

# CLASSROOM INTERVENTION AFTER TEACHERS' PEDAGOGICAL AND CONTENT KNOWLEDGE OF STATISTICS THROUGH DISTANCE LEARNING

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## Abstract

Recognizing teachers' ongoing professional development and learning as a linchpin of instructional innovation and success for their students, the paper presents an EU-funded project that exploits the affordances offered by ODL technologies to help improve the quality of statistics instruction offered in European schools. Twelve in-service teachers participated in the course, originating from three of the partner countries — Cyprus, Spain and Greece. Participating teachers developed and delivered teaching episodes integrating the use of the course tools and resources provided to them. In the paper, firstly, we describe the pedagogical and didactical approach underlying *EarlyStatistics* and the course content and structure. Moreover, the feedback from the target user groups from all partner countries, as well as from the external experts regarding the project content, services, and didactical approaches was generally very positive. In this paper we present teacher's opinion of the program from the pilot delivery of the course and the follow-up classroom intervention.

## Introduction

The development of a statistically literate society is a key factor in achieving the objective of an educated citizenry. In a world where the ability to analyze, interpret and communicate information from data are skills needed for daily life and effective citizenship, statistical concepts will occupy an increasingly important role in mathematics curricula. The overall objective of *EarlyStatistics: Enhancing the Teaching and Learning of Early Statistical Reasoning in European Schools* was to develop an innovative professional development program for the teaching and learning of statistical reasoning at the elementary and middle school levels. The project utilized distance education to offer high-quality innovative experiences to geographically-dispersed teachers across Europe, offered the opportunity to teachers in different countries to collaborate and build communities of practice in social constructivist learning environments and offered access to usable and validated pedagogical models, didactic approaches, and innovative instructional materials for the teaching and learning of statistics. Recognizing

teachers' ongoing professional development and learning as a linchpin of instructional innovation and success for their students (Ginsberg, 2003), the EU-funded project *EarlyStatistics* exploits the affordances offered by open and distance learning (ODL) technologies to help improve the quality of statistics instruction offered in European schools: learn and/or better understand the concepts and methods of statistics; understand statistics as a comprehensive approach to data analysis; develop pedagogical knowledge of statistics; become familiar with a variety of methodologies, tools, and resources for teaching statistics; use real data, active learning, and technology to teach statistics; and develop a long-lasting trans-national community of teaching practitioners who advise and support each other about classroom practices, pedagogy, and statistical concepts (Gould & Peck, 2004).

In brief, the feedback from the target user groups from all partner countries, as well as from the external experts regarding the project content, services, and didactical approaches was generally very positive. This feedback was not only focused on validating the outputs developed, but also on evaluating them in terms of their potential value from the perspective of a range of end users. Key conclusions from the analysis of the user feedback were that *EarlyStatistics* meets its objectives because it helps improve understanding of utilizing interactive learning content, it offers services that improve the instructional process, it offers the opportunity to collaborate with other teachers and begin the construction of a community of practice. In the particular this paper presents teacher's opinion of the program from the pilot delivery of the course and the follow-up classroom intervention.

### **Pedagogical and Didactic Approach**

Recognizing that teachers would bring a diverse variety of strategies into the course as a result of their own professional experiences, and that professional development is most effective when deeply contextualized in teachers' professional activity, *EarlyStatistics* adopted an approach that respects and utilizes teachers' professional knowledge. The distance education environment has been designed as a framework for flexible learning (Collis & Moonen, 2001), regarding teachers as the main agents of their professional development, supported by an environment rich in challenges and interactions. A central conviction underlying *EarlyStatistics* is that learning is a social act best supported through collaborative activities (Vygotsky, 1978), and thus learning as part of a community of practice can provide a useful model for teacher professional development. *EarlyStatistics* participants are provided with ample opportunities for interactive and collaborative learning through use of a wide array of tools, artefacts and resources (Gordon et al., 2007). They are actively involved in constructing their own knowledge,

through their participation in authentic educational activities such as projects, experiments, computer explorations with real and simulated data, group work and discussions. Central to the course design is the functional integration of technology with existing core curricular ideas, and specifically, the integration of new types of tools (e.g. the dynamic statistics software Tinkerplots<sup>®</sup>), which provide teachers, and subsequently their students, with the opportunity to model and investigate real world problems of statistics.

### **The *EarlyStatistics* Course Content and Structure**

The *EarlyStatistics* course design focuses on activity-based learning. The course aims at enriching teachers' (i) knowledge of and about statistics; (ii) knowledge about teaching and learning, and (iii) practical knowledge (Azcarate et al., 2006), through hands-on and computer-based practice, experimentation, intensive use of simulations and visualizations, feedback from each other, and reflection. Teachers participate in a number of collaborative and participatory activities that help them improve their content and pedagogical knowledge of statistics and, being actual practitioners, then apply what they learn to a real classroom setting.

The course lasts for 13 weeks, and is made up of six Modules. In Modules 1–3 (Weeks 1–7), the focus is on enriching participants' statistical content and pedagogical knowledge. To help teachers go beyond procedural memorization and acquire a well-organized body of knowledge, the course emphasizes and revisits a set of central statistical ideas rather than presenting statistical content as a sequenced list of curricular topics. The conceptual "Framework for Teaching Statistics within the K–12 Mathematics Curriculum" (GAISE, 2005), has been used to structure the content presentation. This framework uses a spiral approach so that instructional programs from pre-kindergarten through high school encourage students to gradually develop understanding of statistics as an investigative process with four components: (i) clarifying the problem at hand and formulating questions that can be answered with data; (ii) designing and employing a plan to collect appropriate data; (iii) selecting appropriate graphical or numerical methods to analyze the data; and (iv) interpreting the results. In Modules 4–6, the focus shifts to classroom implementation issues. Teachers customize and expand upon materials provided (Module 4; Weeks 8–9), and then apply them in their own classrooms with the support of the design team (Module 5; Weeks 10–11). Teachers then write up their experiences, including a critical analysis of their work and that resulting from their pupils. This helps them to reflect on their practice, and to apply self-criticism constructively. Finally, once the teaching experiment is completed, teachers report on their experiences to the other course participants, and provide video-taped teaching episodes and samples

of their students' work for group reflection and evaluation (Module 6; Weeks 12–13).

*EarlyStatistics* uses a blended learning approach. There were a few face-to-face meetings with local teachers, but the biggest part of the course is being delivered online by utilizing the project information base for teaching, support and coordination purposes. In addition to the course content, the site offers access to various other links and resources: *Technologically enhanced instructional materials* for the teaching and learning of statistics in the elementary and middle school; *Manuals and guides* related to the course: study calendar, assignment guides, including how to prepare a portfolio of evidence, software manuals etc.; *A digital video case library* containing segments of real teaching episodes, obtained in the classrooms of the teachers participating in the pilot delivery of the course, representing the landscape of practice in statistics instruction throughout Europe; *A database with student work samples* developed through contributions of the participating teachers, providing examples of good practice in European schools; *Collaboration tools* for professional dialogue and support including e-mail, conferencing, chat rooms, discussion forums, wikis, etc.; *Archived forum discussions*; *Reports and articles* developed through the project; *Links to statistics education resources* available on the Internet; and *Multilingual interfaces* (EN, EL, ES) to partly overcome linguistic barriers.

In order to offer teachers flexibility and to accommodate different time zones, the largest portion of the course is delivered asynchronously. Asynchronous means of communication include discussion forums and mail groups. There is also some synchronous communication through use of technologies such as audio/video streaming, and videoconferencing. One-way informational postings such as articles and videos also serve as objects for supporting interaction.

Teachers work according to a loose schedule. This has been deemed necessary for balancing the amount of freedom available in the course with a sense of structure. Each module involves a range of activities, readings and contributions to discussion, as well as completion of group and/or individual assignments. Online moderated discussions allow teachers to share content, ideas, and instructional strategies. Teachers are provided with a space to discuss and grapple with the complexities of teaching and learning, to foster alternative perspectives, and to apply educational theory to practice (Kayler & Weller, 2007).

## Methodology

In order to evaluate the applicability and success of the training modules, participating teachers were asked to develop and deliver teaching episodes integrating the use of the available tools. Further, a follow-up evaluation might

also be conducted several weeks after completion of the training course, through completion of a follow-up online questionnaire that inquired information regarding actual application of the training on the teachers' instructional practices. At the end of the evaluation process the groups completed training in the use of the system and its integration into the educational process. The experiences of the groups from their engagement with the system and training modules to be developed in the project were analyzed, and potential areas of improvement was identified and documented in the project evaluation report for the benefit of institutions wishing to implement similar services.

During the intervention, some cases studies were carried out. For this purpose were used the techniques of data collection: (a) participative observation, (b) video recording of instructive episode and (c) samples of children's work.

### **Teachers' Opinion for the Program**

In this paragraph we present the conclusions obtained from the last face-to-face meeting with teachers about the whole program. Their opinion is presented in the following four categories: distance training, self-learning, urgent communication and alternative instructive proposal of statistics. When the teachers were asked to participate in the course and do an innovative statistical intervention in their classrooms, they expressed that they wanted to learn more about teaching this course. At the end they expressed that the proposal of cooperation between teachers of different countries, the face-to-face meeting to discuss and improve their work helped them to feel more comfortable teaching statistics.

#### **Distance Training**

They expressed that distance training for them has helped to understand that the problems that they have when teaching statistics are common also in other European Countries. This helps to enrich their experiences when contrasting information with other teachers around Europe and they were able to ask to Consortium teachers that they give them well-constructed knowledge.

They expressed that the papers, bibliography, presented in the course were too many and their time to work on them was limited, because of their work. Two teachers of the twelve claimed "I like distance training. You do things in your own time. But, many times, there is no own time and not time for extra reading." They said that the theoretical part was interesting, but they were more interested in the practical part because 'this part showed as how to use theory in our own classes. Furthermore, they said that the course shouldn't have so many assignments on the theoretical part, as there is not time for working on them. They claimed that the approach selected that introduces the method of investigation as a path to construct

knowledge was more interesting, but also more difficult to introduce it as you need extra time from the curriculum to introduce projects or investigations. They expressed that in this case they were innovating in statistics knowledge, methodology and materials.

### **Self Learning**

They expressed that it was very interesting the proposal of pick-up more papers than the ones that were compulsory, to look into the scenarios from different point of views, and looking the viability of working like that with their students. The organization of the program with the aim that they learn by themselves, analyse what they know, and reflect about their practice was a different way of permanent in-service learning. They thought that in the first moment it was very difficult because they had to express what they have understood and its application let a lot of time. So they think that it is very important that this self-learning let teacher freedom on time expending.

### **Urgent Communication**

They expressed that the combination of the use of forum and face-to-face meetings let them to contrast information and it was very important to go in deep in looking for more information. They expressed that it was very useful to be able to communicate with teachers of different levels and perspectives in education that let them to understand the differences in teaching. This direct communication to everybody has helped to continue the hard work of self-learning. Moreover, they claimed that it is good to 'hear' colleagues from other countries that they faced similar problems like you and sometimes because of a different view on a point, suggesting ideas that you didn't thought of it.

### **An Alternative Instructive Proposal of Statistics**

Teachers were impressed how statistics education can be so applicable in everyday life at school. One of the twelve teachers claimed "At the beginning of the course I thought that I would not be able to apply these things, but when I did my teaching intervention and I understood better the idea of scenarios and statistics in everyday life I feel that my students and I earned a lot."

They claimed that within this project they found that there is always a topic on which you can do statistics. The idea of using scenarios and projects for investigation was found very interesting and very motivated way to students. They claimed that although with this way you feel that you are going to get out from the curriculum, at the end the learning that students gained is unpredictable.

## Conclusions

Distance education is a useful framework for in-service teacher training, but it can represent a large variety of pedagogical perspectives. The most common approach is to follow a highly structured format, setting objectives and sub-objectives in detail and designing tasks to fit these objectives. Recognizing the fact that professional development is most effective when deeply contextualized in the teacher's professional activity and that teachers bring a diverse variety of strategies into the program as a result of their own professional experiences, *EarlyStatistics* uses an approach that respects and utilizes teachers' professional knowledge. An important consideration of any model of professional development is whether teachers feel the project is useful and supportive of their efforts to improve their teaching practice (Whitaker et al., 2007). As Robinson (1998) points out, staff development often fails to transfer to the learners' 'real-work' situations, because it might be too remote from 'real-work' needs or organizational realities. The course is based on current pedagogical methodologies utilizing collaboration, statistical investigation, and exploration with online interactive problem-solving activities. Particular care has been taken to build on participating teachers' knowledge and experiences, and to promote collaborative and participatory learning (Barab & Duffy, 2000). Teachers from different countries have the opportunity to improve their content and pedagogical knowledge of statistics through open-ended investigations, simulations, visualizations, collaboration and reflection on one's own and on others' ideas and experience.

The distance education environment was designed as a framework for flexible learning (Collis & Moonen, 2001), regarding teachers as the main agents of their professional development, supported by an environment rich in challenges and interactions. The design was based on the importance of collaboration and reflection, and of inquiry and exploration as a process of knowledge construction. Rather than using text-based, static content, that tends to be the norm in distance education of mathematics/science courses, teachers were provided with ample opportunities for interactive and collaborative learning through use of contemporary multimedia and internet technologies. The strategies employed included open-ended investigations, simulations, visualizations, collaboration and reflection on one's own and on others' ideas and experiences. Through use of these strategies, the project provided a learning environment that served as a model to the participating teachers.

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