



Aalto University
School of Science

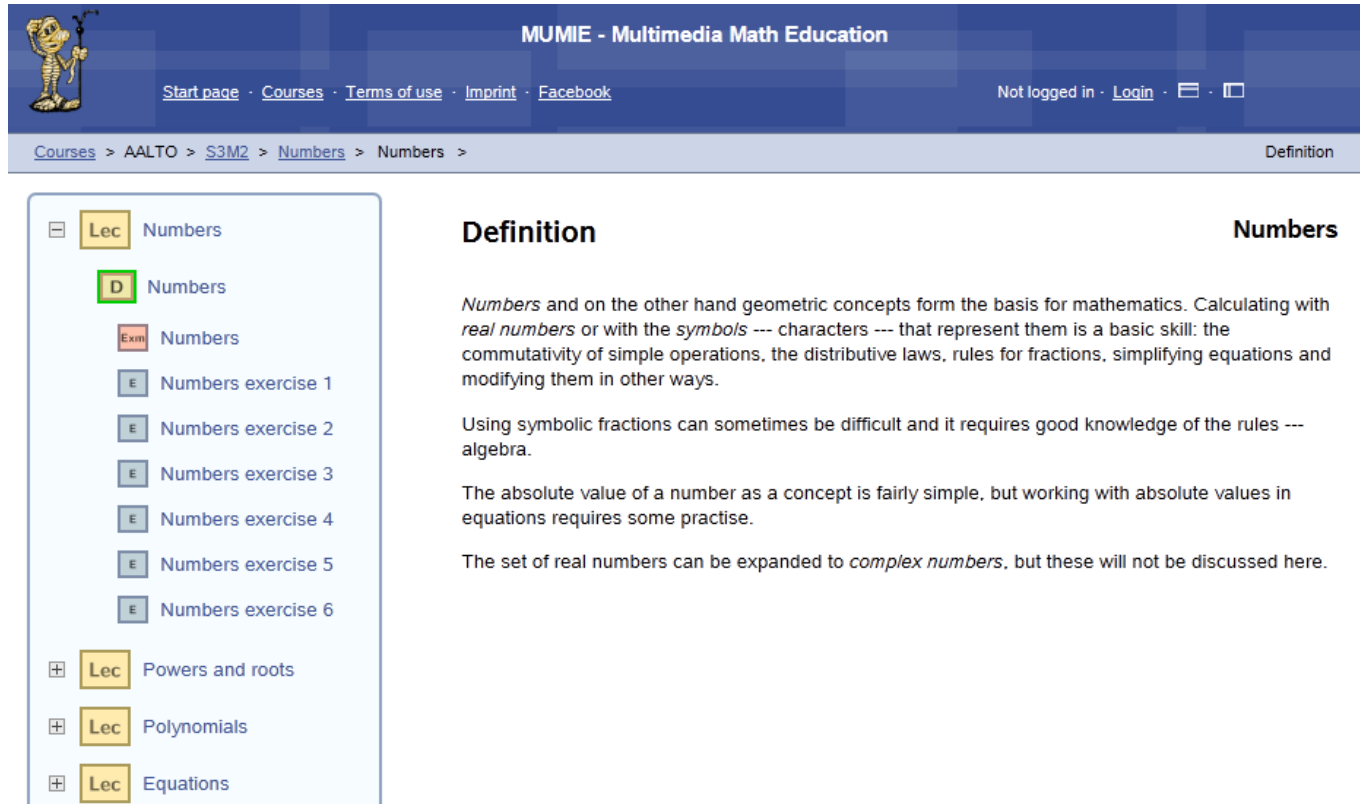
Does practice make perfect?

*A study of the Granger-causal relationship
between attempting to solve online exercises
and mathematical proficiency*

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Support Successful Student Mobility with Mumie





The screenshot shows the Mumie website interface. At the top, there is a navigation bar with a cartoon mummy character on the left and the text "MUMIE - Multimedia Math Education" in the center. Below this, there are links for "Start page", "Courses", "Terms of use", "Imprint", and "Facebook". On the right side of the navigation bar, it says "Not logged in" with links for "Login", a hamburger menu icon, and a search icon. Below the navigation bar is a breadcrumb trail: "Courses > AALTO > S3M2 > Numbers > Numbers >". On the far right of this trail is the word "Definition".

On the left side of the main content area, there is a sidebar menu. It starts with a "Numbers" section, which is expanded to show a "Definition" (D) and several "Numbers exercise" items (E) numbered 1 through 6. Below this, there are three other sections: "Powers and roots", "Polynomials", and "Equations", each with a "Lec" (Lecture) icon.

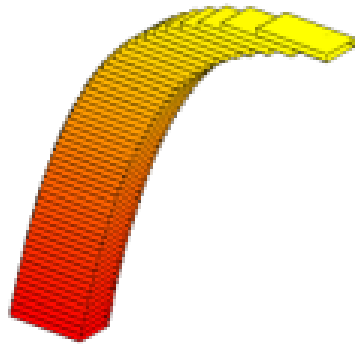
The main content area is titled "Definition" and "Numbers". It contains three paragraphs of text:

Numbers and on the other hand geometric concepts form the basis for mathematics. Calculating with *real numbers* or with the *symbols* --- characters --- that represent them is a basic skill: the commutativity of simple operations, the distributive laws, rules for fractions, simplifying equations and modifying them in other ways.

Using symbolic fractions can sometimes be difficult and it requires good knowledge of the rules --- algebra.

The absolute value of a number as a concept is fairly simple, but working with absolute values in equations requires some practise.

The set of real numbers can be expanded to *complex numbers*, but these will not be discussed here.



*S*ystem for
*T*eaching and
*A*ssessment using a
*C*omputer algebra
*K*ernel

STACK

Kysymys 1

[Näytä yksi tehtävä kerrallaan](#) [Ylös](#) [1](#) [2](#) [3](#) [Alas](#) [Ohje](#)

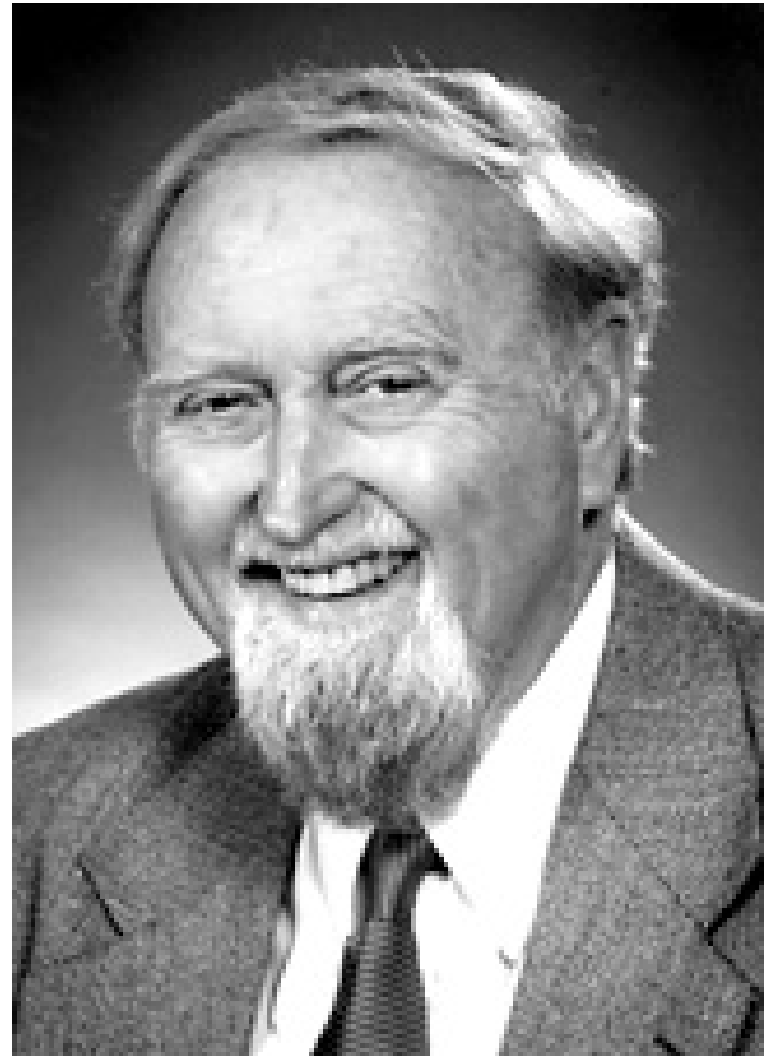
Olkoon

$$A = \begin{pmatrix} 1 & 5 & 5 \\ 1 & 3 & 5 \\ 1 & 3 & 4 \end{pmatrix} \quad \text{ja} \quad B = \begin{pmatrix} 2 & 3 & 3 \\ 3 & 5 & 3 \\ 4 & 4 & 4 \end{pmatrix}.$$

Laske matriisitulot $C_1 = AB$ ja $C_2 = BA$. Tehtävään tulee mallit kierroksen sulkeuduttua.

Sir Clive Granger

(4.9.1934 - 27.5.2009)



Assumptions for Granger causality

- The past cannot be caused by the future.
- Elsewhere unavailable, unique information about an *effect* is contained in a *cause*.

Unrestricted regressions

$$\text{Skills}_t = \sum_{i=1}^L \alpha_i \text{Skills}_{t-i} + \sum_{i=1}^L \beta_i \text{Attempts}_{t-i} + \epsilon_t$$

$$\text{Attempts}_t = \sum_{i=1}^L \alpha_i \text{Attempts}_{t-i} + \sum_{i=1}^L \beta_i \text{Skills}_{t-i} + \epsilon_t$$

If students are penalised for *not* attempting to solve the exercises

“Attempts do not
Granger-cause skills”

Lags	F -statistic	p-value
1	2.5804	0.1239
2	2.2637	0.1344
3	1.5352	0.2492
4	0.4781	0.2506
5	0.8448	0.5544

“Skills do not
Granger-cause attempts”

Lags	F -statistic	p-value
1	5.6624	0.0274
2	3.9399	0.0393
3	2.6198	0.0918
4	1.8507	0.1895
5	1.5160	0.2858

32% penalty

and penalising students for *not* attempting to solve the exercises

“Attempts do not Granger-cause skills”

Lags	p-value
1	0.5386
2	0.3269
3	0.4593
4	0.8607
5	0.8362

“Skills do not Granger-cause attempts”

Lags	p-value
1	0.0283
2	0.0334
3	0.0487
4	0.1295
5	0.2983



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Thank you!