

MATHEMATICAL MODELS IN THE CONTEXT OF SCIENCES

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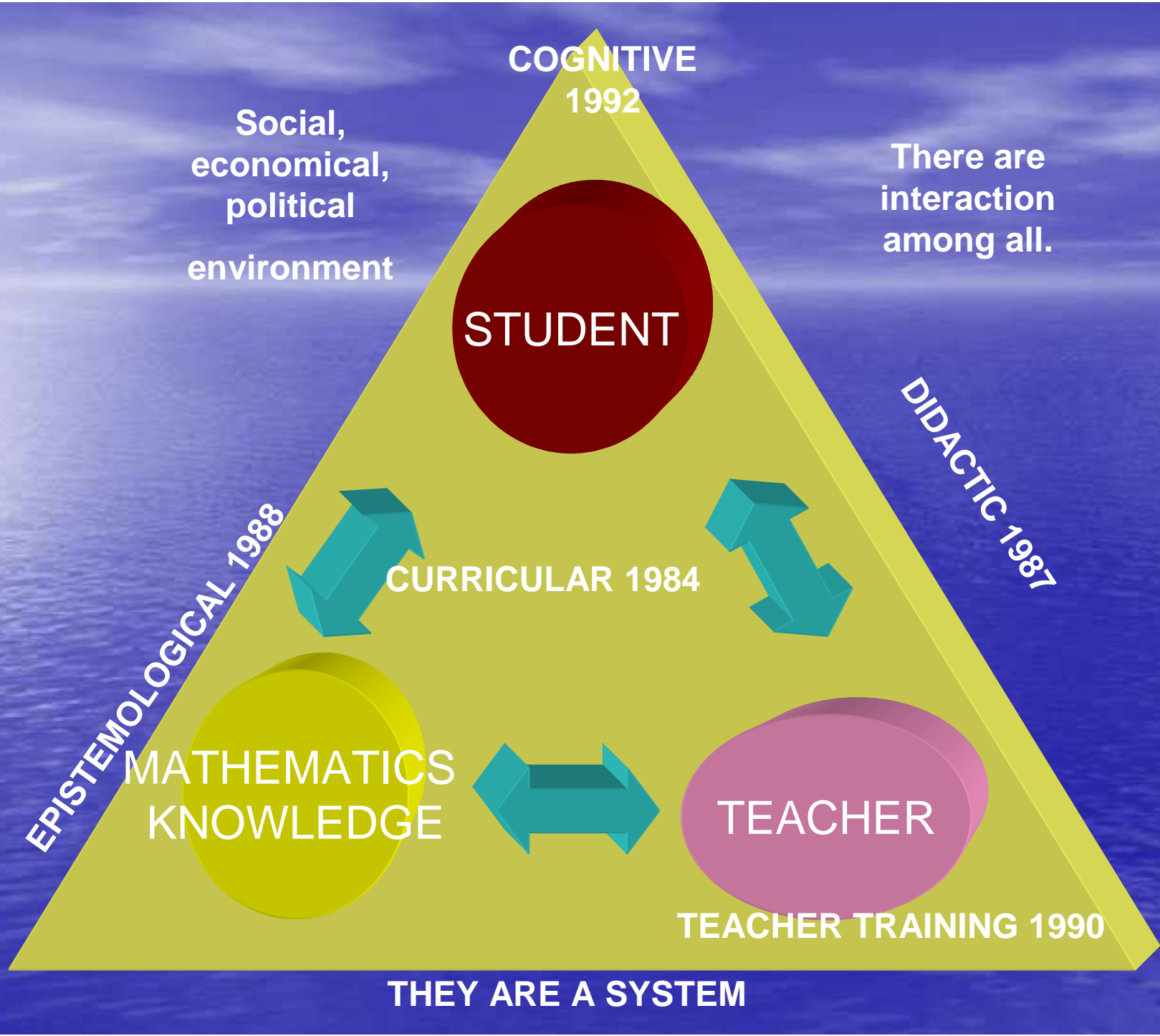
THE RESEARCH PROBLEM

We want to know the cognitive elements and thinking skills that interfere in building a mathematical model, as well as, classifying and characterizing the mathematical models in engineering.

Theoretical framework

Mathematics in the Sciences Context

The educational philosophic assumption of this theory is that the student is trained to transfer mathematics knowledge to the areas which require it, so they apply it in their working and professional life.



**COGNITIVE
1992**

**Social,
economical,
political
environment**

**There are
interaction
among all.**

STUDENT

DIDACTIC 1987

EPISTEMOLOGICAL 1988

CURRICULAR 1984

**MATHEMATICS
KNOWLEDGE**

TEACHER

TEACHER TRAINING 1990

THEY ARE A SYSTEM

Mathematics in Context is a didactic proposition, through which contextualized events are worked, that is, problems and projects in the context of other student's knowledge areas, in the future professional and working activities and, in the daily life.

WORKING METHOD

To analyze engineering text
and some
engineering research projects.

1.- Establishing problems to be tackled.

2.- How the established problems are represented mathematically.

3.- How the concepts of engineering subjects are described mathematically.

We selected 21 students,
3 of each semester,
from third to ninth of
Communications and Electronic
Engineering career from
National Polytechnical Institute
of Mexico.

BASIC SCIENCES

Text book sample

Physic, Chemistry

ENGINEERING BASIC SCIENCES

Electric circuits, Basic Electronic,
Electromagnetic, Basic Communications,
Computation

ENGINEERING SPECIALIZATION SCIENCES

Electronic, Communication, Acoustic,
Control, Computation, Robotic, Telephony

Mathematical Models Characterization

Mathematics in engineering are a language, since almost everything said in engineering can be represented through mathematical symbols.

Inside the engineering knowledge,
there are engineering problems,
there are engineering objects that
are represented mathematically
and there are situations
that can be described
through mathematical symbols.

PROBLEMS

We want to know the charge of a condenser which is connected in series with a resistor to battery terminals which provide a constant tension:

$$R [dq(t)/dt] + (1/C)q(t)=V$$

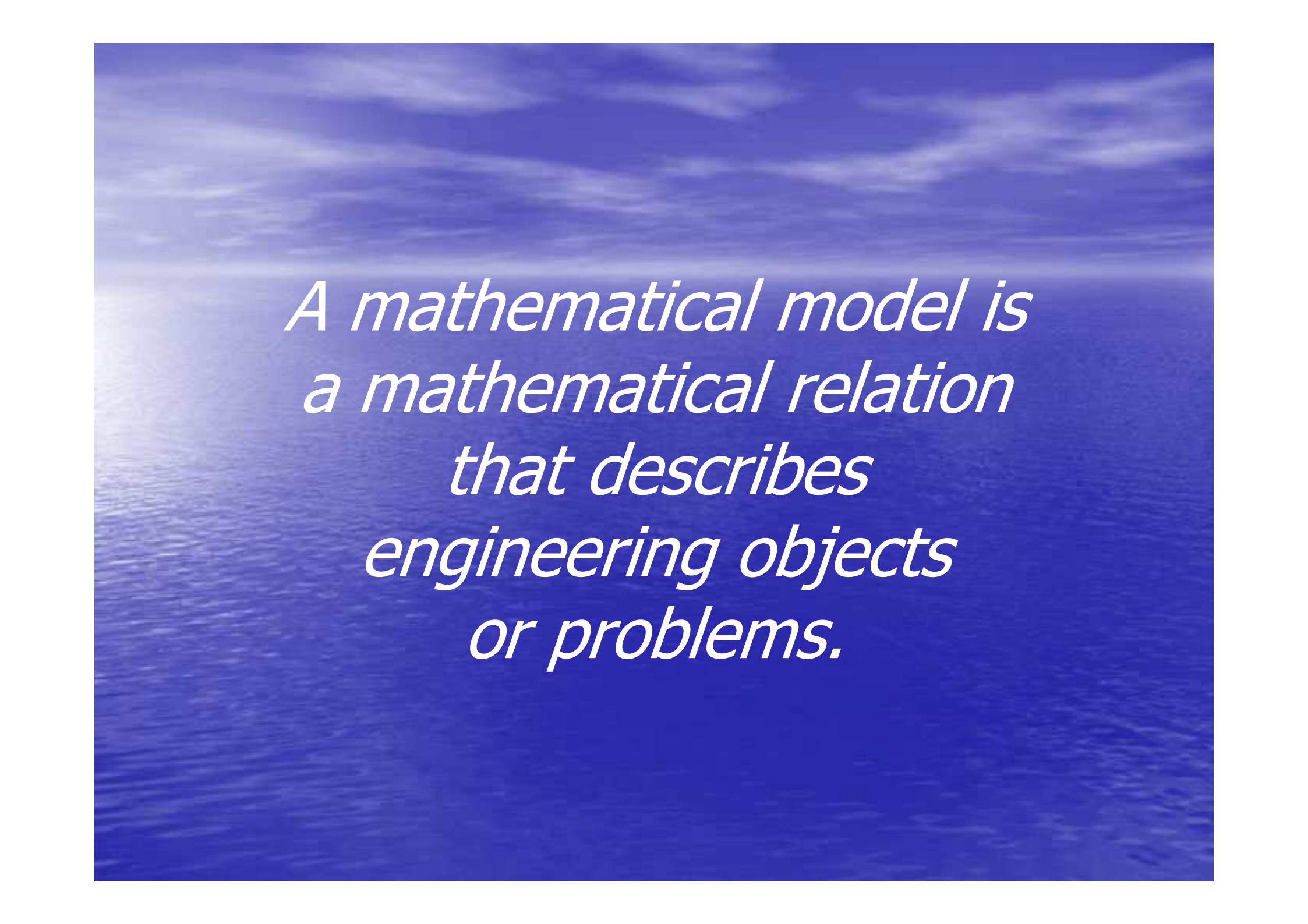
OBJECTS

Consider an electrical signal of the sinusoidal alternating type, the signal is the engineering object which is represented through the function:

$$f(t) = A \sin (t + \varphi)$$

SITUATIONS

A condenser $q=q(t)$ is totally discharged at the beginning of the problem. Taking into account that at the beginning of the problem $t=0$ and the charge is a time function:
 $q(0)=0$.



*A mathematical model is
a mathematical relation
that describes
engineering objects
or problems.*

Mathematical models classification

The first is structured according to the use of the given model by engineering, while the second classification is done according to the knowledge blocks that the future engineer has to study.

First classification

When mathematical models describe *engineering objects*, we have dynamic or static type models.

Dynamic models are mathematical relations that due to the engineering requirements need mathematical modifications constantly, thus mathematical operations are done with them.

$$f(t) = A \sin at$$

If its amplitude wave and frequency are changed, the new function is

$$g(t) = B \sin(bt)$$

where $B=kA$ and $b=ca$,

Static models are
mathematical relations
which describe an
engineering object as if it was a
“nickname”
nothing else is done
mathematically.

$$\delta(t) = 0, t \neq 0$$

$$\delta(t) = \infty, t = 0$$

and

$$\int \delta(t) dt = 1$$

Second classification

The relation among the experimental data of resistance, voltage and current establish mathematical relation which is the Ohm law, $V=RI$.

This is a problem that includes single elements.

We classified these as ***first generation models.***

If we have a problem which includes relations with single element, and we have to relate them to build a new mathematical relation which modeled some problem, we call it ***second generation model.***

$$R [dq(t)/dt] + (1/C)q(t)=V$$

These kind of problems are studied in the electric circuits subjects which are part of the engineering basic sciences.

If we have two electrical net works, where each one is a second generation model, then all net work is modeled by equations system.

This mathematical is called ***third generation model.***

When the student requires models that describe problems where third generation models are included and other models which has to combine and to build new mathematical relations,
are named:
fourth generation models.

MATHEMATICAL MODELS CLASSIFICATION ACCORDING TO THEIR CHARACTERIZATION

Objects

In terms of the use
given by engineering

Static Models

Dynamic Models

Problems

In terms of the engineering
cognitive stages

First Generation Models

Second Generation Models

Third Generation Models

Fourth Generation Models

*The **mathematical modeling**
is conceived as
the cognitive process
that has to be carried out
to build mathematical model
of a problem or object
of the context area.*

1) Identify what changes and what remains constant.

2) Establish relationships between these.

3) Validate "mathematical relation" which models the event.

Cognitive elements which interfere in building a mathematical model

- The focus of mathematical subjects and concepts from the context area
 - The contextualized transposition
 - The conceptual handle of descontextualized mathematics

Knowledge abilities that interfere in building a mathematical model

- Skill to identify mistake control points
- Skill to translate from natural language to mathematical language and vice versa
 - Skills to apply heuristics
 - Skill to travel among the different representations of a mathematical element

CONCLUSION

Mathematical models are a fundamental part of *Mathematics in the Sciences Context*, the classification and characterization of mathematical models, as well as the cognitive elements and thinking skills that had been detected give a knowledge source to teach models in the mathematics classroom.



THANK YOU

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