I-Use: I Use Statistics in Education

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Abstract

There is an increasing importance of statistical literacy for everyday life, almost every economic and scientific activity in the modern world relies on statistical information in one way or another. It plays a prominent role in business and industry, aspects of government and scientific and economic progress. Students are now living in a society that demands evidence-based arguments and decisions.

There are a number of challenges facing education in the use of statistics and data: i) the volumes of information available, ii) the slow response of education and curricula to change, iii) the need for innovative teaching and learning approaches and iv) the absence of significant research in European statistical education.

The I-Use consortium investigated the use of statistics in e.g. the geography curricula of the participating countries. Statistics appear mostly in the curricula of mathematics (where it is a separate item) and in history, although the statistics as a source for real investigation is mostly denied.

The I-Use project deals with data, statistics and pedagogical approaches with their applications to various areas in secondary school curricula.

Its goal is to create an in-service teacher training course dealing with how to make sense of information through different presentation forms and media. A first tryout of this course will take place in Greece in September 2014. Trainees will examine how to develop students' statistical thinking through sophisticated and innovative web-based tools to support the learning process.

After one year running the project has already developed a toolbox, fully integrated with the web site and be based on the surveyed needs of students and teachers.

The tools will make full use of mobile devices (like tablets) and (web)GIS, as it is a simple yet powerful method of visualizing statistical investigation, and this not only in geography.

I-USE will also deal with the assessment of student learning making the distinction between assessment of learning (summative) and assessment for learning (formative) approaches. This will be addressed through three basic components, cognition, observation and interpretation that underlie all forms of evaluation.

1. The importance a being statistical literate

Statistics - as the science of collecting, analysing, and interpreting empirical data - has a central place in education, but certainly in STEM education. Education concerning the use of statistical information is appropriate for lifelong learners at different levels of education. The relevant use of statistics in education is through its multi-disciplinarily, with its roots in such diverse fields as biology, business studies, economics, environment, ICT, mathematics and social studies [1]. So statistical literacy should be a key educational goal for all students.

Teaching using statistics requires a different kind of thinking, because data is not just a series of numbers, they are numbers with a context. Wild and Pfannkuch [2] highlighted ways in which statistical thinking is different from mathematical thinking, having investigative cycles, distinctive types of thinking, interrogative cycles, and characteristic dispositions.

Students are living in a society that demands evidence-based arguments and decisions. Therefore using statistics in the curriculum plays a crucial role in developing statistical thought processes. Statistical thinking or reasoning or literacy needs to be recognised as an important educational goal and the use of statistics needs to be valued in different disciplines to develop students' statistical concepts and thinking.

2. The present situation on the use of statistics in the curriculum.

One of the first tasks of the I-Use project was to analyse the present situation on the use of statistics in education, how Statistics are used in various official national curricula. For the report I-Use mapped the references to "Statistics" in Social Studies, Mathematics and Science secondary school curricula in use in public secondary schools in Flanders (Belgium), Greece, Denmark, Czech Republic and Sweden, at the time of the study (2012-2013).

The choice of these subjects was underpinned by theoretical lenses drawn from curriculum studies According to these within official curricula, subject-areas such as Mathematics, Geography, History, Civics (Social Studies), Economics/Business Studies, ICT and Sciences have been perceived as more relevant to the use and inclusion of statistics [1].

The result of a quantitative analyses (Table 1) shows that most references occur in the subjects of Mathematics and Geography and comparatively fewer references occurred in History/ Civics or Science, a finding relevant to the literature review on this issue.

Also there is a great diversity of frequency of statistical use across countries and subjects. In most countries, most references occur in the Mathematics curricula documents, the second highest frequency was encountered in the subject of Geography.

Table 1. Mapping 'Statistics' across Europe: overall quantitative content analysis results

Subject / Country	Math & Statistics	History	Science (Physics, Chemistry, Biology)	Geography	Social Science (Civics, Sociology)	Economics	Total
Belgium (Flemish)	20	2	10	14	-	-	**46**
Denmark	26	1	5	5	14	-	**51**
Sweden	9	1	1	3	1	-	**15**
International Baccalaureate	26	1	6	6	2	-	**41**
Greece	76	28	12	74	14	66	**270**
Czech	10	-	-	5	3	-	**18**
Total	167	33	34	107	34	66	**451**

Besides the quantitative overview also a qualitative analysis was made, indicating that low or high counts in the terms in focus did not necessarily mean the absence or presence of statistics content.

As a result of analysing quantitative and qualitative data, the reports on the pedagogic approaches to statistics use and on the pedagogic importance of statistics [3] clearly marks that the presence of statistics takes three forms:

1) Pure statistics and probabilities in mathematics, emphasized in mathematical theory, where the key concepts/phrases or activities for exemplifying this theory were apparent, enhancing students' knowledge skills on problem solving (using mathematical theory and data from this topic), but not to promote interplay between theory and application for the real life nor prepare students for dealing with contextual problems.

2) Apparent in the data collection, visualisation and interpretation using tables, charts/ diagrams and maps to solve problems in real- world. In this case there is an indirect reference to use of statistics, but there is a wide occurrence of such references mainly in other subjects' curricula besides of mathematics, especially in the geography curriculum.

3) The use of statistics in researches or field studies in everyday life, for the development of statistically literate and professional competent people. This is e.g. apparent in the curricula of geography, history, social sciences and economy (Greece).

3. Challenges faced

There are a number of challenges facing education in the use of statistics and data. These include i) the volumes of information available, ii) the slow response of education and curricula to change, iii) the need for innovative teaching and learning approaches and iv) the absence of significant research in European statistical education.

The over-abundance of information poses serious questions, for example what degree of statistical literacy should we expect for every pupil? How can we structure opportunities to enable students to reach this level and to ensure that teachers have sufficient skills to be able to use statistics to improve their teaching? The dilemma is that as more data and information becomes more readily available and the tools for presenting and analysing the statistics become more sophisticated, the ability to introduce and integrate statistical information and undertake analyses is not matched by educators' capacity to use the information, tools and technologies productively.

While the world is changing rapidly with respect to the prevalence and use of statistics, the curriculum in schools tends to be slow to respond to these changes. Although statistics as a content domain is widely accepted, typically statistics is not an interdisciplinary topic in the school curriculum but is mainly taught as part of mathematics and rarely integrated into other subject areas. Consequently there is a need for a better preparation of teachers, who are responsible for teaching with statistics. As a result in high school, many students do not have an opportunity to learn to work with statistics. Statistics is a powerful tool but many students are not able to make meaning from data and information.

4. Recommendations

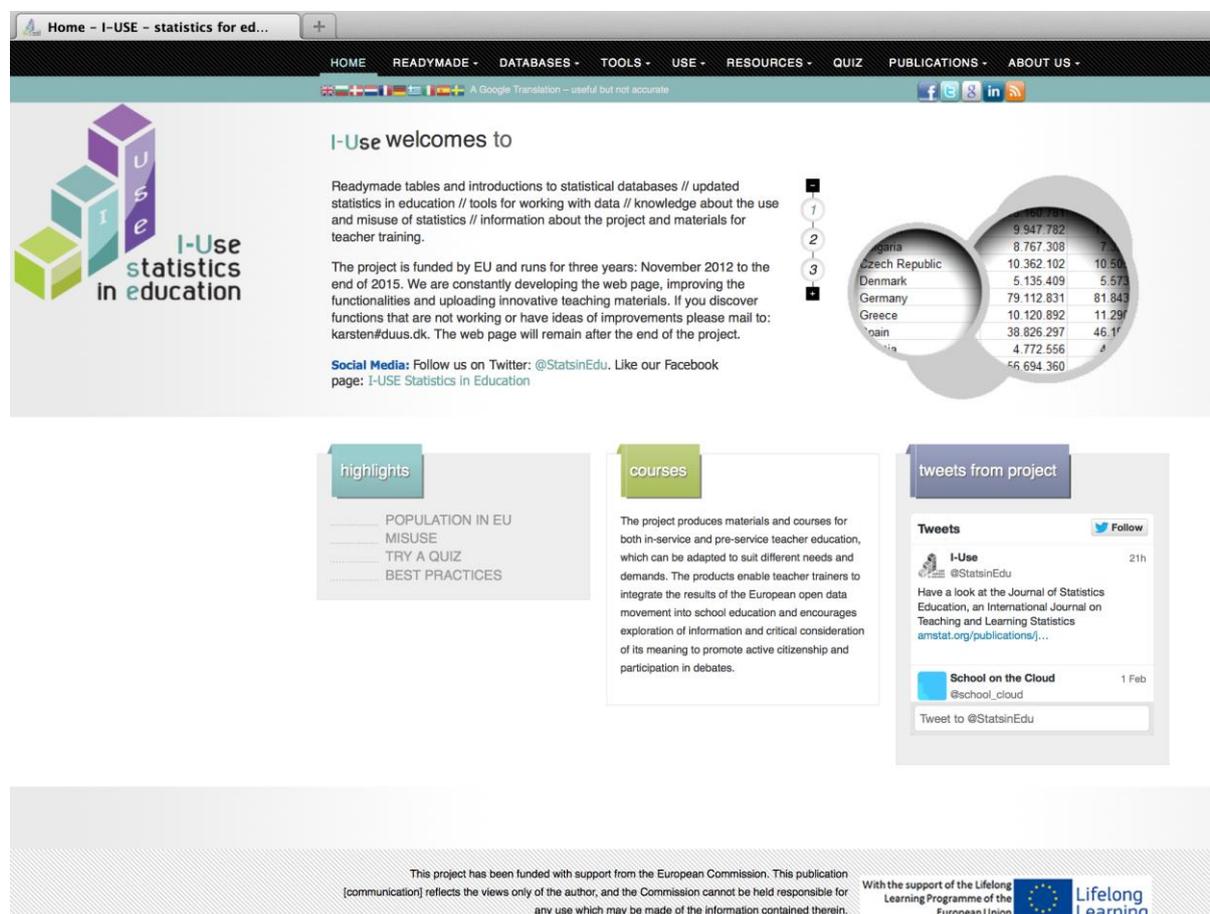As a summary in the reports [3] following recommendations were made:

- A course for secondary school teachers requires a focus on curriculum to make a clear connection between the statistics presented and the subject under study in a school classroom. A focus on pedagogy is needed so that teachers learn to regularly adopt the use of statistics in their own classrooms and develop similar types of activities for their students to experience. A focus on learners is required so that teachers understand the diversity of statistical perceptions and misunderstandings of students.

- Working with new technology helps to engage teachers and students in tasks that simultaneously develop their understanding of statistical ideas and allows them to experience how technology tools can be useful in fostering statistical and spatial thinking [4]

- Stressing problem-solving ensures that the outcomes have a real-world dimension. Ideas should develop in the context of the problem-solving activities using statistics, which encourage the development of statistical reasoning skills so that the use of statistics is a means of supporting learning [5] [6].

- The data analysis/interpretation phase requires a thorough understanding of data representations. Different representations of distributions also affect students' understanding of concepts.

- Teachers and should experience the full cycle of statistical use through enquiry-based projects. Godino et al. 7] suggested that a formative cycle where teachers are first given a statistical project and then carry out a didactical analysis of the project can help to simultaneously increase the teachers' statistical and pedagogical knowledge.

5. I-Use deliverables

Taking into account the recommendations the I-Use project deals with data, statistics and pedagogical approaches with their applications to various areas in secondary school curricula. The I-USE Comenius Project aims to:

- help cope with the over-abundance information-rich resources
- encourage teachers engage their students in learning to use statistics and work with statistics
- make statistical education more visible under the Life Long Learning Program
- prepare teachers for the technology-mediated nature of working with statistical information
- keep up with Web-based innovation
- develop teachers classroom statistical competence
- provide training for teachers of different subjects

After one year running the project is fully busy developing material for its website www.i-use.eu (Figure 1)

Figure 1: The I-Use website

The project has already developed a toolbox, fully integrated with the web site and based on the surveyed needs of students and teachers. The tools will make full use of mobile devices (like tablets) and (web)GIS, as it is a simple yet powerful method of visualizing statistical investigation, and this not only in geography.

With the use of this toolbox teachers will be able to work interactively with statistical data visualizing it in both space and time in an innovative way.

The finale and major goal is to create an in-service teacher training course dealing with how to make sense of information through different presentation forms and media. This will explore various

methods of using statistical data within an educational context. There will be a cross-curricular approach: the course will be useful for teachers who have specialisms in a range of subjects, from social studies over geography to economy, history ... A first try-out of this course will take place in Greece in September 2014. Trainees will examine how to develop students' statistical thinking through sophisticated and innovative web-based tools to support the learning process.

I-USE will also deal with the assessment of student learning making the distinction between assessment of learning (summative) and assessment for learning (formative) approaches. This will be addressed through three basic components, cognition, observation and interpretation that underlie all forms of evaluation.

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