Teaching Critical Thinking to Computer Science Engineering students

Ludwig Krippahl and Luís Moniz Pereira

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The Critical Thinking course at FCT/UNL
The Critical Thinking course

- Offered for 6 years, 2006/07 through 2011/12
  - One semester, 12 lectures and tutorial sessions
- Average 200 students enrolled in each semester
  - (mandatory for all Computer Science students, 2nd year of curriculum)
- Introduced as a Bologna Soft Skills type course
The Critical Thinking course

- The main goal was to improve the students' ability to:
  - Interpret and express reasoning
  - Evaluate sources and claims
  - Assess scientific experiments
  - Decide, attentive to ethical concerns

- Focus on thought process and argumentation
  - In contrast to focusing on information content, as in most other courses
Critical Thinking
Critical Thinking

- John Dewey
  “Active, persistent and careful consideration of a belief or supposed form of knowledge in light of the grounds that support it, and the further conclusions to which it tends.”

- Robert Ennis
  “…reasonable reflective thinking focused on deciding what to believe or do…”

- Michael Scriven & Richard Paul
  “Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information […] It entails the examination of those structures or elements of thought implicit in all reasoning…”
Critical Thinking

- Active, conscious, reflective
  - Taking charge of one's own thinking processes
1. Argumentation
Argumentation

- An argument is the visible expression of a thought process
- The first part of the course focused on arguments
  - Logical structure
  - Evaluation of premisses, inferences and implicit assumptions
  - Argumentative dialogues
    - With others and with oneself (self criticism)
- Help students become more aware of how they think and express themselves
Argumentation

Fallacies

- Arguments often follow generic schemes that provide a valid justification for the conclusion
  - e.g. appeal to the authority of a cardiologist for diagnosing heart condition
- Fallacies were presented as mimicking valid schemes in inappropriate contexts
  - e.g. appeal to the authority of a football player for selling shampoo
2. Credibility
Credibility

- Questioning and assessing sources and premises is an important part of evaluating reasoning
  - However, it is independent of the logical structure of the argument itself
- Examples:
  - Does the source have access to the information it claims to have?
  - Is the claim consistent with other data?
  - Are there conflicts of interest?
3. Scientific Reasoning
Scientific reasoning

- Distinguish the elements of the problem
  - Reality, model, data, predictions

- Understand the hypothesis:
  - That the model corresponds to those aspects of reality under consideration

- Reject the hypothesis if the data disagrees with the predictions

- Assess the likelihood of agreement if the hypothesis was false
  - Beware of confirmation bias
Scientific reasoning

- Statistical and causal models
  - Distinguish correlation and causality
  - Evaluate experiments
    - Retrospective
    - Prospective
    - Randomized
4. Decision
Decision

- Descriptive theories of decision
  - Biases, framing problems

- Normative theories of decision
  - Maximize utility
  - Ethical considerations

- Focus on delaying decision towards the end of the thought process
  - To prevent rationalization of unreasoned decisions
Our approach
Our approach

- Discussing issues that lack a clear, “back of the book”, answer
  - Alien abductions, news, politics...
- Focus on the process, not on the results
- Have the students exercise their critical and argumentative powers with each other
  - Presentation of prepared texts, followed by discussion, in tutorial classes
Conclusions
Conclusions

- Discontinued due to curriculum reforms at FCT
  - Uniform offer of soft-skills courses
- Impact is difficult to assess
  - ~30% students filled questionnaires
  - ~65% gave a positive classification
    - Slightly below average for students who passed the course, when compared to all FCT courses
    - Significantly below average for students who failed the course
Conclusions

- In general, stronger student response
  - Both positive and negative
  - Correlated with approval or failure
  - Possibly because of connotation with thinking and intelligence

- Major complaint: not relevant for Computer Science curriculum
  - General problem with soft-skills courses

- Long term effects?
  - Hopefully, some...
More information

- Course page is still online:
  - ssdi.di.fct.unl.pt/pc

- Textbooks
  - Manual de Pensamento Crítico
    - (work in progress...)