RELATIONSHIPS BETWEEN CURRICULUM KNOWLEDGE OF IN-SERVICE MEXICAN TEACHERS AND STATISTICS

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Mexican curriculum is a competency-based curriculum; it promotes the use of teaching situations relevant to the students' life. Such curriculum is more difficult to realize in mathematics education, since it is not easy to find situations that promote the kind of mathematical thinking that should be taught, but it is not the case for statistics education. It is however not clear how to promote the teaching content of statistics to best prepare secondary school teachers to highlight this point. We ask: How do mathematics pre-service teachers understand the connection between competencies and statistics? Thus a questionnaire to evaluate the pre-service teachers' knowledge about the relationships between statistics and competency-based curriculum is proposed. The teachers' knowledge of such relationships is analyzed through the responses to 7 questions from 12 in-service teachers. The results show evidences on what in-service teachers know and what they keep hidden with respect to those relationships.

INTRODUCTION

One of the most important challenges education has in our modern society is that the knowledge acquired in school be truly useful in the private and professional life of people. The increasingly more accelerated changes that society suffer and the slow pace of educational institutions have produced a gap between what is taught (and learnt) and what is needed to know in order to perform well in the varied fields in which people will develop. In an attempt to move forward in finding the solution to this problem, the concept of *competency* has been proposed and a competency-based curriculum has been promoted. Despite these actions, it is premature to believe that the concept of competency has been sufficiently discussed in society and that the different fields of knowledge have clarified what constitutes the teaching of its contents from this perspective.

Statistics can play a crucial role in a curriculum designed to develop competencies since its nature is linked with all the key competencies outlined by the OECD (Díaz, Arteaga & Batanero, 2011), however, in most of academic environments are not aware of this role of statistics; for instance, statistical competencies are not mentioned in the PISA (2009) assessment framework. And although within the statistics education community great advances have been made to establish the importance of statistics in relation with different areas of personal, social and professional activities of individuals, they have been scarcely linked with the discussion about the role of statistics in a competency-based curriculum; among the exceptions are the works by Watson (2006) and Díaz et al. (2011). In particular, it seems that there still are not studies on the curriculum knowledge of statistics teachers concerning the competency-based curriculum and the role they attribute to statistics in it.

In Mexico, a competency-based curriculum was adopted since 2009. Most of the teachers have attended courses and refresher workshops in which the ideas related to the competency approach are studied and discussed. While it is known that new curricular ideas take a long time to be understood, and even more to become practices, after 5 years of the institutionalization of the competency-based curriculum, the question arises: Do teachers discern that statistics contribute to a competency-based curriculum? Particularly, do they discern that relating mathematics with non-mathematical contexts of social relevance is a problem and that this is no problem for statistics?

In this work, we make an initial exploration to advance hypothesis on the knowledge teachers possess about the competency-based curriculum and how they relate it with mathematics and statistics.

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CONCEPTUAL FRAMEWORK

The main idea underlying in the concept of competency is to enable the mobilization of knowledge to carry out the tasks derived from the situations that are faced: “a competency is the ability to mobilize a set of cognitive resources and deal effectively with a family of situations” (Perrenoud, 2002). The encyclopedic knowledge with declarative content and without consequences to carrying out tasks is inert knowledge opposed to the concept of competency. On the other hand, in the PISA Project the mathematical competencies are defined as “the ability of a subject to identify and understand the role that mathematics play in the world, to construct well-founded reasoning and to use and get involved with mathematics so that the needs in the subject’s life as a constructive committed and reflexive citizen are satisfied” (INCE 2004, p. 12) [PISA].

In this statement the project PISA emphasize the aspects that distinguish the proposal of education by competencies from others, such as problem solving or constructivism, namely, the relationship with the world (applications) and the usefulness in the life of an individual. In particular, the condition that mathematics are “useful in the life of an individual” is still a controversial matter since it depends largely on what is understood by usefulness; but even under a broad concept, many of the classical mathematical contents would have to be substituted by “more useful” ones. This is why Goñi (2005) considers that the expression “knowledge useful in the life of an individual” must be replaced with the concept of “knowledge useful in socially relevant contexts or situations” in which mathematical knowledge is significant. It remains that the mathematics community clarify which those contexts are. Nevertheless - according to Góñi - it still needs the mathematical community clarifies which are those socially relevant contexts. Without going into detail, it is possible to see that such a problem does not exist for statistics because its nature is linked to socially relevant situations.

Gal (2004, p. 49) considers that the Statistics Literacy “pertains to what is expected of adults […] particularly those living in industrialized societies. It is proposed here that in this context, the term statistical literacy refers broadly to two interrelated components, primarily (a) people’s ability to interpret and critically evaluate statistical information, data-related arguments, or stochastic phenomena, which they encounter in diverse context, and when relevant, (b) their ability to discuss or communicate their reactions to such statistical information, such as their understanding of the meaning of the information, their opinions about the implications of this information, or their concerns regarding the acceptability of given conclusions”. Watson’s work (2006, p. 11) in the context of school issues considers that: “Statistical Literacy is the meeting point of the data and chance curriculum and the everyday world, where encounters involve unrehearsed contexts and spontaneous decision-making base on the ability to apply statistical tools, general contextual knowledge, and critical literacy skills”. In summary, statistics has such characteristics that naturally agree with a competency approach. The contrast between mathematics and statistics point out an important difference of their positions respect to competency approach, as Rossman (2006, p. 323) noted: “A primary difference between the two disciplines is that in statistics, context is crucial. Mathematics is an abstract field of study; it can exist independently of context […]. But in statistics, one cannot ignore the context when analyzing data”. It shows that while in mathematics education the competency-based curriculum does not match very well with the abstract nature of mathematics, in statistics education there is a good connection of it with the contextual nature of statistics.

METHODOLOGY

Participants

12 teachers participated in the study; 5 from middle school and 7 from high-school. The teaching experience of the middle-school teachers varies between 2 and 7 years, while the experience of the high-school teachers goes from 5 to 20 years. With the exception of 2 cases, both groups belong to public education systems (SEP and UNAM). Nine of them answered they were familiar with concepts of the competency-based curriculum thanks to courses or talks held at their schools.

Instrument

A questionnaire including 7 questions related to the competency concept was made; the first three refer to the concept of competency, questions 4 and 5 focus on the types of practices the teachers emphasize when implement competencies in the classroom, while questions 6 and 7 asked about the relationships between mathematical competencies and statistics.

1. What do you understand by competencies?
2. What do you understand by mathematical competencies?
3. What do you understand by statistical competencies?
4. Do you follow any special strategy to promote the mathematical competencies of your students?
5. Do you follow any special strategy to promote student statistical competencies?
6. Which role do you think statistics play in a curriculum that promotes competencies development?
7. Do statistics help developing mathematical competencies? Explain.

Procedure

The questionnaire was sent electronically to statistics teachers known by the authors, who have worked for several years in refresher courses for teachers. The teachers were asked to answer according to their current knowledge or to give their opinion on what they thought was a convenient answer without looking up concepts they did not know.

Procedure of Analysis

The answers were compared with each other and similarities and differences between them were collected emphasizing characteristics which were near or far from those of the definitions of competencies. In particular, it was intended to know the extent to which teachers understand the role of statistics in competency development as well as the advantage statistics represent with respect to mathematics in that curricular context.

RESULTS

The teachers' understanding of the concept of competency is associated fundamentally to *abilities in problem solving* (Table 1). However, there are some who, within that concept, include ideas that bring them closer to the most popular definition of competency; for example, professor 1 answered: "Knowledge, abilities and attitudes that allow problem solving and decision making.". Four responses mention 'knowledge and abilities' and not only 'abilities'; in 4 cases values and attitudes are considered, and in 2, job performance is mentioned. There is a variety of terms that add a slight emphasis or represent a small variation of these ideas, including 'decision making', 'know-how', 'strategies', 'tool', 'skills', and 'habits'. In their characterizations the idea of that a competency-based curriculum intends that knowledge acquired in school helps students learning to performance in real life is not underlined.

With respect to the mathematical competences, in general, the concept underlying in what the majority of the teachers expresses is that these are competencies, as defined above, whose problems have a mathematical content; if those competencies were abilities to solve problems, then the mathematical competencies are abilities to solve mathematical problems; for example, teacher 4 wrote: "It is solving problems concerning that subject. It is having resources like procedural or algorithmic abilities, knowing the theoretical foundation of the subject…". Again, there are some who provide significant clarifications; 2 teachers refer to problems in (non-mathematical) context, while other 2 refer to applying mathematics in their environment or common life. Nevertheless, none of them refer to the difficulties that taking this idea into practice represents for most of mathematical contents.

Regarding statistical competencies, the situation is not different since in their answers the concept that they are competencies whose problems have a statistical content is filtered, however, 7 of them add that the problems are placed in varied (non-mathematical) contexts. For example, teacher 9 says: "it is the same, it's just applied to the subject statistics; this subject becomes more and more important because many of the things around us are related to statistics." In some cases,

instead of referring to problem solving, they talk about statistical activities such as “abilities to collect and organize data” (3 cases) or “decision making” (2 cases).

In the organization of Table 1, for responses to question 1, value 1 was assigned if the response is a variation of abilities in problem solving; 2 if it adds that problems should be in different contexts; and 3 if it is specified that competencies are useful in daily life or work life. For responses to question 2, 1 was assigned if the answer says they are competencies with mathematical content; 2 if they also refer to problems in context; and 3 if they refer to daily life or work life. For question 3, value 1 was assigned when the responses say they are competencies with statistical content; 2 when they emphasize in non-mathematical contexts; and 3 when they refer to daily life or work life.

Table 1. Scores assigned to responses to questions 1, 2, 3

Teacher	Question 1	Question 2	Question 3	Teacher	Question 1	Question 2	Question 3
1	1	1	1	7	1	1	2
2	2	1	NR	8	1	NR	1
3	1	3	2	9	3	1	2
4	1	1	2	10	1	1	1
5	1	2	2	11	1	1	1
6	1	1	2	12	3	3	2

When asked about the way in which they implement mathematical competencies in their class, 2 teachers did not answer and 4 referred to statistical competencies and not to mathematical ones, probably because some of them do not teach mathematics and some others understood the questionnaire focused on statistics. In the rest of the answers, 4 refer to problem solving and three of them add it is in context. In one case, the teacher’s strategy is to interpret results provided by computers and in other one the teacher makes sure to introduce the mathematical concepts related to historical and scientific contexts.

The ideas they expressed about the way to implement statistical competencies in class refer to contents or statistical abilities (two cases among them refer to public information, relevant contexts for students and a critical attitude development when facing data) and to problem solving in context. One case stresses the use of technology, another one frames the statistics class in relation with the scientific method; finally, another teacher refers to linking the different probability approaches. Three participants did not answer. In sum, only in two cases can it be said that the treatment they give to statistics in class has a bias towards competency development.

In the question: *Which role do you think statistics play in a curriculum that promotes competency development?* All the answers refer to the relevance of statistics in general. However, in 6 cases real problems of daily life or social environment are mentioned and in 4 statistics are considered to contribute to analysis and interpretation of data, but it is not specified why those statistical activities help developing a competency-based curriculum. In general, justifications point to explaining the relevance of statistics instead of their relevance in the development of a competency-based curriculum; as if the very fact of being relevant as a subject would imply that contribution.

Those teachers who answered the question: *Do statistics help developing mathematical competencies? Explain* claim that statistics do contribute, but in 6 cases the arguments emphasize that statistics require the same abilities (or competencies) as mathematics: problem solving, logical reasoning, argumentation, communication, and symbolization or representation. In 4 answers teachers mention that statistics help handling and analyzing data and that these are mathematical abilities; also in 4 answers they refer to one of the following concepts: daily life, social environment and job environment.

DISUSSION AND CONCLUSIONS

We will organize the discussion around two interrelated aspects, the first refers to the concept of competencies that the teachers have, and the second, to the perception they possess about statistics.

The Association of Competencies with Problem Solving

The teachers tend to assimilate new curricular guidelines to concepts and ideas elaborated in previous or past curricular proposals and to neglect or minimize the news ideas that would represent a truly transformation. In this respect, the idea that makes more sense to them concerning the definition of competency is that of *the ability in problem solving*, which does not deal with the major problem that originates competencies. On the other hand, in relation with mathematics, the tendency to leave aside the problem of knowledge working in (non-mathematical) contexts may have its origins in the impossibility of the teacher to conceive scenarios on which to create such link, especially when the mathematics curriculum is organized in content units and not in terms of the situations in which certain mathematical knowledge works. There is then an assimilation of new ideas into old practices and not a reorganization of the teacher's activities to provide an answer to the needs the new curriculum seeks to solve.

Teachers' Assumption that Statistics is Part of Mathematics

As the idea that mathematical knowledge should be mobilized or work for solves problems of social and professional life of the individual is neglected, it would be surprising that statistics were considered to have a privileged position in a curriculum based on competency-based curriculum. But, a probably deeper cause for this inhibition may be that the teachers regard statistics as part of mathematics without considering the particularities which make them different from one another. The mere idea that in statistics, unlike mathematics, numbers are numbers in context may start the reflection on their differentiated position with respect to the competency-based curriculum. The no differentiation between mathematical problem and statistical problem also contributes to that inhibition. Certainly, both types of problems are the same for teachers, it is only that in statistics its content is statistical; it is worth pointing out it refers to graphs, measures, measures of variation, or probability. However, they consider that solutions are reached with the same means, through reflection and the use and transformation of representations.

A consequence of researching in statistical education is strengthening the tendency to develop statistical literacy as one of the three spheres in which statistical education is organized, showing how mathematical concepts are mobilized to clarify socially relevant situations thanks to statistical resources. As for the teacher training field, to provide resources so that the teachers transform the way they teach statistics, abandoning the mathematical style and following a teaching methodology according to its nature, like organizing teaching around research projects (Batanero & Díaz, 2011, MacGillivray & Pereira-Mendoza, 2011).

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