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ABOUT THE SCIENTIFICITY OF PANCAKE-MAKING: A CRITERIA-BASED APPROACH

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Abstract: A bottom-up approach of the nature of science is proposed. Teacher-friendly formulations of criteria of scientificity based on actual classroom practices allow the straightforward derivation of evolutive definitions of kindergarten science from arbitrary criteria subsets, and to distinguish 'scientific' and 'non scientific' practices, even when superficially similar. Suitable formulations of Primacy of experiment, Local reproducibility and Robustness of an experiment are proposed. Three actual implementations of investigation sequences about the making of pancakes with 5-6 y.o. children are analysed using this epistemological tool, and their eligibility as 'scientific' kindergarten practices is shown to depend on the set of criteria elected by the teacher, thus on his own pedagogical objectives. This bottom-up approach of NoS appears to be complementary to the usual top-down approach, better suited to more advanced students.

Keywords: Early childhood education; Nature of Science; Scientific Competences

INTRODUCTION

Early childhood education involves a wide diversity of activities. Many of those participate to the simultaneous development of various skills (Blanquet, 2010, 2014). For instance, 'float and sink' investigations also allow the honing of communication skills. Reciprocally, (pre-) scientific skills can be involved in activities which could appear at first glance farthest from science. For instance, the participation in cooking activities, such as pancake-making, has been shown to impact the later science achievements of kindergarten pupils (Saçkes et al., 2011).

This intrication appears to puzzle some kindergarten teachers, who tend to consider themselves as 'unable to teach science'. More generally, many teachers appear uncertain about the nature of science (Lederman, 2010). Several authors have proposed criteria-based epistemological tools to serve as guidelines for distinguishing between scientific and non scientific activities. Such criteria of scientificity are usually derived from a representation of 'scientist's science', then adapted to the needs and level of high school students (Lederman et al., 2002; Sandoval 2005; Duschl & Grandy, 2013); attempts have also been made to adapt this 'top-down' approach to kindergarten children (Akerson et al., 2010).

Here, we propose an alternative, 'bottom-up' approach based on actual experimental classroom practices.

ADAPTED CRITERIA OF 'SCIENTIFICITY' FOR EARLY CHILDHOOD EDUCATION

Most criteria of scientificity suitable at high school (Lederman et al., 2002) or even elementary school (Blanquet & Picholle, 2016a) levels appear too abstract, thus unsuitable at kindergarten level. By considering attainable skills for young children (Metz, 2011; Blanquet & Picholle, 2016b), we can nevertheless identify three classes of suitable criteria.

First, any 'scientific' expression calls for language skills, such as attention to the *internal coherence* of one's discourses. These skills are not science-specific, and coincide with broader objectives in terms of language proficiency. A second class concerns 'good experimental practices', and the third involves the pupil's awareness of the status of a discourse (generality, etc.) or a model (*distinction between the real world and its representations*) (Blanquet & Picholle, 2012). For the sake of simplicity, we'll limit the scope of this communication to the second, more obvious class, but the same approach applies to all kinds of elements of scientificity.

Demonstrated experimental skills attainable by 5-6 y.o. children include (Blanquet & Picholle, 2015b) the willingness:

— to give the primacy to the experiment when in contradiction with a discourse

— to check the reproducibility of an experiment

— to check the robustness of the considered experiment

We can thus define a set of at least three 'criteria of scientificity' suited to kindergarten activities. The very concept of scientificity being far too abstract for kindergarten pupils, their formulations only have to be adapted to their teachers. We have repeatedly tested their wording with a number of French teachers, and ascertained that the resulting criteria for school-science were understandable and well received by their overwhelming majority (Blanquet & Picholle, 2015b).

Nevertheless, please note that this careful tuning was performed only with the original French formulations, of which the following expressions are mere translations, and that a similar tuning would probably be needed before using them with English-speaking teachers.

Primacy of Observation (C1):

All statements are consistent with all observations.

Local reproducibility (C2):

The result of an observation does not depend on the observer, and any statement about it can be tested and confirmed by any observer present.

Robustness (C3):

A minor modification of the conditions of an experiment does not dramatically change its results.

Please note that we have considered here, if not highly concrete criteria, at least criteria that can be readily illustrated through standard classroom experiment, rather than more abstract criteria, such as *cultural embedment* (Akerson et al., 2010; Lederman et al., 2002), even if the latter can usually often been made obvious to the teachers (Figure 1).

Figure 1. A direct illustration of the cultural embedment of pancake-making: French '*crêpes*' (left) vs. American pancakes (right).

ARBITRARY SUBSETS AND EVOLUTIVE DEFINITIONS

A key feature of the bottom-up approach to the nature of science is that the number of relevant criteria depends both on the pupil's skills and on the teacher's pedagogical objectives. It typically increases from level to level, but also, at a given level, following the progression of the group. Thus, while the full set of criteria suited to kindergarten may include up to 7 simple criteria, and up to 21 for K-6 (Blanquet, 2014), a given teacher will only consider a reasonable subset suited to his needs. Such subsets are arbitrarily chosen, and typically involve only 2 or 3 criteria in kindergarten, and up to 5, seldom 6 in elementary school.

From an epistemological point of view, the choice of a particular subset is equivalent to the adoption of a restricted definition of science, suited to the needs of the class. The criteria formulation has been chosen to facilitate the derivation of these definitions.

For instance, if a teacher was to consider only Primacy of experiment (C1) as a very first step toward a scientific approach in his class, he could straighforwardly derive a first definition of science:

Definition (1):

> *Science is a method to solve an issue by establishing statements consistent with all observations.*

Taking into account both Primacy of experience (C1) and reproducibility (C2) would yield:

Definition (1+2):

> *Science is a method to solve an issue by establishing statements consistent with all observations, provided that any result of observation does not depend on the observer, and that any statement about it can be tested and confirmed by any observer present.*

Taking into account both Primacy of experience (C1) and robustness (C3) would yield instead:

Definition (1+3):

> *Science is a method to solve an issue by establishing statements consistent with all observations, provided that a minor modification on the conditions of an experiment does not dramatically change its results.*

and so on, *mutatis mutandis*. Let us emphasize that (a) the above criteria are aimed at teachers and that (b) a discussion of the nature of science is seldom necessary in kindergarten, much less formal definitions of science.

A key future of such definitions of science is their evolutivity: according to the progression of his pupils, a teacher is naturally brought to set new pedagogical objectives, including an emphasis on additional elements of scientificity — yielding new definitions of science.

From the pupils' point of view, this means an evolutive conception of the nature of science, which gets more and more sophisticated with the progression of the pupil in his personal scientific cursus. Primary school students are not troubled by such epistemic evolutions, no different from the deepening of the contents or the widening of the disciplinary fields they early on become accustomed to.

This appears consonant with more advanced conceptions of NOS, intrinsically tentative and dynamic (Lederman & al., 2002).

THE SCIENTIFICITY OF PANCAKE-MAKING: A MULTI-VALUED ISSUE

We are now equipped to solve the question of the scientificity of any given classroom practice, for a given choice of criteria. Let us consider three actual kindergarten implementations of pancake-making.

None can be considered scientific, or non-scientific, *per se*. Their scientificity depends on the set of criteria previously elected by the teacher.

Table 2. Eligibility of various kindergarten implementation of pancake-making as 'scientific practices' for three different choices of criteria subsets. From left to right: details of the implementations; compatibility with three criteria of scientificity (C1-C3); eligibility with regards of three definitions of kindergarten science.

Implementation of the 'pancakes' IBSE sequence	C1	C2	C3	D(1)	D(1+2)	D(1+2+3)
I1: The children prepare the mixture by small groups, following step by step the teacher's instructions. Each group uses equipment provided by the parents, thus differing from one group to another. No specific questions are asked about the equipment, and no systematic comparison of the results is proposed.	✖	✖	✖	not scientific	not scientific	not scientific
I2: The children prepare the mixture by small groups, using similar equipment and following step by step the teacher's instructions. They are asked to define their expectations before each step, then to compare it to the result. The teacher ascertains that every dissonance is solved by reconsidering the statements, according to the experiment. Their results are systematically compared. Any divergence is discussed until justified by an experimental difference, and then the experiment is redone with the difference suppressed.	✔	✔	✖	scientific	scientific	not scientific
I3: Same as I2. Moreover, any experimental difference is discussed, as	✔	✔	✔	scientific	scientific	scientific

well as any additional idea, and their relevance experimentally checked by varying the considered parameter (e.g. adding more eggs to the mixture).						

Let us emphasize that:

a/ The scientificity of a given activity, such as pancake-making, can be an issue for some teachers, but will never be one for kindergarten pupils. While it may be important for the children to experience some elements of methodology during their (pre-) scientific activities, there is no necessity for them to be presented as such; actually, in many cases, it might be advantageous for the teacher to be casual about them, as long as he makes it obvious that they are important to him during certain type of activities.

b/ that their inclusion does not diminish in any way the pleasure experienced by the pupils, as long as it doesn't get in the way of the ultimate goal of the exercise (to the children): eating the pancakes! Much to the contrary, very young children thoroughly enjoy being introduced to the 'right' way of performing it.

CONCLUSION

A bottom-up, criteria-based approach to the nature of science allows kindergarten teachers to legitimate actual classroom practices as 'scientific' at this level, and to distinguish them from 'non scientific' practices, even when superficially similar. A direct consequence is the arbitrary and evolutive character of the operating definition of science in school, which can be seen as a generalisation of the level-dependent perimeters of disciplinary fields. Its obvious limitation is an increasing complexity of these definitions with the level of the pupils, as more elements of scientificity are taken into account. This bottom-up approach, well adapted to early-years science education, thus appears complementary to the more usual top-down approaches, better suited to advanced students.

REFERENCES

Akerson, V. L., Weiland, I., Pongsanon, K. & Nargund, V. (2010). Evidence-based Strategies for Teaching Nature of Science to Young Children. *Journal of Kirsehir Education Faculty*, *11(4),* 61–78.

Blanquet, E. (2010). *Sciences à l'école côté jardin*. Nice: Somnium. [in French]

Blanquet, E. & Picholle, É. (2010). Les Critères de scientificité : un outil pour distinguer sciences et non sciences ? (pp. 124-128) In C. Loisy, J. Trgalova & R. Monod-Ansaldi (Eds). *Actes des journées scientifiques DIES.* France: Editions INRP. [in French]

Blanquet, E. & Picholle, É. (2012). Inquiry-based analysis of early years children books: Developing skills for later science education. *ESERA 2011 Proceedings*, Lyon, France.

Blanquet, E. (2014). *La Construction de critères de scientificité pour la démarche d'investigation : une approche pragmatique pour l'enseignement de la physique à l'école primaire*. PhD Dissertation: Un. Nice and Geneva. [in French] http://archive-ouverte.unige.ch/unige:42783

Blanquet, E. & Picholle, É. (To be published, 2016a). Les critères de scientificité explicites: un outil épistémologique bottom-up pour la démarche d'investigation à l'école primaire. In M. Bächtold, V. Durand-Guerrier & V. Munier (Eds.) *Epistémologie et didactique*. France: Presses Universitaires de Franche-Comté. [in French]

Blanquet, E. & Picholle, É. (To be published, 2016b). Two attainable skills in Kindergarten: testing reproducibility and robustness in an experiment. *ESERA 2015 Proceedings*, Helsinski, Finland.

Duschl, R. & Grandy, R. (2013). Two Views About Explicitly Teaching Nature of Science. *Science and Education, 22(9),* 2109–2139.

Lederman, N. G., Abd-El-Khalick, F., Bell, R. L. & Schwartz, R. (2002). Views of nature of science questionnaire: Towards valid and meaningful assessment of learners' conceptions of nature of science. *Journal of Research in Science Teaching, 39(6),* 497–521.

Lederman, N. G. (2007). Nature of Science: Past, Present and Future. In S.K. Abell and N.G. Lederman (Eds.), *Handbook of Research on Science Education* (pp. 831–880). U.S.A.: Lawrence Erlbaum Associates Inc.

Metz, K. E. (2011). Disentangling Robust Developmental Constraints from the Instructionally Mutable: Young Children's Epistemic Reasoning about a Study of Their Own Design. *Journal of the Learning Sciences*, *20(1),* 55–110.

Saçkes, M., Trundle, K. C., Bell, R. L. & O'Connell, A. A. (2011). The influence of early science experience in kindergarten on children's immediate and later science achievement: Evidence from the early childhood longitudinal study. *Journal of Research in Science Teaching*, 48(2), 217–235.

Sandoval, W. A. (2005). Understanding students' practical epistemologies and their influence on learning through inquiry. *Science Education, 89(5),* 634–656.