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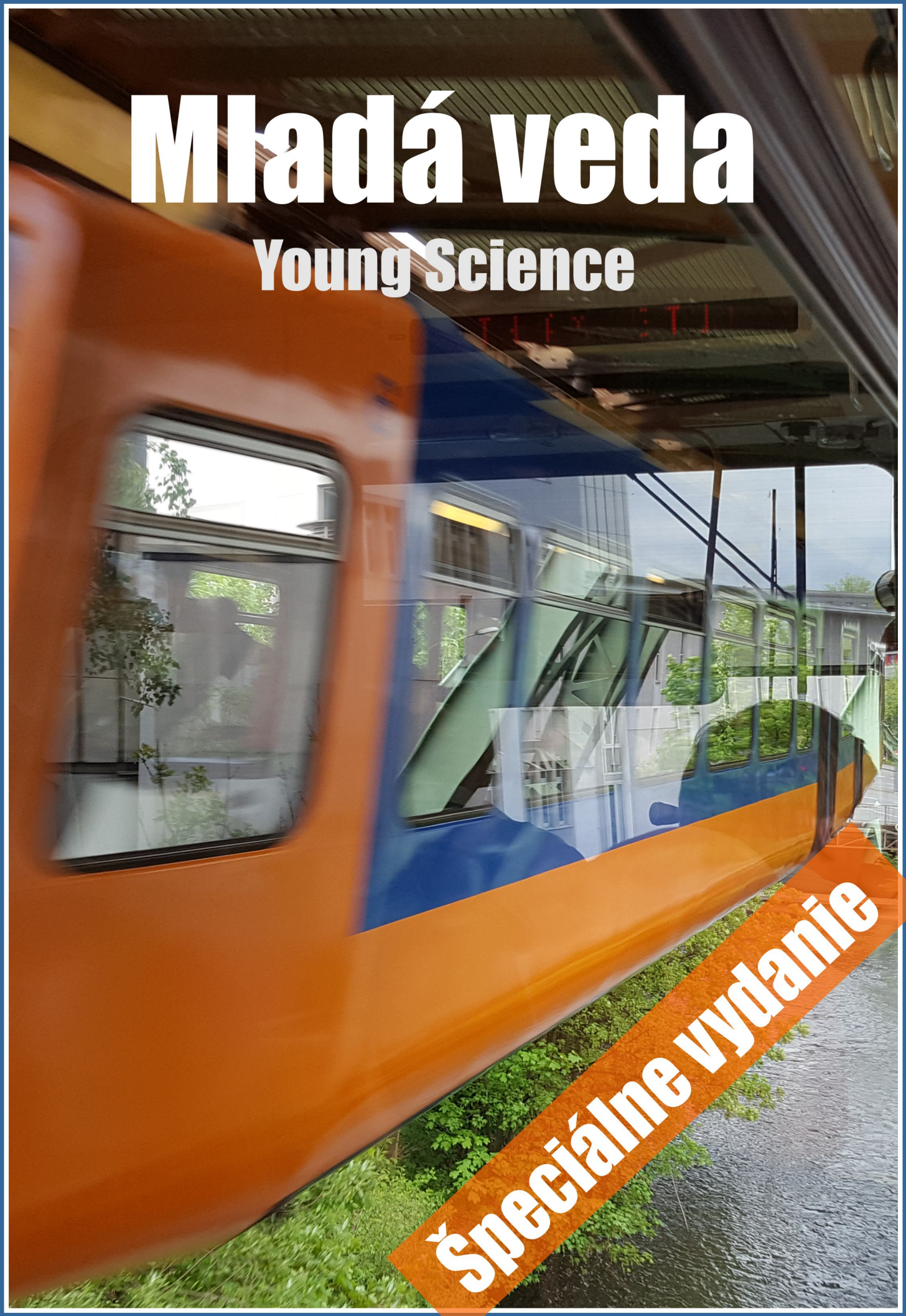

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ELEMENTÁRNÍ APLIKACE OBYČEJNÝCH DIFERENCIÁLNÍCH ROVNIC V PRAXI

ELEMENTARY APPLICATION OF ORDINARY DIFFERENTIAL EQUATIONS IN PRACTICE

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Abstract

This study focuses on the application of differential equations using mathematical models in practice. The authors focused their research on deterministic models (Plevný 2005) (models that do not include random variables) and contain a time factor (dinamic models) (Lukáš 2012) as well. Specific model which is solved by authors is ”The Ebbinghau’s Model of Forgetting” (Jaber 1997). This Model is solved based on results of studies of students at selected ”High School”. The Authors thus created empirical research of forgetting, which will be used for the public. Research of this Study is not offered for the students only, but it can also be benefical at all employers whose employees returning to work after an extended sick leave or vacation. The final model shows that it is much better to learn as much subject matter that will be slowly forgotten. This fact will be shown in primary, secondary and tertiary eduacation as well. We hope the study will encourage pupils and students to continuous learning and overall learning curriculum.

Key words: Education, differential equations, Ebbinghau’s model, curriculum

Abstrakt

Cílem této studie je zaměřit se na aplikaci diferenciálních rovnic pomocí matematických modelů v praxi. Autoři zaměřují svůj výzkum na deterministické modely (modely, které neobsahují náhodné veličiny) a zároveň obsahují faktor času (tedy dynamické modely).

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Konkrétní model, který autoři řeší je „Ebbinghausův model zapomínání“. Tento model autoři řeší na základě výsledků studia studentů na vybrané „Vysoké škole“. Autoři tedy vytvoří pomocí empirického výzkumu model zapomínání, který bude sloužit pro širokou veřejnost. Výzkum této studie není určen pouze na studenty, ale může být také přínosem všem zaměstnavatelům, jejichž zaměstnanci se vrací do práce po delší pracovní neschopnosti nebo dovolené.
Kľúčové slová: Vzdělání, diferenciální rovnice, Ebbinghauův model, učební osnovy

Title of the section (automatically numbered)

One of this study's objectives is to increase the university students' motivation to study ordinary differential equations they come across in selected subjects during their studies, also involving the equations´ necessary use in compulsory courses, such as Economic theory. This study aims to point out that the differential equations included in mathematics courses are meaningful and may be used not only for solving economic relations.

On the basis of empirical research similar to (Atkinson 2003) and using certain mathematical relations, the authors will form a particular mathematical model of forgetting, which is based on (Heuser 1995).

According to Samuel (Samuel 2002), most definitions of forgetting state that it is a loss of the ability to remember knowledge or to recall facts, or else, the inability to remember them. When an individual is distracted upon receiving a specific piece of information to an extent that he/she does not manage to sufficiently become conscious of it, he/she tends to forget it quicker than having an opportunity to repeat it and think about its content. An important benchmark in this context is indeed the individual's age. Forgetfulness associated with aging is evident, but healthy elderly people generally remember things very well and their forgetting is not so noticeable in comparison with younger people (Schacter 2003).

Ebbinghaus observed that the majority of forgetting takes place in the nearest time after learning, slowing down afterwards. It is therefore important to repeat certain information as soon as possible after its learning. This phenomenon is shown by the Ebbinghaus forgetting curve which is not linear, but logarithmic. Also, a forgetting rate, which is initially higher, gradually decreases (Baddeley 2009). Furthermore, it is essential to note that a piece of knowledge, having both sense and meaning, tends to be forgotten rather slower and to a lesser extent than meaningless knowledge or material, with the wordings of rules and principles being learnt or memorized the best (Nakonečný 2011).

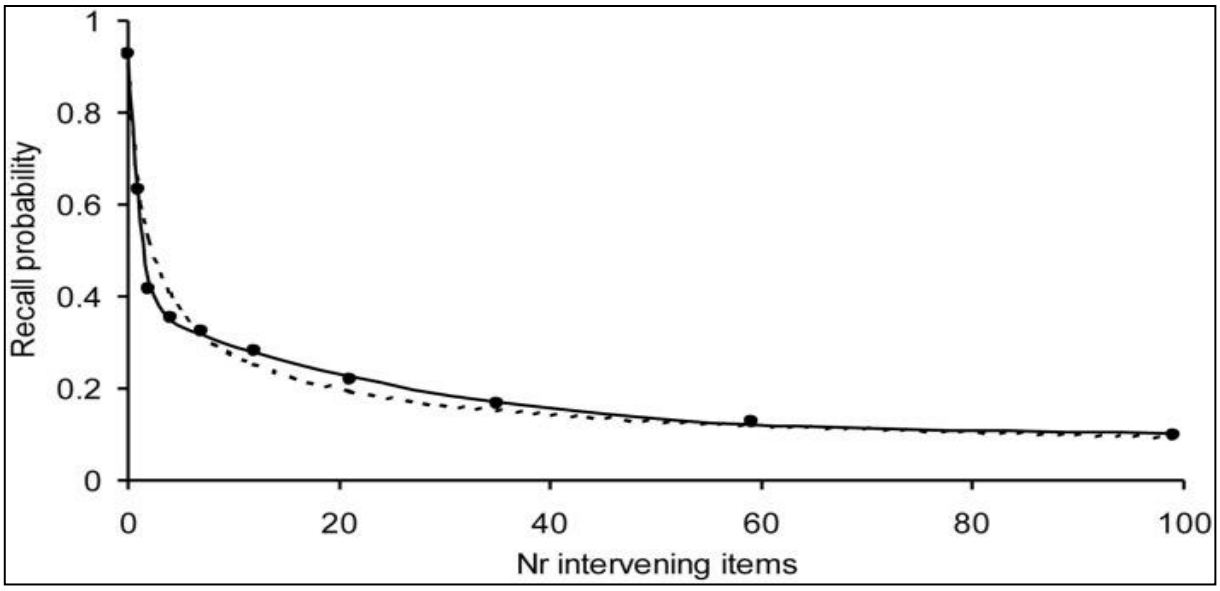

Figure 1 - Forgetting model

The Ebbinghaus' model in practice

The Ebbinghaus' model of forgetting assumes that the rate of forgetting knowledge after the test is directly proportional to the difference between what a student remembers and what he never forget. It is assumend, that a good student knows to test 90 percent of the curicculum, a week after the test remembers 80 percent and 20 percent of the curicculum never forget. A worse student knows to test 60 percent of the curicculum, a week after the test remembers 30 percent and 10 percent of the curicculum never forget. Let create a model that could compare students' knowledge over a given time period.

The differential equation of the model

Let us the function of forgetting as $y = f(t)$ where t represents time in weeks. Constant of forgetting denoted as k and the quantity of the curicculum that will never be forgotten is a. The form of the equation is

$$y' = -k(y(t) - a).$$

The solution of this equation is easy, we can us the variation of constans.

$$\frac{dy}{dt} = -k(y(t) - a)$$

$$\frac{dy}{y(t) - a} = -k\ dt$$

$$\ln|y(t) - a| = -kt + c_1$$

$$y(t) - a = \pm e^{-kt} \cdot c^{c_1}$$

$$y(t) = a + c \cdot e^{-kt}$$

This model which was created by authors is universal and we can use a random a, k.
Let solve our cases with the specific constans.

The good student

We need to know c and k.

$a = 0{,}2$ and $t = 0$

$y(0) = 0{,}9$

$0{,}9 = a + ce^{-tk}$

$0{,}9 = 0{,}2 + ce^{0}$

$c = 0{,}7$

$a = 0{,}2$ and $t = 1$

$y(1) = 0{,}8$

$0{,}8 = 0{,}2 + 0{,}7e^{-k}$

$\frac{0{,}6}{0{,}7} = e^{-k}$

$k = 0{,}154151$

$\mathbf{y(t) = 0,2 + 0,7e^{-t \cdot 0{,}154151}}$

The worse student

We need to know c and k.

$a = 0{,}1$ and $t = 0$

$y(0) = 0{,}6$

$0{,}6 = a + ce^{-tk}$

$0{,}6 = 0{,}1 + ce^{0}$

$c = 0{,}5$

$a = 0{,}1$ and $t = 1$

$y(1) = 0{,}3$

$0{,}3 = 0{,}1 + 0{,}5e^{-k}$

$\frac{0{,}2}{0{,}5} = e^{-k}$

$k = 0{,}916291$

$\mathbf{y(t) = 0,1 + 0,5e^{-t \cdot 0{,}916291}}$

The GeoGebra

For visualizing the data we can use The GeoGebra. This mathematical software is good for visualizing and counting specific values in any time. Everybody can use our material here and you can change our constants and put your own.

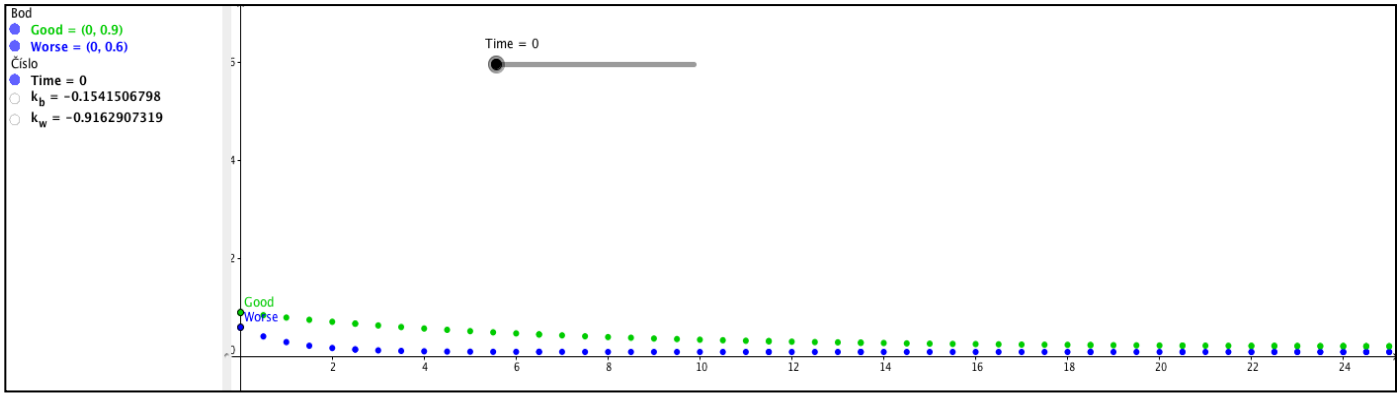

Figure 2- View our material in The GeoGebra

Summary

We have succeeded in construct general model of forgetting students. In our case with our specific constant we can say that it is much better to study more. Because our forgetting is substantially slowly than we learn 60 percent only. On the basis of empirical research similar to (Atkinson 2003) and using certain mathematical relations.

In describing economic growth, it is useful to use the lessons learned from the optimal management of theory. It has also been shown that the role of optimal control is relatively widespread for the creation of mathematical models with economic content. Therefore, it is important to pay attention to the conditions for an optimal process of optimal control, which are collectively called Pontrjagin's maxim principle. Here are shown the necessary conditions for the optimal solution of Lagrange tasks and the demonstration of the necessary conditions for optimal solution of basic tasks of optimal control.

This article was recommended for publication in the scientific journal Young Science by:
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