A SUGGESTED THEORETICAL BASIS FOR TEACHER LEARNING IN STATISTICS

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The suggested theoretical basis for teacher learning in statistics has many dimensions. Some of the most important of them are paradigm shifts in science, mathematics, education, mathematics education and curricula. All these paradigm shifts have been described and their implications on teacher learning in statistics have been identified. Some of these implications are: Rejecting linear statistical models, applying statistics in real life situations and employing advanced technology both in teaching and learning. The suggested strategy for learning is "professionalization" which is basically means that teacher education should be conducted in an atmosphere comparable to what ought to be at school in its ideal form and analyzing reality of schools with the intension to develop it. The paper was concluded with exploring the futuristic nature of its findings.

SOURCES

The major sources of the suggested theoretical basis for teacher learning in statistics are paradigm shifts in science, education and curricula. Keeping in mind that statistics has been widely taught as a part – or branch – of mathematics, paradigm shifts in mathematics and mathematics education should be considered in the present context.

Paradigm shifts in science is from "simplification" to "complexity" (Mina, 2000). Complexity can be described in terms of the following developments (Mina, 2013):

1. The emerge of the relativity theory, the second law of thermodynamics and some other scientific developments lead to realize that there is no more simple and absolute laws controlling motion and the globe.
2. The appearance of the general systems theory and cybernetics, then the emergence of theories dealing with behaviour of systems, e.g., chaos theory and catastrophe theory, lead to transdisciplinarity and rejecting the liner vision.
3. Researchers constitute a component of a research system, so it is not possible to consider research neutral.
4. The undecidability theory of Kurt Gödel and falsifiabity (instead of verification) of Karl Popper make scientists suggest that thought is no more controlled by logic. Further, the Heisenberg law of uncertainty, makes people think that it is not likely to have "certain facts".
5. In the light of the above mentioned developments it is suggested that the main goal of science is to understand reality with the intension to influence and change it.
6. Cohesion of Knowledge and its technological applications.
7. The development in technologies of communication, measurement and its units and scientific calculations.

Paradigm shift in mathematics is from seeing mathematics as the study of formal systems to seeing mathematics as a living body.

This first has been reflected in primary school mathematics programmes "from seeing mathematics as a large collection of concepts and skills to be mastered in some strict partial order to seeing mathematics as something people do" (Romberg, 1994, p. 3655), and in secondary school programmes from "the formal teaching of mathematics to introducing mathematics as a human activity in order to provide a basic preparation of learners for the full participation as functional members of society" (Travers, 1994, p. 3661). This paragraph explains what the writer means by *paradigm shift in mathematics education.*

Three interacted characteristics distinguish *paradigm shift in education*: self-education, concurrent education and developing creativity. *In a paradigm shift in curriculum* we could, contrary to other relevant paradigms; define curriculum as "Each learning aims at actualization of

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understanding and choice for learner, through continuous and concurrent learning, in order to maximize his/her development" (Mina, 2003, p. 11).

Needless to say, the above mentioned paradigm shifts are interacting, whether in terms of what should be in school curricula, pre- and in-service teacher learning. The writer will concentrate on the expected curricular changes to cope with these paradigm shifts in order to reach teacher learning in statistics.

EXPECTED CURRICULAR CHANGES

The following curricular changes are expected to take place in school curricula in different degrees and senses. The following elements explain procedures leading to put the previous paradigm shifts into practice (Mina, 2000; 2003; 2006; 2011):

1. Dealing with knowledge in integrated contexts: Whether issues or problems related to multiple disciplines or projects (of theoretical nature, practical nature or both).
2. Developing a global view: By raising questions about possible relevant things to the subject of study and their relationships, whatever seems to be strange, and discussing them.
3. Recognizing sources of knowledge and collecting them in a systematic way.
4. Thinking about collected knowledge, expressing views about them, attempting formulation of new relationships among them and functioning them.
5. Developing a special sensitivity towards noting strange matters, recognizing and questioning them in order to discover their nature.
6. Developing intellectual and behavioural habits related to dialogue.
7. Practicing team work.
8. Training on stating a number of possibilities of the development of a studied phenomenon and their consequences.
9. Paying more attention to educational activities as means to practice collective work, building up pupils' personalities … and so on.
10. Developing pupils' abilities to state assumptions behind phenomena (e.g., motion in constant speed), summing up, explaining and reporting.
11. Using calculators in performing mathematical operations in a "directive way".
12. Giving pupils the chance to be familiar with computers and their use.
13. Distributing pupils in classes on bases of "the multiple intelligences theory".
14. Paying more attention to the special cases of pupils.

IMPLICATIONS OF THE ABOVE MENTIONED CURRICULAR CHANGES ON TEACHER LEARNING IN STATISTICS

A statistics teacher—whether a teacher of integrated curricula, a mathematics teacher, or a specialized teacher of statistics—must learn how to cope with the above mentioned curricular changes, which many of them affect his work as a teacher and some of them affect his work as a teacher of statistics in particular. The most important requirements to cope with those curricular changes are to practice and /or learn the following, ordered from the most general to the most particular:

1. Continuous self concurrent learning.
2. Continuous self refinement.
3. Establishing strong relations with local institutes and parents.
4. Linking partial problems with the wholes they belong to.
5. Behaving as a researcher with the intention of problems solving, not necessary in terms of rigorous research (Pring, 2004).
6. Criticizing Blooms Taxonomy and adopting recent one coping with developments in psychology and knowledge, and giving ample opportunity to develop creativity (Bloom, 1956; Anderson & Krathwohl, 2001; Marzano & Kendall, 2007).
7. Administering dialogues, with multiple views and interpretations.
8. Conducting team works, whether with his/her colleagues or among students.

9. Distributing students in classes on basis of "the multiple intelligences theory" or with its guidance.
10. Coping with possible changes in methods of teaching (e.g., problem solving, self-education, cooperative learning), and evaluation (e.g., "portfolios", self evaluation, … etc.).
11. Paying more attention to the special cases of pupils, particularly, inclusion for handicapped children and teaching enrichment materials for talented ones.
12. Adopting non-linear models or/and help students to deduce assumptions underlying linear models (and criticizing them) (Aida, 1984; Butz, 1995; Mina, 2000; 2003; Woodcock & Davis, 1978).
13. Updating computer developments, including the use of the latest computer statistical packages.
14. Concentrating on statistical concepts and their use in the context of problems solving.
15. Applying statistics in real life situations.

A SUGGESTED STRATEGY FOR LEARNING

The major suggested strategy to be employed in teacher learning in statistics is "professionalization", which means that teaching and learning in programs of teacher education should be conducted in an atmosphere comparable to what ought to be at school in its ideal form, in relation to analyzing and teaching particular curricula. Also, intensive discussion and analyses of the reality of schools, curricula and teaching, and the role of the teacher in developing them are essential to teacher education in the context of professionalization (Mina, 1994)

So, particular emphasis will be given to developing creativity, introducing major change in the teaching and evaluation processes and educational activities, employing "complexity" in dealing with different issues, practicing self-education, using advanced technology in learning and teaching processes, providing examples to the use of non-linear models in statistics (and their theoretical bases), stating assumptions underlying the use of linear statistical models, applications of statistics in everyday life situations… and so on.

As for in-service teacher education programs, there are some alternatives, but the most important common factor among these alternatives is the commitment to the essence of "professionalization".

A FINAL WORD

The above mentioned suggested theoretical basis for teacher learning in statistics, with all its dimensions, is meant to be applied in the future. To the best of the knowledge of the writer, paradigm shifts in science, mathematics, education, mathematics education and curricula have not been considered—or at least totally considered—in a single country all over the world. So we are speaking for the future, which could have many alternative paths are likely to take place. However, it is rather a mission for development, whether in our narrow area – i.e., teacher learning in statistics, or the area of paradigm shifts discussed above.

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