

# **CAN SCIENCE BE DANGEROUS? REFLECTION ABOUT ETHICALLY AND CULTURALLY SENSITIVE TOPICS IN THE SECONDARY SCIENCE CLASS**

*Science teachers report more and more difficulties to tackle ethically and culturally sensitive topics related to science, e.g. the theory of evolution, homosexuality or genetic modification. Some even report not mentioning these topics in class in order to avoid conflict. Indeed, these topics can induce resistance among students and even lead to polarization, especially in a context of super diversity where students of many different cultures share a classroom. In this work, a method is presented which aims at stimulating dialogue among students about these sensitive topics.*

*The teacher plays a key role when sensitive topics emerge in the class. As the teachers personal opinions influence his or hers didactic approach, a reflection instrument is developed allowing teachers to reflect upon their views on society, education and the nature of science. Additionally, we formulate eight didactical guidelines to help the teacher in facilitating the dialogue among students in the classroom.*

*The method is developed following a design based research protocol and in co-creation with both science and religion teachers. Group interviews of teachers and observations of the use of this method suggest that this method focusing on reflection through challenging questions may be an interesting tool to overcome polarization and stimulate dialogue.*

**Keywords:** Cultural Diversity in School, Ethics in science, Citizenship

## **INTRODUCTION**

Discussions on controversial themes reveal the close entanglement of science, society and world view. This social dimension of science also has a place in (science) education. After all, the citizens of tomorrow must be able to make well-informed and considered choices about ethical and cultural topics. This implies that science education has a broader focus than merely an emphasis on knowledge, research and technical skills (Pitt, 2009).

This is also taken up by the Flemish government, the interaction between science and society is part of the final objectives of (natural) sciences (onderwijsdoelen, n.d.). A 'Bildungs' vision also resonates in Flemish STEM (Science Technology Engineering Mathematics) (Lieten & Smet, 2012) policy and echoes at European level in the emphasis on science education as a means of promoting participation in debate (Hazelkorn, 2015). Attention to the social and ethical dimension of sciences appears to increase the involvement and openness of young people for science. This can be done through focusing on ethical (pre)judgements and ideas of young people (Braeckman, 2016; Werth, 2013).

Cultural and ethical topics relevant to the science class are topics that challenge students to take an ethical position on the basis of a substantiated consideration. This includes culturally sensitive topics, for example theory of evolution or (homo)sexuality, and ethically sensitive topics like medical applications. Attention to this requires scientific insight of students, but also requires students to think ethically. Jones and colleagues formulate indicators for successful ethical thinking such as: giving arguments for convictions, distinguishing descriptive and normative statements and understanding for other people's convictions (Jones et al., 2010; Kabasenche, 2014).

The teacher plays a crucial role when these culturally and ethically sensitive topics are being treated in the science class. Since the didactic approach is to a large extent influenced by the view of teachers, it is crucial that teacher get more insight in their own views. We distilled three themes which are key determinants which influence the didactic approach of teachers: teachers view on (i) society, (ii) education and (iii) science.

The aim of this project is twofold. First, we investigate the current situation about sensitive science topics in Flemish secondary school. This is done through a questionnaire with science teachers and teachers involved in religious education. Second, we develop a method including a reflection instrument for teachers and dialogue guidelines. This will help teachers to map their own opinions in order to clarify the link with their didactic approach.

## METHODOLOGY

A correlation between the teachers' beliefs of teaching, learning and science was found international studies (Chin-Chung Tsai, 2002; Lederman et al., 2002). Hence the first step was to get to perform a small exploratory research to gain insight in the current Flemish situation. This was done using a structured interview wherein 42 pre-service teachers and 70 in-service teachers were interviewed. The interview contained 45 statements, see table 1. Pre- and in-service teachers were asked to score these statements on a 5-point Likert scale (from 1-totally not agree to 5-totally agree). In addition to scoring, teachers also had the opportunity to explain why they indicated a certain value or to add an example.

Table 1: examples of statements teachers were asked to score.

Topic	Example	Number
Science	Science and technology can solve all our problems.	11
Didactics	When confronted with culturally diverse students I change the course content.	15
Society	Multiple opinions are an enrichment for society.	6
Education	Good teaching means that the teacher does most of the talking.	13

Given the results, see further, out-of-class material is needed allowing teachers to reflect upon their views, and how these are related to their teaching style. Hence we developed some materials following the principles of Educational Design Research (EDR) (Plomp et al. 2013). I.e. educational materials are designed, evaluated and adapted in several consecutive development-cycles. In different steps the method is introduced in schools, evaluated and refined. This is done in co-creation with both science and religion teachers. Group interviews of teachers and observations of the use of these materials are used to improve the developed materials.

## RESULTS

### *Questionnaire*

The results of the structured interviews were analyzed for exploratory insights. From the pre-teachers study 20 sciences, 3 Roman Catholic religion and 19 study other courses. From the in-service teachers teach 29 science, 31 religious education, and 10 other courses. The interviews were conducted in March 2018.

- A first notable result was that 43 out of 70 in-service teachers reported being challenged regarding the relationship science and religion in class (i.e. 60%). In the open answers teachers reported how they were challenged. For example: *'Some students do not accept that homosexuality is not a choice.'* (teacher behavioral sciences). Additionally notable is that 11 out of 42 preservice-teachers reported being challenged during their internships, i.e. very early in their careers.
- Both in service and preservice teachers report a wide variety of themes that (may) provide tensions between the scientific worldview and the sociocultural convictions of students: the origins of life and the universe, homosexuality, the theory of evolution and the existence of complot theories.
- A large variety of answers among the in-service teachers was found to the questions related to their didactic approach. With regard to the question whether or not they adapt their content and teaching style 47 out of 70 teachers answered that they would not (1 or 2 on the Likert scale), 8 would (4 or 5 on the Likert scale). In the open answers teachers illustrated why they would or would not change their didactic approach.
- Analysis of the answers shows a slight correlation between the teachers view on science (e.g. *'Science excludes the existence of God'*) and his/her didactical approach (e.g. *A teacher must be neutral, which is why I prefer to avoid ethically sensitive issues such as abortion, euthanasia, the origin of the earth.* ).

Group interviews of education experts and observations of students and teachers teaching in a culturally diverse context suggest that the developed method focusing on reflection through challenging questions may be an interesting tool to overcome polarization and stimulate dialogue.

### *Reflection instrument for teachers*

As the teachers opinion influences his or her didactic approach, a reflection instrument is developed allowing teachers to reflect upon their views on society, education and the nature of science. The reflection instrument includes (i) open questions on science, education and society, (ii) polarizing statements, (iii) cases of class situations with possible reactions of teachers, (iv) quotes. Through the discussion of these items this instrument

helps teachers reflect upon their own didactic approach with regard to these sensitive themes. This reflection instrument can be used in a workshop for teachers with the guiding of a project member. Or it can be used without guidance by a group of teachers of the same team.

### *Didactical guidelines*

We developed an approach based on Socratic dialogue (Anthone et al. 1997; Lipman, 1988), and intercultural communication (Van Houte, 2015). These approaches not only provide an understanding of dialogue in culturally diverse classrooms, but also provide a dialogue technique allowing students to investigate a shared question. The use of a key question such as ‘*Can a scientist be religious?*’ allow students to explore the issues at hand in an open and trusted environment. The teacher acts as a dialogue facilitator taking the Socratic stance, which means that he or she facilitates without intervening with regard to the content of the discussion allowing students to discover and develop a shared language to explore these sensitive scientific issues. Based on our preliminary research results, we formulated eight design criteria.

## **CONCLUSION AND DISCUSSION**

Science classes and teachers are increasingly prone to discussions regarding sensitive subjects (e.g. evolution vs creation, homosexuality, genetic manipulation,...). These subjects, the subsequent discussions and reaction of teachers might turn some students away from science as a whole.

Already in the small sample questioned in this work views on society, education and science vary widely. In a second part of this work we develop a methodology that will allow an open and fruitful discussion of these sensitive issues in the science classroom. Recognizing and dealing with sensitive issues is not trivial. Several boundary conditions are needed on a classroom, teacher and school level for example allowing co-teaching by religion and science teachers.

Material aimed at teacher has been designed in the previous months and has been through the first EDR cycles, namely it has been presented to experts and in-service teachers. In the upcoming months the material will be adapted and presented to a large group of teachers. Results, and finished materials should be ready at the time of the conference.

## **REFERENCES**

- Anthone, R., Mortier, F. (1997) Socrates op de speelplaats. Filosoferen met kinderen in de praktijk. Leuven: Acco.
- Braeckman, J. (2016) "Het kan niet dat wij van de open afstammen." Of toch? Retrieved January 31, 2019, from <http://deredactie.be/cm/vrtnieuws/opinieblog/opinie/1.2829198>
- Chin-Chung Tsai (2002) Nested epistemologies: Science teachers' beliefs of teaching, learning and science, *International Journal of Science Education*, 24:8, 771-783, DOI: 10.1080/09500690110049132
- Hazelkorn, E. (2015) Science education for responsible citizenship.
- Jones, A. McKim, A., Reiss, M. (2010) *Ethics in the Science and Technology Classroom*. Sense publishers: Rotterdam
- Kabasenche, W. P. (2014). The Ethics of Teaching Science and Ethics: A Collaborative Proposal. *Journal of Microbiology & Biology Education*, 15(2), 135–138
- Lederman, N.G., Abd-El-Khalick, F., Bell, R.L., Schwartz, R.S. (2002). Views of Nature of Science Questionnaire: Toward Valid and Meaningful Assessment of Learners' Conceptions of Nature of Science, *Journal of research in science teaching*, 39(6), 497–521
- Lieten, I. & Smet, P., (2012) Actieplan voor het stimuleren van loopbanen in wiskunde, exacte wetenschappen en techniek. Nota van de Vlaamse Regering, 1478(1)
- Lipman, Matthew (1988) *Philosophy goes to school*, Temple University Press.
- Onderwijsdoelen. (n.d.). Retrieved January 31, 2019, from <https://onderwijsdoelen.be/>
- Pitt, J. (2009) Blurring the Boundaries – STEM Education and Education for Sustainable Development. *Design & technology education*, 14(1)
- Plomp, T. (2013). Educational design research: An introduction. *Educational Design Research*, 11–50
- Van Houte, H. Merckx, B. De Lange, J. De Bruyker, M. (2015). Goesting in STEM. Acco: Leuven
- Werth, A. J. (2013). An evolutionary focus improves students' understanding of all biology. *Reports of the National Center for Science Education*, 33(1), 3–20