My experience using ITP for teaching maths

Julien Narboux

January 2021

My experiences

- 1st year : students in Maths and Computer Science. Introduction to proof (200-400 students). Edukera in Maths mode.
- 2nd year : students in Computer Science. Symbolic Logic (150-200 students). Edukera in Logic mode (natural deduction).
- 4th year : ITP per se (50 students). Coq.
- 5th year : Software Foundations. Coq/Frama-c.

My experiences

- **1st year : students in Maths and Computer Science. Introduction to proof (200-400 students). Edukera in Maths mode.** Focus on this experiment today.
- 2nd year : students in Computer Science. Symbolic Logic (150-200 students). Edukera in Logic mode (natural deduction).
- 4th year : ITP per se (50 students). Coq.
- 5th year : Software Foundations. Coq/Frama-c.

Introduction to proofs

Second semester : Vocabulary and structure of a mathematical document, sets, functions (surjective, injective, ...), relations, ...

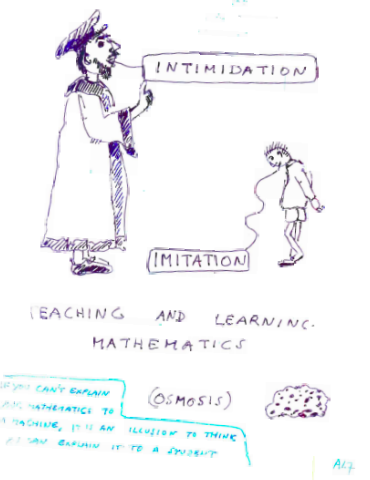
Why ?

- A colleague : "Can we use Coq with first year student ? I cannot stand when they complain about bad marks for their non sense proofs [1]."
- Me : "No, we can't use Coq with 1st year students, explaining the syntax, tactics, and curryfication would take the whole course (20 hours). But we should teach them the logical rules they are allowed to use, ALL of them not just 'proof by contradiction' and 'proof by cases'. Let's use Edukera".

1. Tobias Nipkow : Teaching Semantics with a Proof Assistant : No More LSD Trip Proofs

"If you can't explain mathematics to a machine, it is an illusion to think you can explain it to a student." De Bruijn

"Invited lecture at the Mathematics Knowledge Management Symposium", 25-29 November 2003, Heriot-Watt University, Edinburgh, Scotland



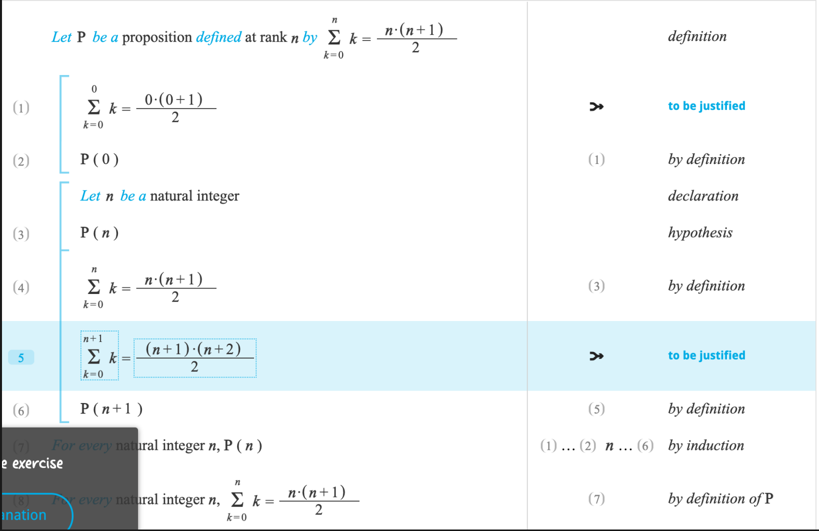
What is Edukera ?

Edukera

- Web service based on Coq.
- A point and click user interface with a tutorial.
- A proof text combined with a LCF style interaction.
- Forward chaining or backward chaining elaboration of proofs.
- Presentation of proofs in the forward chaining style.
- Pragmatic use of automation.

We give natural deduction rules using french words plus some less fined-grained rules inspired by coherent logic.

Screenshot


Let P be a proposition defined at rank n by $\sum_{k=0}^{n} k = \frac{n\cdot(n+1)}{2}$
definition
(1) $\sum_{k=0}^{0} k = \frac{0\cdot(0+1)}{2}$
to be justified
(2) P (0)
(1) by definition
Let n be a natural integer
declaration
(3) P (n)
hypothesis
(4) $\sum_{k=0}^{n} k = \frac{n\cdot(n+1)}{2}$
(3) by definition
5 $\sum_{k=0}^{n+1} k = \frac{(n+1)\cdot(n+2)}{2}$
to be justified
(6) P ($n+1$)
(5) by definition
(7) For every natural integer n, P (n)
(1) … (2) n … (6) by induction
e exercise
(8) For every natural integer n, $\sum_{k=0}^{n} k = \frac{n\cdot(n+1)}{2}$
anation
(7) by definition of P

Impressions

- Good student involvement.
- They solve much more exercises than on paper.
- But there is a risk of random point and click strategies.
- We have seen difficulties transferring the competences from formal proof to paper and pencil proofs.
- The system helps the students (too much ?) : no incorrect reasoning, perfect memory of the theorem statements.

Project

Collaboration with a team of people from maths education specialized in the role of logic in the teaching of proof : Viviane Durand-Guerrier, Zoé Mesnil, Richard Cabassut, . . .
Please join.