Educational Products of Official Statistics Agencies: In Search of Vision, Standards, and Impact

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Official statistics agencies aim to expand the reach of their products to different user groups, and face various challenges when trying to align their dissemination plans with the needs, skills, and expectations of learners and educators from diverse backgrounds. This paper focuses on Internet-based educational resources published by official statistics agencies, and raises the need for a model describing key desirable features of such resources. The paper outlines possible building blocks of such a model and illustrates its application in the analysis of selected features of Web-based products from three statistics agencies. Suggestions are made for research and development steps in this area, and for future quality standards, which can increase the contribution and benefit of educational products both to statistics agencies and to their users.

Background: The Internet and Statistics Education

The Internet is increasingly used to provide access to educational resources in diverse areas. Possibilities for using Web resources in statistics instruction at all educational levels are broad and increasingly broadening. Garfield, Hogg, Schau, and Whittinghill (2002) reported survey results showing that many college teachers use the Web to enable students access to data sets, diverse types of applets, and discussion groups. Students can become familiar with the collection of official statistics as part of the Census at School project (http://www.censusatschool.org/) promoted in a number of countries, and can access many types of official statistical data for use in classroom projects. Several Internet-based simulations were developed to illustrate statistical principles and processes such as sampling. These and other important Web-based resources, such as specialized guides and project ideas for teachers and students, are discussed in various sources (e.g., Mulekar, 2000; Phillips, 2003).

The rapid maturation of Internet-based resources for statistics education is also manifested in scholarly research. Review articles (e.g., Mills, 2002, on simulation programs) suggest that a sufficient number of materials has already accumulated to enable an overview in certain subareas. Attention is also being given to the need to develop evaluative criteria (Belli, 2003) and assessment tools (Garfield, delMas & Chance, 2003). Utts, Sommer, Acredolo, Maher, and Matthews (2003) quite recently examined the impact of a hybrid course using both class-based and Internet-based modes of instruction, which was developed in light of the need to rethink and adapt learning processes to diverse students and to increasing enrollment numbers.

Internet-based resources for statistics education are being developed by diverse actors, such as educators in schools or colleges, research groups, professional associations, or governmental bodies interested in education. This paper focuses on educational products created by *official statistics agencies* (or 'national statistics offices') and on the need to delineate their characteristics and establish clear quality standards for them.

Official Statistics Agencies and their Educational Products

Official statistics agencies are responsible for conducting a variety of data-gathering, analysis, and dissemination activities on a national or international basis, primarily to provide information to policy-makers and public officials. However, they increasingly attend to other user groups, such as businesses and employers, administrators, researchers and citizens at large (Murray & Gal, 2002). In order to serve the information needs of such diverse users, agencies produce many services and products, such as statistical indicators, executive summaries, press releases, reports, aggregate tables, or data files. Yet, over the last two decades, numerous statistics agencies have also invested in *dedicated* products for educational purposes that are mainly accessible through the Internet.

General products of statistics agencies, although not designed with educational uses in mind, can be used by educators and students. Possible applications have been described, for instance, by Gelman, Nolan, Men, Warmerdam, and Bautista (1998) who explored the use of press releases, and by Gal (2003a, 2003b) regarding press releases and executive summaries or research briefs. Yet, general products of statistics agencies can be used for statistics education, only *if* a teacher (a) can locate those relevant to his or her needs from among the many hundreds of items that exist on each agencies' Websites, *and* (b) has a clear conception for *how*, when, and for what purposes to incorporate such general materials (most of which are created for trained users who are familiar both with statistics and with the subject matter) into classroom activities, taking into account his or her students' needs and characteristics. However, locating and adapting such general materials to local circumstances are complex processes (Gal, 2003b).

Given the above concerns about the suitability of general products of statistics agencies for educational purposes, the present study focuses on the educational potential of dedicated educational products which statistics agencies publish specifically for teachers or students. Dedicated educational products may take diverse forms. They could include lesson plans describing general issues in learning statistics and explaining how they can be taught by using data related to the special thematic areas of the agency. They could suggest ways for using any of the agency's general products for statistics education, such as how to use existing data tables as part of students' projects. They may also include specialized datasets with accompanying documentation created expressly for educators. These examples do not cover all possible types of dedicated educational products, but suggest that many types or variants are possible.

In our view, the interest in the characteristics of such products and in improving their range and quality should be shared both by statistics agencies as well as by educational communities. From the point of view of statistics agencies, educational products can be a significant component in their dissemination plans, and can serve various functions such as building users' skills, improving the public's trust and loyalty, and more (Ho, 2005; von Oppeln-Bronikowski, 2006). From the point of view of educators working in schools, colleges, and adult education contexts, educational products of statistics agencies are important for several reasons: (1) Statistics agencies operate outside formal educational systems and hence bring extra independent resources and additional public funding into the educational arena. (2) Statistics agencies offer users Web-based access to products based on up-to-date data collected through credible methodologies. (3) The data and reports from statistics agencies cover a very wide range of topics that reach far beyond what students themselves can collect through classroom based efforts. (4) The data and reports address topics of social and civic relevance.

Taken together, these arguments imply that educational products of statistics agencies can engage diverse types of learners with meaningful statistics on a broad range of current issues and this has

motivational benefits. Thus, such products can be of interest for teachers and students engaged in learning statistics. It follows that statistics agencies and educators should *work together* to find ways to improve the range and quality of educational products offered by official statistics agencies, as this can be valuable for all parties involved and eventually benefit society. However, for such collaboration to happen, there should be a mutually shared set of ideas, or a model, regarding the desired characteristics of educational products of statistics agencies, to which all parties could refer when developing or evaluating educational resources. So far, a comprehensive model has not been proposed in this regard. As a first step towards that end, this paper outlines possible building blocks of a model describing key desirable features of Web-based educational resources from statistics agencies, and illustrates the model's applicability through the analysis of selected features of products posted by three statistics agencies.

A Proposed Model of Desired Characteristics of Educational Products from Statistics Agencies

Based on literature regarding the uses of educational technology and Web-based education or e-learning (e.g., Liu & Johnson, 2004), and on our own work, we developed a working model which can serve as a conceptual tool for analyzing key features of educational products posted by official statistics agencies to support the learning or teaching of statistics. The proposed model has at this preliminary stage of development three main dimensions, *Content*, *Pedagogy*, and *Technology*, which are outlined below:

Content. This dimension relates to the statistical topics and contextual themes and terminology of the educational products. It examines specifically the following three aspects:

- *Thematic coverage*: what is the statistical content, and in what contextual themes within which the statistics is covered (e.g., science, demography, etc.).
- *Purpose*: what is the declared purpose of the materials, using as a first approximation the categories of statistical literacy (e.g., familiarity with basic statistical terms, ability to think critically about data and about common statistical arguments), statistical reasoning (e.g., more fundamental understanding about statistical procedures such as calculations, graphing), or statistical thinking (ability to solve more complex problems in statistics).
- *Information and data*: What are the sources or types of data to which the materials relate, such as materials based on census, survey samples, experiments, public information repositories (e.g., cumulative information regarding people served by different agencies or organizations), and so forth.

Pedagogy. This dimension relates to the pedagogical and educational tools and considerations of specific products, including:

- *Educational resources*: from plain raw materials which may serve as building blocks for lesson plans, to complete learning units, project suggestions and curricular solutions.
- *Instructional modalities*: expert/teacher-based (such as lecture, ask-an-expert, tutor-support) or student-based (peer interaction or reviewing, structured group activity, project-based instruction, as well as effective use of both the dynamic and visual (or even auditory) possibilities that a modern Website offers, such as the use of interactive displays and simulations, or posting of adaptive quizzes).
- *Educational tools:* tools that support cognitive functions, for example, tools for the creation of materials that support teachers' or students' creativity and initiative, allowing them to generate and publish their own units or artifacts.
- *Target population*: whether the products are designed for students/learners at different age or educational levels, teachers, or both.

Technology. This dimension relates to features of the Website which affect accessibility and the degree of ease with which users can find and use relevant products:

- *Positioning*: apparent complexity of locating educational products or of using the Website.
- *Navigation tools*: navigational interface features such as menus, hyperlinked access to different parts.

- *Terminology*: the clarity and meaning of the language used to name Website parts or to label products.
- *Search options*: facilities for finding products or information on specific statistics topics.
- *Communication*: such as e-mail, help, and electronic forums.

Method

Given that little is known about educational products of official statistics agencies, we conducted an exploratory study to examine the applicability of the proposed model described above. We focused on three statistics agencies in the USA which offered dedicated educational products on their Websites. Such a multiple-case-study approach was deemed helpful to chart changes in the offerings by the selected agencies, and is overall an accepted way to aid the formulation of research directions in an uncharted area.

Sites. In the United States, there are ten federally-funded Principal Statistics Agencies (Federal Register, 2002): 1. Census Bureau, 2. National Agricultural Statistical Service. 3. National Center for Health Statistics, 4. Economic Research Service, 5. Energy Information Administration, 6. Bureau of Economic analysis, 7. Bureau of Transportation Statistics, 8. Bureau of Justice Statistics, 9. Bureau of Labor Statistics, 10. National Center for Education Statistics. Each agency is autonomous and it collects, compiles, and reports data and findings within its designated area. Yet all agencies, together with several other statistical units and organizations, are members of the Interagency Council on Statistical Policy, and all can be accessed via the FedStats portal (www.fedstats.gov/agencies). The present study focuses on these agencies because they operate within a single national and cultural context and relate to the same general educational arena, hence their educational products can be more easily compared.

Procedure and instrument. Internet sites of all ten agencies were accessed *twice*, in March 2004 and again in March 2007. In March 2004, we found that only three of the ten federal agencies (U.S. Census Bureau, National Agricultural Statistical Service, and National Center for Health Statistics) carried dedicated educational products focused on learning statistics. The remaining seven agencies did not post such educational resources, although some did carry other products geared for educators or students but unrelated to statistics learning, such as quizzes or lesson plans in the thematic areas with which the agency or its parent department (i.e., ministry) are involved. A re-analysis of the same three Websites in March 2007 showed that they carried the same products, i.e., none of the agencies introduced any changes in the course of the three intervening years. Thus, the results below describe the situation found both in 2004 and in 2007.

The three Websites analyzed were examined from the point of view of a teacher who is looking for materials that can support statistics learning by students from elementary school to college levels. A semi-structured protocol was developed with a focus on two of three areas in the proposed model, content and technology. Regarding *Content*, we examined the presence and features of three types of products, *lesson plans*, *project suggestions*, and *data sets*, and whether these are designed for students, teachers, or both. We also examined several aspects of *Technology* listed in the model: *Positioning and Navigation* (apparent complexity of locating educational products or of using the Website), *Terminology* (the clarity and meaning of the language used to name parts of the Website, or to label products), and *Search options* (facilities for finding products or information on specific statistics topics). Given the number of facets in the model on the one hand, and the exploratory nature of our work on the other, it was not deemed necessary to apply all facets of the model, but to first test its applicability by focusing on a subset of elements in the model.

Results

The Websites of the three agencies chosen for analysis differed substantially in the range and number of materials dedicated to statistics education, as well as in how they are accessed. Table 1 presents observations regarding one aspect of Technology, the location of resources aimed at teachers, as well as observations regarding the content and format of lesson plans. These aspects do not cover of course all topics subsumed under Content and Technology, yet help to sketch the nature of dedicated educational products created by official statistics agencies and can point to areas of interest for future research and development.

Table 1: Descriptions of selected aspects of Technology and Content for three Websites.

Agency	*Technology*: Location and organization of teacher materials	*Content*: Lesson plans
U.S. Census Bureau [1]	Available via homepage, under "For teachers". About 5-6 lesson plans and activity suggestions for teachers in each of three grade groupings: K-4, 5-8, 9-12, as well as for English as Second Language and Adult learners, and for teachers in certain US territories such as American Samoa and Puerto Rico.	Lesson plans focused on "Census at School" theme. Designed to help students understand how the census operates and its uses and contributions. Some lesson plans touch on sampling and data collection topics, using maps for planning sampling, and more. Lesson plans have uniform format.
National Agricultural Statistical Service [2]	Available under "NASS Kids" on agency homepage. *Note*: the NASS Kids section also provides brief explanations geared for young students about the activities of statisticians and about some graphs and charts.	Most lessons plans deal with agriculture and span grade levels K-12 - no obvious connection to statistics. Links point to few outside resources: two lessons related directly to statistics (on Chi-square and descriptive statistics), not created by NASS itself and not focused on agriculture-related issues or using NASS-specific data. Another link points to an online statistics book, HyperStat.
National Center for Health Statistics [3]	No link visible directly on homepage. However, under "Publications and Information products" one can find "Training materials" which describe a course, based on a video tape and workbook, designed for college students learning about health statistics, and for field personnel in health departments or community agencies. *The course itself is not online*. A separate path, via Site Index, leads to the label "Education", which links to a self-study online course on Finding and Using Health Statistics offered by the National Library of Medicine.	No lesson plans are offered on the NCHS Website, only links to an elaborate online course (see left). *Note*: The National Center for Health Statistics is part of the CDC (Centers for Disease Control). CDC also operates a separate Website called EXCITE which carries a collection of teaching materials designed to introduce students to public health and epidemiology, including some aspects of bio-statistics. However, EXCITE is not mentioned on the NCHS Website and is not listed in its A-to-Z index.

[1] http://www.census.gov

[2] http://www.nass.usda.gov

[3] http://www.cdc.gov/nchs

In addition to the above aspects of the three Websites, many other issues related to accessibility and content could be observed. Some examples follow:

- Search engines are usually generic for the whole agency and not specific to the educational section (if such existed), hence it is difficult to identify educational products via search engines.
- None of the Websites makes an explicit distinction between "activities", "projects", and "lesson plans", nor do they distinguish between materials aimed at teachers and at students.
- None of the Websites offer any datasets (e.g., in plain ASCII or as a spreadsheet in Excel format) that teachers or students can download and analyze as part of learning statistics.
- No suggestions could be found as to where on the Website teachers or students can find general datasets, tables, graphs (i.e., which are part of the general products of the agency) that can be used to support learning of statistics.

Discussion and Conclusions

Official statistics agencies can play a unique role in helping to improve the statistical literacy and statistical knowledge of a range of users, including not only school pupils and college students, but also adult learners who are outside the reach of formal educational systems. This unique role stems in part from agencies' ability to support learners in examining and interpreting statistical data in meaningful contexts related to the diverse thematic areas in which agencies operate (Barbieri & Giacché, 2006). Internet-based educational products of statistics agencies carry additional promise for educators looking to use technology in statistics education, as well as for educators who lack access to print-based resources (Helenius, 2006).

Our preliminary findings suggest, however, that at this point the potential of statistics agencies to enhance learning of statistics is only partially fulfilled. Two of the three agencies analyzed seem to give some saliency to educational materials, as they were available directly from these agencies' homepage. Nonetheless, materials vary widely in content, and accessibility seems to be problematic in many cases. Materials are sometimes organized according to criteria (e.g., grade, level), but not overviewed and annotated in a way that can help teachers or students selecting the materials most suitable to their teaching or learning needs (e.g., in terms of the type of statistics used, whether or not a lesson plan involves actual data analysis, etc). Hence, finding specific classroom activities necessitates some trial and error, for those seeking materials on Websites of Federal agencies in the USA.

In addition, educational materials offered by the statistics agencies analyzed seem to make surprisingly little use of the generic products found on the same Website such as press releases and executive summaries, even though these generic products could be used for various educational applications (Gal, 2002). Existing generic products of statistics agencies, such as press releases or executive summaries, can become a useful resource if a mid-layer of supporting materials is created to enable educators to map their needs onto what statistics agencies already offer in their generic products. Likewise, the vast and diverse collections of tables, graphs, charts and datasets that each agency carries are not being put to use or linked and explained, and it is not inconceivable that teachers or students will not even know they exist.

While the Websites surveyed appear to have room for improvement in regard to their educational products, a forward-looking and balanced view has to be adopted. The primary focus of official statistics agencies is not on education. Thus, materials that can promote statistics education are not supposed to receive much attention from such agencies, and their current scarcity, organization, or content cannot be viewed as a weakness of an agency. Rather, the current observations are better viewed as representative of a stage in an evolutionary process that is affected by multiple factors, both internal to agencies, and external in the civic environments within which statistics agencies operate.

Despite any shortcoming of current dedicated educational products geared for statistics education, we must also look at the filled half of the cup, not just on what is missing. Our findings suggest that the basic infrastructure for creating a rich and productive network of products that can support statistics education is already in place in most agencies. Lesson plans, datasets, and activity suggestions for diverse student

populations do exist, and in the future can be expanded, linked and annotated in ways that will make them useful and accessible to diverse educators and students. Further, some statistics agencies outside the USA, in particular Statistics Canada (Townsend, 2006) but also in some other countries (e.g., Finland, New Zealand, Australia) offer larger collections of materials geared to the needs of different educational users. It is interesting to note that these other agencies (outside the USA) are not necessarily larger than those agencies operating as part of the federal statistical system in the USA which was analyzed in this study.

As an exploratory research that used a semi-impressionistic approach, our conclusions are obviously limited. Nonetheless, we believe that they have implications for future activities of statistics agencies. A differentiation of educational products is called for in light of the characteristics of potential educational user groups (e.g., elementary school children, high school pupils, college students, adult learners; teachers with varying levels of professional experience in teaching statistics or familiarity with statistics). Developers of Web-based resources face significant challenges regarding content and accessibility, or interface design, given the heterogeneity of needs, backgrounds, and skill levels of such user groups. It is also possible to envision stronger collaborations between different statistics agencies in order to pool resources and enable expansion of educational offerings by linking of products available on different agencies. After all, educational users often "shop around" on the Internet, ignoring national borders.

This paper has attempted to describe and show the relevance of a model that can be used to characterize educational products of official statistics agencies, organized around the three themes of Content, Pedagogy and Technology. In the present study, selected facets of the model were applied in the analysis of three statistics agencies which at this point in time offer a limited set of educational resources. Further development of the model can be conducted by attempting to apply more of its facets to educational products of other agencies, including some which have a larger or more mature collection of field-tested materials for educators and learners. We envision a recursive process that can serve dual roles, both helping to expand the model as well as testing and validating its relevance to a wide range of statistics agencies.

In further developing the desired model, we believe it should satisfy at least three main demands:

- *Mapping power*: The model should include and integrate a large variety of properties in the different dimensions (content, pedagogy, technology) of educational products. It should allow capturing the rich complexity, as well as the limitations and drawbacks, of these novel educational products.
- *Generalizability and adaptability*: The model should be comprehensive enough to cover many possible configurations of variables in different dimensions for the continuously growing population of educational products in official statistics agencies Websites. But at the same time it should be flexible enough to undergo changes and additions, as new technological or pedagogical features and Website models appear.
- *Clear definitions*: To support analytic processes, and ensure portability of the data collected with the tool, it should offer a sound structure, precise terminology, and definite scaling and classing schemes.

We believe that further investment in developing the model outlined in this paper is a worthwhile undertaking, given its potential to contribute both to statistics agencies, educational stakeholders, researchers, and learners. Such a model, when sufficiently developed, can provide a common language, inform design specifications, and influence quality criteria and thus be of interest to all those involved in planning, creating, using, or evaluating Web-based statistics education resources. We see the proposed model as an evolving instrument rather than a fixed set of specifications, and would welcome reactions and suggestions that may contribute to its improvement.

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