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TEPSIS PAPERS
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GALILEO IN THE JUVENILE SECTION: A PRISON TEACHER'S PERSPECTIVE

School attendance at the penitentiary of Varennes le Grand is mandatory for all juveniles. In this prison environment which often interferes with education, our task is to change the binding and discontinuous nature of the time spent in class into a constructive and linear moment conducive to learning and providing each pupil with clear objectives: pursuing a training course, preparing for an exam, changing one's attitude towards knowledge and school, getting high school credits.

Classes consist of groups of three to four juveniles. Pupils have different levels, with most of them being dropout or special needs students. We try to tailor learning objectives to individual needs without neglecting group work. The structure of the course is modular: a stable group of pupils share common or partially common objectives over a short, specific time. Contents are interdisciplinary.

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USING SCIENTIFIC INQUIRY TO INTERROGATE THE WORLD

In all the disciplinary fields that we cover, the pupils regularly invoke the God hypothesis to explain the world. In the wake of the tragic events of January and November 2015, we consider it fundamental to conduct educational sequences leading the pupils to observe the world without exclusively resorting to this hypothesis.
During scientific modules that are short and organized on a just-in-time basis, structure time and address the permanence of humanity's great questions, we hypothesize that introducing complex experimentation and the epistemology of science as a remedy would allow pupils to construct their own knowledge without resorting to textbooks or prerequisites that they would have to accept without knowing their justification.

Using Galileo's works and the epistemological break they constitute, we bring the pupils to conduct hands-on experiments, isolate parameters in order to interpret their results, and emit, verify, or invalidate hypotheses. In this way, they come to observe and test phenomena that radically contradict their representations and are totally counter-intuitive: they thus come to acknowledge the fact that all objects free-fall at the same speed regardless of their mass. The pupils design their experiments in writing or using a diagram and systematically describe the results in individual essays. Writing engages them in the work at hand and allows them to get some distance from their manipulations and formalize their results. This is necessary for an eventual transfer.

At the outset, pupils must discover, just like Galileo did, that the period of oscillation of a simple pendulum solely depends on the length of the cord to which the object is attached, regardless of the mass of the object. But does this experiment actually work? Can one reach clear-cut conclusions through manipulation? And if the oscillations of a pendulum do not depend on mass, would the same object, if detached from the cord, free-fall at a speed independent of mass?

The pupils of the penitentiary are not ready to abandon their representations of the world, particularly if it means accepting counter-intuitive physical phenomena. Nor are they ready for concessions regarding experimental facts. Going back to the works of Galileo, who did not compromise on facts either, helps us out of this predicament. We can use his observation notes and discover that it is possible to solve the question with a thought experiment, an experiment that is as structured and dependable as real ones, but conducted in the imagination, and that can thus be realized an infinite number of times, anywhere. Why not on the Moon? Galileo did it, and reached major conclusions. All objects free-fall at the same speed regardless of their mass. The American astronauts of the Apollo 15 mission reproduced it on the Moon. "For real?" the pupils ask. We can then watch a video realized in 1971. (1) The astronauts' conclusion, 450 years later, is final: "Galileo was correct!"

The pupils realize that one can ask the same questions as Galileo did five centuries ago, to devise similar experimental protocols, obtain the same results, and experience the same doubts. This stability of phenomena over time, from the Earth to the Moon, gives them a feeling of security. They experience this permanence because they have built it through their experiments.

Throughout these experiments, the epistemology of science encourages the pupils to observe and interrogate the world without having recourse to the God hypothesis. Even so, the purpose is not to organize into a hierarchy or set against each other two ways of apprehending the world, but to allow oneself to interrogate the world without resorting to God during an experiment in which everything can become an object of research. This, in fact, is what surprises the pupils most: one can and is allowed to seek to explain any "scientific phenomenon," and if one does not reach understanding, one can always rely on someone else to reach an explanation. However, if one uses the God hypothesis, one cuts the inquiry short. For this reason, science does not allow itself to invoke God to explain a phenomenon.

INTERROGATING THE BELIEF/ KNOWLEDGE DISTINCTION…

Here, we directly deal with the epistemology of science with the pupils, justifying the scientific community's methodological and systematic refusal of recourse to the God hypothesis by citing four essential characteristics of scientific knowledge. It is important not to approach and address the legitimacy of belief.

First, scientific knowledge has this specificity that it is refutable. As Karl Popper wrote, "a theory that is not refutable by any conceivable event is non-scientific." (2) According to Popper, this criterion helps differentiate scientific knowledge from nonscientific discourse. Our task is to make the pupils understand how scientific knowledge can be intellectually structured. In order to remain valid and structure reasoning, it must be liable to be called into question and discussed at any time. This implies, of course, that it can, as a last resort, be proved wrong. This is referred to as falsifiability. Beyond the epistemology of science, this scientific character criterion enables one to apply reasoning when analyzing everyday discourse and distinguish between what pertains to common thought and what is a refutable proposition.

Next, in the modern period – which is traditionally thought to start with Galileo's works – experimental science has the particularity of being elaborated on the basis of observation and analysis of reality. In order to produce a verifiable, and

(1) NASA, Apollo 15, https://www.youtube.com/watch?v=FieGv8gyP5A, retrieved Nov. 15, 2016.

(2) Karl R. Popper, Conjectures and refutations: The growth of scientific knowledge (London: Routledge, 1963).

consequently refutable, knowledge, scholars must elaborate valid and thorough hypotheses on the modes of study of phenomena before attempting any experimental exploration. Once these hypotheses have been discussed and sorted out, the pupils, just like scholars before them, can devise how they will set up structured experiments in order to test their relevance.

Scientific experimentation is reproducible. This is the third characteristic of the elaboration of scientific knowledge. An experimentation whose results cannot be replicated should then be excluded from scientific inquiry. Concretely, the same experiment conducted by two different groups of pupils must yield identical results. Comparison of these results can then necessitate that groups negotiate in order to agree on what has actually been tested. This experimentation should also yield the same results as those conducted by experimentalists remote from them in space or time. This criterion establishes that knowledge constructed in such a way is endowed with spatial and temporal stability which, in the future, will permit to draw upon it to predict the behavior of objects submitted to the same phenomenon.

Here, we touch on the fourth characteristic of scientific knowledge, prediction of the behavior of an object submitted to known influences. It differentiates scientific knowledge from traditional knowledge.

The completion of processes allowing the pupils to appropriate these epistemological characteristics takes part in the development of a scientific and reasoned approach, since the stability and predictability of the covered scientific content make this approach relevant to them.

Recourse to the history of science and the use of narratives also lead our pupils to feel the necessity of interrogating written sources and differentiating between myth, primary and secondary sources. Last, the history of science allows us to make a pedagogical detour: Galileo stood against the God of the Roman Apostolic Church 450 years ago; this allows us not to address the existence of a God present in our pupils' daily culture frontally.

A SECULAR PEDAGOGY

It seems to us that this educational sequence on Galileo's discoveries engages our pupils in acquiring an inquisitive approach and free will. In February 2016, a pupil told us: "My dad used to say there are things you know and things you must learn." Scientific inquiry takes our pupils on the complex path to distinction between belief and knowledge. It allows them at least to bring that question which has no definite answer to the foreground. We do not seek the stability and permanence of the answer, but that of the inquiry, regardless of the environment. Instilling critical thinking, a scientific mind, a whole new attitude in our pupils on a long-term basis offers a possible way towards the construction of secularism and citizenship.

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