

## ONDERRIGTEORIE EN -PRAKTYK IN WISKUNDE: 'N KORTBEGRIP

Onderrig*teorie* behels pogings tot

- identifisering en beskrywing van die *verskillende opsies* (alternatiewe) wat daar ten opsigte van Wiskunde-onderdig en -leer bestaan
- identifisering en ontleding van die *implikasies* van die uitoefening van verskillende opsies ten opsigte van die aard en gehalte van leeruitkomste sowel as van die produktiwiteit (spesifiek tydeffektiwiteit) van Wiskunde-onderdig, en
- *verklaring* van die verskille tussen die implikasies van verskillende opsies.

Onderrig*praktyk* behels die *rasionele keuse* tussen opsies vir spesifieke inhoude en spesifieke leerlinge.

Uiteraard kan onderrigteorie nie los van leerteorie bestaan nie; onderrigteorie is dus bloot 'n ekstensie van leerteorie. 'n Onderrigteorie berus ook op 'n perspektief op die aard van Wiskunde. Ons brei kortliks uit.

### 1. **Om Wiskunde te leer behels die konstruksie van wiskundige "begrippe" (in die mees algemene sin van die woord) deur leerders. Leer is 'n individuele konstruktiewe sowel as 'n sosiale interaktiewe proses.**

Wiskunde-onderdig behels

- die inisiëring van leergeleenthede, d.w.s. geleenthede waarbinne leerders wiskundige begrippe kan konstrueer, sowel as
- die bestuur van hierdie geleenthede, en
- die monitering van die leeruitkomste.

'n Basiese opsie wat telkens in Wiskunde-onderdig uitgeoefen moet word, is of leerders geleentheid gegee word om hul kennis na aanleiding van die uitvoering van take/die oplos van probleme te konstrueer, of by wyse van vertolking van beskrywings (uiteensettings, verduidelikings) wat aan hulle verskaf word. Indien dit d.m.v. take/probleme is, is daar die opsie om die probleme individueel of in kleingroepe op te los.

### 2. **Om 'n stuk Wiskunde te *verstaan* beteken per definisie om dit te koppel aan en te interpreteer in terme van reeds-bestaande kennis.**

Onderrig moet dus kinders in staat stel om potensieel nuwe kennis te kan koppel aan hul bestaande kennis. Een benadering is vir die *onderwyser* om die formele inhoud vir kinders te verteer ('n *top-down* benadering of *logiese volgorde*). 'n Ander benadering is om die onderrig te baseer op en te struktureer volgens *kinders* se bestaande kennis en natuurlike ontwikkeling ('n *bottom-up* of *kind-gesentreerde* benadering of *psigologiese volgorde*).

### 3. **Wiskundige kennis sluit in *logiese kennis* (kennis van logiese noodwendighede en van logies-verantwoordbare alternatiewe), *sosiale kennis* (kennis van konvensies waartoe mense gekom het), *fisiese kennis* (waarneembare verskynsels in die fisiese werklikheid) en *strategiese kennis* (heuristieke).**

Onderrigteorie moet hierdie verskeidenheid van basiese wiskundige kennistipes ondervang: verskillende kennistipes word op verskillende wyses geleer en dus onderrig.

### 4. **Om enige Wiskunde-inhoud te beheers behels die bemeesting van die betekenis, funksionaliteit, aard en logika van spesifieke inhoude, die onderlinge samehange tussen inhoude en paraatheid (vaardigheid, vlugheid, soepelheid in die reproduksie en benutting van die inhoude).**

Onderrigteorie moet dus aandag gee aan die vraag *hoe*, asook in watter *volgordes*, vir hierdie verskillende vorme (dimensies) van beheersing voorsiening gemaak kan word.

### 5. **Om Wiskunde werklik te beheers beteken egter meer as om die inhoude (*produkte*) te bemeester - dit sluit ook in die *prosesse* of wiskundige *handelingstipes* waardeur die produkte geskep word, bv. simbolisering, abstrahering, veralgemening, spesialisering, definiëring, aksiomatisering, bewysvoering, modellering, ens.**

'n Onderrigteorie moet hierdie prosesse insluit.

### 6. **Wat kinders leer word tot 'n groot mate bepaal deur *hoe* hulle dit leer: kinders se houdings en perspektiewe op wat Wiskunde is, hoe dit geleer moet word, oor hul vermoë om dit te leer, ens. beïnvloed wat hulle leer. Wiskunde-onderdig en -leer geskied in die sosiale kookpot van die klaskamer.**

Onderrigteorie moet dus ook aandag gee aan die *klaskamerkultuur* of *didaktiese kontrak*, dit is die interpersoonlike verhoudinge wat in die onderrig-leersituasie kan bestaan, in terme van sowel die onderlinge verwagtinge wat die deelnemers van mekaar koester, as die verantwoordelikhede wat die verskillende deelnemers opneem en die kodes wat die interaksies tussen persone beheer.

## TEACHING MATHEMATICS: THEORY AND PRACTICE

A theory of teaching mathematics involves attempts

- to identify and describe the *different options* (alternatives) that exist for teaching and learning mathematics
- to identify and analyse the *implications* of choosing different options in terms of the nature and quality of learning outcomes as well as productivity (in particular the time and cost efficiency of teaching)
- to *explain* the differences between the implications of different options, if any.

The practice of teaching involves making *rational choices* between alternatives for specific contents and specific students.

A theory of teaching is obviously not independent of a theory of learning; a theory of teaching is merely an extension of a theory of learning. A theory of learning also explicitly or implicitly assumes a certain perspective on the nature of mathematics. We briefly outline some essential dimensions of a theory of teaching:

1. To learn mathematics means to construct mathematical “concepts” (in the broadest sense of the word). Learning is an individual constructive as well as a social interactive process.

Teaching mathematics involves:

- initiating learning opportunities, i.e. opportunities in which learners can construct mathematical concepts, as well as
- managing these learning opportunities, and
- monitoring the learning outcomes.

A theory of learning must repeatedly choose between the options of giving learners opportunity to construct their knowledge via solving problems/completing tasks, or via the interpretation of explanations (expositions) given to them. In the case of tasks/problems, there is the option to solve the problems individually or in small groups.

2. To *understand* a piece of mathematics means, by definition, to connect it to and to interpret it in terms of an already existing framework of knowledge.

Teaching must therefore enable learners to *potentially* can connect new knowledge to their existing knowledge. One option is for the *teacher* to digest the formal content for learners (a *top-down* approach or *logical sequencing*). Another option is to base teaching on and to structure teaching according to *learners'* existing knowledge and natural development (a *bottom-up* or *child-centred* approach or *psychological sequencing*).

3. Mathematical knowledge includes *logico-mathematical knowledge*, *social knowledge* (conventions agreed by people), *physical knowledge* (observable phenomena in the physical world) and *strategic knowledge* (problem solving strategies or heuristics).

A theory of teaching must provide for these different basic types of knowledge: different types of knowledge are learned differently and should therefore be taught differently.

4. To master a piece of mathematics content means to understand the *meaning, functionality, nature and logic* of specific contents, the *connections* between contents and to develop *skill* in the reproduction and application of the contents.

A theory of teaching must therefore address the question of *how*, and in which *order* to provide for these different dimensions of understanding.

5. However, to really understand mathematics requires more than mastering the contents (*products*) – it also includes the mathematical *processes* through which the products are established, e.g. symbolising, abstracting, generalising, specialising, defining, axiomatising, proving, modelling, etc.

A theory of teaching should provide for these processes.

6. *What learners* learn depends to a large extent on *how* they learn it. Learner's attitudes and beliefs about the nature of mathematics, about how it should be learned, about their ability to learn it, etc. influences what they learn. Mathematics-teaching and learning happens in the social melting pot of the classroom.

A theory of teaching must therefore also address the issue of *classroom mathematical culture* and the *didactical contract*, i.e. the inter-personal relationships that exist in the learning-teaching situation, in terms of both the underlying expectations participants have of each other, the obligations and responsibilities that the different participants assume, and the codes which govern the interactions between participants.