BUILDING STATISTICAL LITERACY ASSESSMENT TOOLS WITH THE IASE/ISLP

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Statistical literacy assessment tools developed in one part of the world or for a particular constituency may not be the best tools for others. The wording, the level, the context, the objects mentioned may be foreign and thus render the assessment tool useless. This is a predicament that the countries involved in the CensusAtSchool and other international projects know very well. Statistical literacy instruments must be customized and therefore the tools to assess statistical literacy must be customized too. The International Statistical Literacy Project of the IASE contains a variety of learning and assessment tools developed by many different international sources for a variety of groups. In this paper and related documents, we illustrate with examples how to take advantage of the numerous resources in the ISLP web page to build tools to assess statistical literacy suitable for different models and constituencies in the statistics spectrum.

INTRODUCTION

Definitions and conceptions of Statistical Literacy vary as much as data. Consequently, tools to assess statistical literacy vary too. The ISLP contains a page dedicated to compiling definitions of statistical literacy. The impression one gets from there is that there is no wide consensus. However, looking more closely one can gather two different models: sequential and longitudinal (See Figure 1), each model appears throughout the literature in different disguises. An example of the sequential model is the ARTIST web site, one of the links in the "*assessment page*" of the ISLP, and perhaps one of the projects that has gone farther at trying to coin a "definition." ARTIST distinguishes among statistical literacy, statistical reasoning and statistical thinking but sees these as sequential and happening one after another. Much of the curriculum development efforts in the United States follow this sequential model (Guidelines for Assessment and Instruction in Statistics Education (GAISE)).
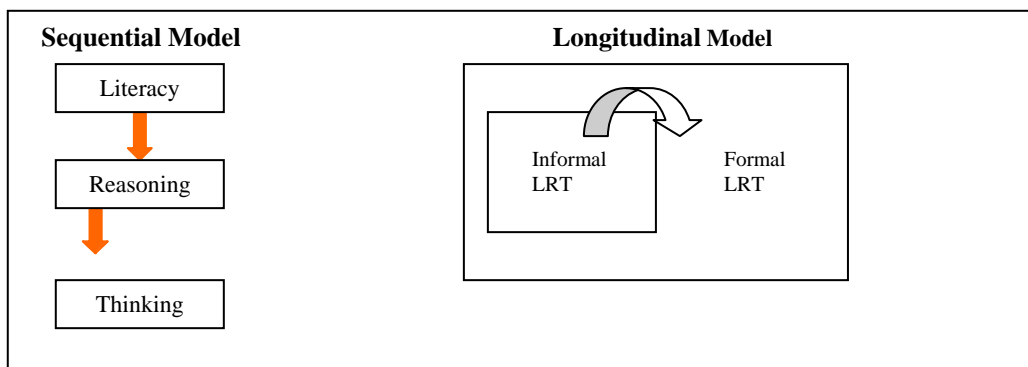

Figure 1. General models of Statistical Literacy

On the other hand, the Longitudinal model views statistical literacy as the understanding of the whole statistical process, with the three elements of the sequential model (literacy, reasoning and thinking –LRT) being simultaneously "statistical literacy widely understood." At an informal level, this wide notion involves an understanding of the whole statistical process (data collection, description, summary, inference) without the formal apparatus of the tests and confidence intervals, the sampling distributions and such. At a formal level it involves them. Examples of the longitudinal approach are hinted by Wild (2006), Watson (2006), Gould (2004), National Council of Teachers of Mathematics and others, all featured in the ISLP web site on *assessment*. "As new courses and curricula are developed, a greater role for informal types of statistical inference is anticipated, introduced early, revisited often, and developed through use of instructional activities, simulation and technological tools. However, studies on the nature of this

informal, inferential reasoning provide results that have implications for teaching and learning formal methods of statistical inference." (SRTL-5 statement, 2007)

Both models, the sequential and the longitudinal are synchronized in practice with schooling and curriculum development efforts in a society where an awareness of the importance of statistics in the curriculum has been or is being established and where materials and efforts are created to enhance this new curriculum. They are closely tied up to pedagogy established only in the past decade and only in some countries. But in a de-schooled society, that is, one of individuals outside the school system (dropouts, adults, a society where curriculum reform has not taken place yet), tools built to asses with those models in mind, may not be appropriate. Gal (2002), featured in the *assessment page* of the ISLP, explains that we should not expect the same success of our teaching and assessment tools with all citizens. Since the extent of our success depends on things beyond our control, such as the knowledge base, beliefs and difficulty of the statistics information, we should be prepared to have different expectations, teaching and assessment tools for different situations. Persons that can not read will have to be taught and assessed differently than someone who can read and has many years of schooling or someone who is training in statistics, like the students taking our statistics classes. Gal's approach is relevant at the schooling stage and in the de-schooled society: we can believe in the same models of statistical literacy, but we must create different instruments tailored to the different constituencies.

BUILDING ASSESSMENT TOOLS WITH RESOURCES COMPILED BY THE ISLP

The ISLP web site contains resources gathered from all over the world that allow construction of assessment tools to fit both models described above and hybrid models not described, for the literacy needs of the schooled and the de-schooled society. I have no space in this paper to provide a large amount of examples, so I will only provide one. Several documents with different questions to assess literacy under both models for different needs can be found at the ISLP web site and in Sanchez (2007).

The ARTIST web site defines very specifically statistical literacy as "understanding and using the basic language and tools of statistics: knowing what statistical terms mean, understanding the use of statistical symbols, and recognizing and being able to interpret representations of data." Basic keywords that define assessment items in basic statistical literacy, according to the ARTIST web site, are: *identify, describe, translate, interpret, read, compute.*" Reasoning involves what we usually consider statistical inference, and thinking involves being able to do the whole process. An item designed to measure statistical literacy (in particular, the concept of variation) found in the ARTIST web site is the following:

> AI.1 *A random sample of 30 first year students was selected at a public university to estimate the average score on a mathematics placement test that the state mandates for all freshmen. The average score for the sample was found to be 81.7 with a sample standard deviation of 11.45. Explain to someone who has not studied statistics what the standard deviation tells you about the variability of placement scores for this sample.*

This assessment question would not be very helpful to assess the understanding of variability in a person who has not gone through an education that has taught the word standard deviation. If would not assess either the informal level of the longitudinal model. Compare this question with the following one assessing the same concept but not requiring such training and encompassing data awareness and informal inference (from Project ALEA, a link found in the ISLP's page "*Training Programs and Learning Materials*" under Portugal-translated by the author).

> A1.2.*The following graph in Figure 2 indicates the distribution of doctors per district in Portugal in 2002 and 2006. For example, in the district of Bragança, there is one doctor per 593 persons in 2006. (a) A newspaper reported that Beja is the worst district in 2006, because it has the smallest number of doctors per person. Would you agree? (b) Comment on the quote "Doctors in Portugal are very poorly distributed across districts, but the asymmetry is decreasing."*
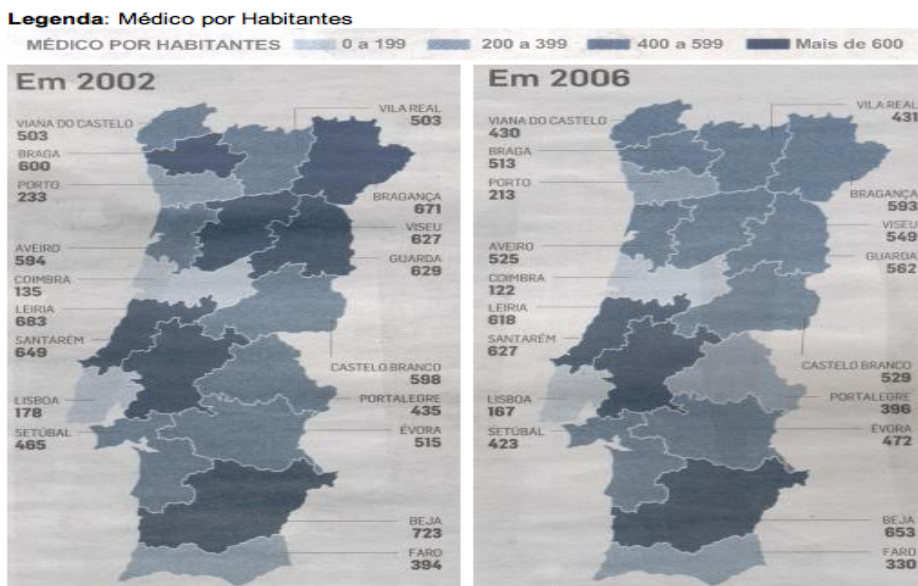
Figure 2. ALEA, challenge question number 19: doctor per number of persons

But this question would not help much to assess whether someone who has not learned ratios and cannot read understands the notion of variation. The following question would address assessment of those people. It is taken from *Statistics Canada, Power from Data*, which is featured in the ISLP Statistical offices web page under Canada.

> A1.*3 Suggest reasons why data would be collected on the following topics (and what that data mean):*
>   *a)*   *Burglaries*
>   *b)*   *Causes of death*
>   *c)*   *Climate*
>   *d)*   *Forests*
>   *e)*   *Immigration*
>   *f)*   *Schools*

Those topics would be irrelevant to a child. So an alternative way of assessing understanding of variation might be this example inspired by an activity in the UK CensusAtSchool project, described in the "*Resources to start a Census for Children*" page of the ISLP.
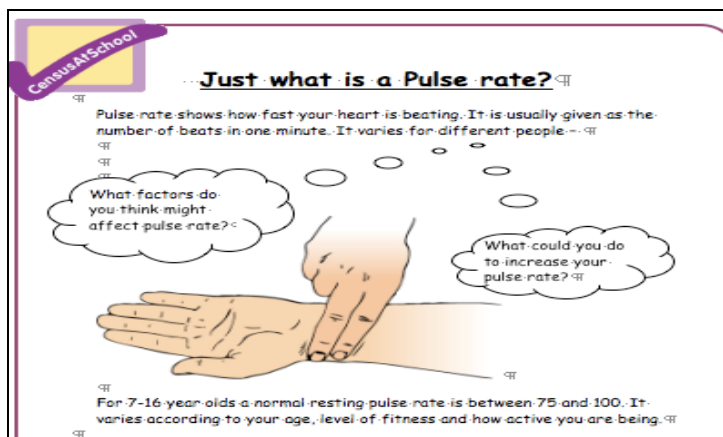

Figure 3.- UK CensusAtSchool: pulse rate activity.

> A1.2. *Figure 3 above shows how to measure your pulse rate. Measure your pulse rate and that of friends at different times of the day. Summarize what you find any*

way you want, and explain what you find and what may have caused it. Use what you find to predict what will be the pulse rate of a friend that you did not measure.

This last question allows us to find out how the person reasons about variability and about the whole process of data collection, questioning the data, and drawing some inferences from the data at a very informal way. It allows, at the same time, evaluation of the person's reasoning process, something that might help research in statistics education and programs to make citizens statistically literate.

THE ISLP PAGES

During the tenure of Carol Blumberg as Coordinator of the ISLP (2002-2006), a set of pages were created with a structure that reflects the different needs of different constituencies in the Statistical Literacy spectrum. The motivation is the belief that statistics plays a very important role in the analysis and synthesis of information by different elements of society and the more shared the available statistical resources in the world are, the faster the world will become statistically literate. The way society evolves depends to a large extent on how well that analysis and synthesis is done by those elements and how much sharing of what is known is done. Here is some of the pages found in the *list of pages* of the ISLP.

(a) *Assessment of Statistical Literacy*
(b) *General Resources of Statistical Literacy*
(c) *Newspaper and Internet Articles and Reports Useful for the Classroom*
(d) *Resources for Teachers to use in the Classroom or to Improve their knowledge of statistics/Resources for those training the teachers.*
(e) *Resources for Journalists and other Members of the Mass Media*
(f) *Resources for Adult Learners and Adult Educators*
(g) *Resources for Planning and Conducting a Children Census*

All of the ISLP pages except the home page are Wiki based (like Wikipedia). Once you register for free you can edit and enter any resources you may want to include in the language of your choice. The pages are continuously evolving and new pages are added as needed.

In its current phase, the ISLP is compiling available resources following that structure described above, but is also taking a more pro-active approach to guiding visitors on how to make the best use of the resources we compile depending on their needs by building documents (brochures) for them that recommend resources in all pages (Sanchez, 2007). We are doing this, because we must recognize that there is a little bit of each in each person. For example, the child needs to learn to report, and to read news, and to teach, so the resources are interconnected. For example, it is known that statistical literacy starts in the family. Similarly, family members-as children's first teachers-are crucial to children's success in life and need to help the child evolve in those. The more adults become engaged in their children's education, the greater the chances that children will succeed. The resources at ISLP for families may help parents work with their kids at home while having fun. There is currently available a brochure for parents which has been put together with resources that were already in the ISLP (Sanchez, 2007). Of course, a selection was made, and it is imperfect, but selecting and making attractive and easy to use the material are three qualities that need to be there for success in bringing statistical literacy to the home. Thus, if we had to assess parents' success in conveying to children the main concepts, we might want to use instruments from those selected resources. In preparing a tool for the teachers to use in the classroom and to train teachers, other resources that have fully developed assessment tools might be used. For example, in the *pages for teachers to use in the classroom and to train teachers,* the link *Illuminations* (Lessons -> Data Analysis and Probability. Choose your grade.) would be recommended. Another resource might be Project Interactivate (Click on Statistics, a topic,and then teachers resources which have assessment questions). And the CensusAtSchool page might be invaluable to those teachers, among many other things.

The ISLP is also paying more attention to guiding the visitor to the adaptation of the resources to the different models of statistical literacy mentioned in the Introduction.

DISCUSSION

Statistical literacy assessment tools depend on what is the model we believe in. The tools also depend on the constituency to whom we apply the model. When assessing statistical literacy we do more than an assessment of the curriculum while students are at school. For parents, who require to know things about the education system, the economy of their life and phenomena about them, statistical literacy comprises how capable are these parents to present objective information to their children about educational opportunities, how prepared is the parent to help the kids understand statistical concepts, how do these parents read the news. Obviously, for the teacher who is preparing students to graduate from school, the requirements are different, and so are they for the journalist that needs to convey information or the adult who is trying to create a better niche in its profession. Therefore assessment tools for them should be different. Within that difference in tools in the different groups, we can rank citizens as more or less statistically literate depending on the model we believe. The pages of the ISLP are structured to recognize those different constituencies, and are moving towards recognizing the different models.

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