work per day. Looking back at the time distribution of the total time of study, it is evident that the strategy of massive two-last day effort to pass the exam is flawed.

$$Grade = 3.22 + 0.00153 \cdot Total\ Time\ of\ Study\ (min)$$

Conclusions (for the student)

- From the student point of view, efficacy means to pass the exam (short-term goal)
- The strategy of massive two-last day effort to pass the exam is flawed
- The temporal pattern of study forced students to choose among topics, concentrating their efforts into a few topics deemed to be the most likely to be tested on the final exam
- Low efficiency.
- Low persistency.

Conclusions (for the instructor)

- From the instructor point of view, efficacy means to satisfactorily acquire capacities, skills and knowledge (long-term goal)
- The time per problem provides useful information to the instructor by giving a direct account of how much time consumed per problem, thus quantifying the estimated time required to complete any given amount of suggested problems
- Only a tiny portion of available problems were explored by the students
- Although working individually, students coincidentally flocked to the same type of exercices, mimicking the type solved in class.

Conclusion: total time of study (for high-performance students) is correlated with grade

- Students are provided with an equation that precisely addresses the question of how much time is required to pass the course
- smart phones + apps let track every facet of the student performance, thus rising self-awareness
- Instructors have a powerful tool for quantifying course and student performance
- Learning biases and patterns of low productivity can be easily visualized.
- Soft spots on the course methodology could be clearly identified and properly addressed.

Future work

- More data is needed to validate the results,
- A better estimation of the parameters of the course equation
- Extend data collection to other assignatures to identify patterns of study across assignatures.
- Improve the methodology of quantification of the course and student performance (more flexible apps...).