UNDERSTANDING FIRST YEAR UNIVERSITY STUDENTS' CURIOSITY AND INTEREST ABOUT PHYSICS

Antti Laherto[1], Olivia Levrini[2], Anna De Ambrosis[3], Sabine Hemmer[4], Massimiliano Malgieri[3], Ornella Pantano[5] and Giulia Tasquier[2]

[1] University of Helsinki, Finland [2] University of Bologna, Italy [3] University of Pavia, Italy [4] INFN, Padova, Italy [5] University of Padova, Italy

The European shortage of students pursuing further studies and careers in Science, Technology, Engineering and Mathematics (STEM) is particularly severe in the field of physical sciences. Many physics departments suffer from high dropout rates, partly caused by students' decrease of interest during their studies. To address these problems and to help teachers at all educational levels improve their practices, the EU-funded HOPE (Horizons in Physics Education) project examined the views of first-year Physics students in European universities. Here we report the results of an interview study on how students perceive their reasons for choosing physics as their field of study. 94 semi-structured interviews were conducted in 16 universities and analysed through a two-round process. The results show that the first-year students used chiefly expressions of interest and intrinsic motivation to describe factors inspiring them to study physics, while expectations of success as well as utility and attainment values played smaller roles. The interviewees were either strongly motivated by their curiosity in understanding how the world works, or interested in what characterises physics as knowledge (its practises, methods, and way of knowing and thinking). Often both aspects were present. The division in subcategories shed more light on the precise nature of such curiosities and interests. We will discuss these tendencies using exemplary quotes, and contrast our results with earlier research. We suggest the articulated picture of interest and curiosity built in this study could inform the development of first year Physics courses – both the choice of contents and pedagogical approaches. Results can also be useful for designing targeted recruitment and outreach initiatives, which aim to foster interest in physics at pre-college levels.

Keywords: Physics, Student choices, Student interest

INTRODUCTION

Europe needs to attract more young people to pursue further studies and careers in Science, Technology, Engineering and Mathematics (STEM) (Caprile et al., 2015). The demand is particularly high in the field of physical sciences; and to make things worse, many physics departments suffer from high dropout rates, partly caused by students' decrease of interest during their studies. To address these problems, the EU-funded HOPE (Horizons in Physics Education) project examined the views of first-year Physics students.

Earlier research has indicated that university students typically use expressions of intrinsic motivation to describe their decision-making on further studies and careers, while expectations of success as well as utility and attainment values play smaller roles in motivating them (Cerinsek et al., 2012). Especially among those who choose physics as a field of study at postcompulsory stage, research suggests that interest may be a very important explaining factor (Bøe & Henriksen, 2013).

A closer look at students' interest in science immediately reveals that interest in a science topic may not necessarily indicate interest in scientific practices and pursuits. Recognising the ways in which students express curiosity to understand the nature of an object, phenomenon, or a given topic may shed light on whether their interest is in the topic itself, or in the line(s) of practice associated with it (Azevedo, 2011; Luce & Hsi, 2015). To better understand the nuances and viewpoints in students' interest, Luce and Hsi (2015) differentiated between six types of curiosity: mechanistic, teleological, inconsistency, cause & effect, engineering or medicine and general knowledge. In this paper we employed and adapted their typology of curiosity, which was originally used to analyse children's perspectives, to better understand university students' curiosity about physics and about its special ways to understand and investigating the world. Yet, our typology for university students became more fine-grained.

The aim of this paper is to provide a comprehensive picture of first year university students' interest and curiosity in physics in order to inform teaching choices in academia.

METHODS

An analysis of the literature on students' interest oriented the design of the interview protocol. The protocol was designed in English and translated in each of the national languages by respecting the original formulation. 94 semi-structured individual interviews of 20-30 minutes were carried out between December 2014 and June 2015 in 16 universities on a selection of students who had previously answered the questionnaire on motivational factors within the HOPE project. Interviews were audio-recorded, transcribed and analysed according to the template and the coding scheme built on trials and shared in the working group which negotiated the controversial issues and codings.

In the first round of data analysis the category of "curiosity" was found to be overpopulated with respect to the others. This result revealed the necessity of refining it, in order to have a more detailed and informative picture of the data. The new coding was tested against the interview data of a small group of scholars, in order to check its validity and try its applicability. Finally, it was applied by each partner to their own data.

Our interview sample is not statistically representative of European students. Our main result is a categorization of first year physics students' interests and curiosities which has proven operative and robust, producing a non-trivial distribution of students in categories when applied to data from several countries.

RESULTS

The first results from the interviews indicated that deeply *internal* factors were most significant. Therefore, we focused our analysis on gaining a more fine-grained picture of the different *kinds* of interest and curiosity the students have. Based on our shared interpretation of themes emerging from the data, the "interest/curiosity" cluster was broken down into two macro categories: A) Curiosity to understand the world, natural phenomena and universe; and B) Interest in physics knowledge as a *special* way of knowing, investigating, questioning and thinking. Both of these macro categories were then further divided into sub-categories that represent different aspects and perspectives of students' interest/curiosity (see Table1). The subcategories were formed using a twofold approach: by searching themes emerging from the data, as well as using the literature on interest and curiosity to find fruitful specification. Especially, the macro category A was broken down following the typology of Luce and Hsi (2015).

Table 1 – Synthetic view of the coding specifying the meaning of categories A and B.

A. Curiosity to understand the world, natural phenomena and universe	
A1. Mechanisms underlying phenomena	Curiosity about how something works or how a process occurs. Wanting to understand underlying mechanisms for processes or observations. Wanting understand cause-effect relationships, or to know how the entities in a causal relationship interact. Wanting to explain phenomena through principles or laws.
A2. "Teleological" (that is the wish to know *beyond* the mechanism)	Curiosity about the purpose of things, why things exist, or why processes occur. Curiosity about function, design, purpose. This category includes also ontological and theological questions.
A3. Inconsistency/ surprise/ wonder	Curiosity about an observation that is surprising or inconsistent with prior knowledge.
B. Interest in physics knowledge as a *special* way of knowing, investigating, questioning and thinking	
B1. Mindset of physicists, rational thinking and problem solving	Interest in ways of thinking that deeply characterize physics ways of solving problems, arguing, modelling...
B2. "Think different – and –	Interest in divergent thinking, critical thinking, counterintuitive ideas toward not obvious

critical"	things, unusual and unconventional ways of thinking.
B3. Math cluster	Interest in the formal/mathematics aspect of physics.
B4. Experiment/real world connection	Interest in the experimental method of physics and/or in the processes of observing, selecting, reproducing phenomena, … .
B5. Theoretical modelling	Interest/fascination toward comprehensive pictures provided by fundamental laws and unifying theories
B6. Never-ending questioning	Fascination toward the never-ending process of physics research, toward the "infinitely open-ended" process of asking questions.
AB. Generic fascination	Fascination about the world, generic or sometimes purely aesthetic fascination toward physics.

A total of 50 out of the 94 interviewed students expressed motivational factors classified as Category A. 33 answers were collected in **A1: Mechanisms underlying phenomena**, 21 in **A2: Teleological cluster** and 4 in **A3: Inconsistency, surprise, wonder**. Out of the 94 interviewed students, 49 mentioned their interest in physics knowledge. More in detail, 17 answers were categorized in **B1: Mindset of physicists**, 8 in **B2: "think different and critical"**, 12 in **B3: Math cluster**, 6 in **B4: Experiment/real world connection cluster**, 13 in **B5: Theoretical cluster**, and 6 in **B6: Never-ending questioning cluster.** A total of 20 students provided an answer classified as category **AB: General fascination**.

A majority of students (80 out of 94) mentioned at least one aspect classified in categories **A** or **B**, and in many cases two or even more. Of the remaining students, 9 expressed a general interest or fascination for physics that could be included in the category **AB**, while 5 only mentioned different reasons, included in the categories **C-K**. Motivational factors other than those described by their curiosities or interests were mentioned by 40 students, and 56 times in total.

DISCUSSION AND CONCLUSIONS

By and large the results support the findings from earlier studies (Cerinsek et al., 2012; Bøe & Henriksen, 2013): university students chiefly use expressions of interest and intrinsic motivation to describe why they chose physics. Our interviewees were either strongly motivated by their curiosity in understanding how the world works, or interested in what characterises physics as knowledge (its practises, methods, and way of knowing and thinking). Often both aspects were present. The division in subcategories shed more light on the precise nature of such curiosities and interests. We will discuss these tendencies using exemplary quotes. We will also contrast our results with earlier research e.g. the role of family support in choosing physics.

We suggest the articulated picture of interest and curiosity built in this study could inform the development of the first year Physics courses – both their content and their pedagogies – and help inventing new strategies to support and encourage university students' personal interests since the very beginning of their university studies in Physics. Results can also be useful for designing targeted recruitment and outreach initiatives, which foster interest in physics at pre-college levels.

REFERENCES

Azevedo, F. S. (2011). Lines of practice: A practice-centered theory of interest relationships. *Cognition and Instruction, 29*(2), 147-184.

Bøe, M. V., & Henriksen, E. K. (2013). Love it or leave it: Norwegian students' motivations and expectations for postcompulsory physics. *Science Education, 97*(4), 550–573.

Caprile, M., Palmén, R., Sanz, P., & Dente, G. (2015). *Encouraging STEM studies for the labour market.* Directorate General for Internal Policies, European Union.

Cerinsek, G., Hribar, T., Glodez, N., & Dolinsek, S. (2012). Which are my future career priorities and what influenced my choice of studying science, technology, engineering or mathematics? Some insights on educational choice—case of Slovenia. *International Journal of Science Education, 35*(17), 2999–3025.

Luce, M. R., & Hsi, S. (2015). Science□Relevant Curiosity Expression and Interest in Science: An Exploratory Study. *Science Education, 99*(1), 70-97.