Teacher guide: Drug concentration

http://www.fisme.science.uu.nl/toepassingen/22038

This activity is designed for 16 year old students (grade 10) as introduction to difference equations in mathematics. It is an activity for two lessons.

A sample lesson plan

Lesson 1

10 minutes: create groups & introduce the problem and the working plan and distribute the task
10 minutes: students work in groups on the task
10 minutes: discuss with the whole class whether all groups have an idea how to start and how to proceed. Exchange strategies and make sure that everybody has an idea what is expected.
15 minutes: students work on the task, finish calculations and prepare the building blocks for their flyer.

Lesson 2

20 minutes: students finish their flyer
20 minutes: presentations of a few examples
10 minutes: reflection on the task (and positioning it in further work)

A doctor presents the following details about the use of a specific drug:

- An average of 25% of the drug leaves your body by secretion during a day.
- The drug is effective after a certain level is reached.
- Therefore it takes a few days before the drug that you take every day is effective.
- Do not skip a day.
- It can be unwise to compensate a day when you forgot the drug with a double dose the next day.

N.B. These details are a simplification of reality.

Investigation

- Use calculations to investigate how the level of the drug changes when someone starts taking the drug in a daily dose of 1500 mg with for instance three times 500 mg.
- Are the consequences of skipping a day and/or of taking a double dose really so dramatic?
- Can each drug level be reached? Explain your answer.

Product

Design a flyer for patients with answers to the above questions. Include graphs and/or tables to illustrate the progress of the drug level over several days.

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Original idea of this task: Mascil Team The Netherlands

Suggestions

The task can be extended by asking students what happens when you vary the daily dose and/or the percentage by which the drug leaves your body. What is the effect on the resulting (converging) drug level? Such questions can also be used to differentiate within a class and to challenge high achievers.

Example student work

The illustrations below show parts of solutions of students. They illustrate the kind of reasoning of the students with repeated calculations using tables and graphs. This work can be used for the introduction of difference equations. As you can also see, with similar information students reached quite different results. This is important for reflecting on the relevancy for understanding such mathematical processes in the world of work.

Solution 3 shows the work of a small group (in Dutch) that really prepared a kind of flyer. The teacher of these students highly valued the reality character in the task

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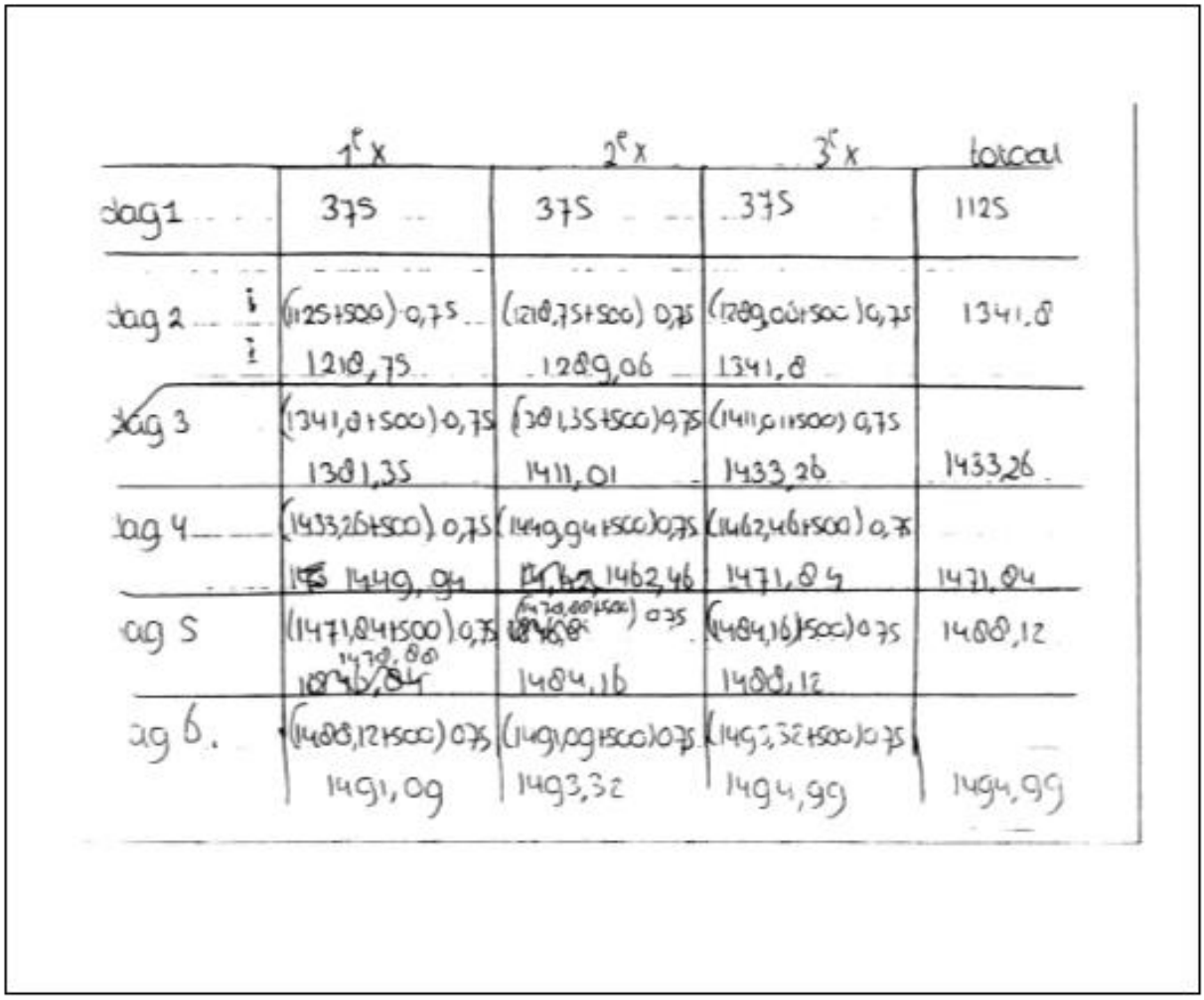
Solution 1



	1e x	2e x	3e x	totaal
dag 1	375	375	375	1125
dag 2	(1125+500) 0,75 1218,75	(1218,75+500) 0,75 1289,06	(1289,06+500) 0,75 1341,8	1341,8
dag 3	(1341,8+500) 0,75 1381,35	(1381,35+500) 0,75 1411,01	(1411,01+500) 0,75 1433,26	1433,26
dag 4	(1433,26+500) 0,75 1449,94	(1449,94+500) 0,75 1462,46	(1462,46+500) 0,75 1471,84	1471,84
dag 5	(1471,84+500) 0,75 1484,16	(1484,16+500) 0,75 1493,12	(1493,12+500) 0,75 1499,84	1499,84
dag 6.	(1499,84+500) 0,75 1499,84	(1499,84+500) 0,75 1499,84	(1499,84+500) 0,75 1499,84	1499,84

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Solution 2

1e dag werkt 1500 mg
2e dag werkt 1125 mg + 1500 mg = 2625 mg
3e dag werkt 844 mg + 1125 mg + 1500 mg = 3469 mg
4e dag werkt 633 mg + 844 mg + 1125 mg + 1500 mg = 4102 mg
5e dag werkt 475 mg + 633 mg + 844 mg + 1125 mg + 1500 mg = 4576 mg
6e dag werkt 356 mg + 475 mg + 633 mg + 844 mg + 1125 mg + 1500 mg = 4932 mg

DAGEN	1	2	3	4	5	6
werkend medicijn (mg)	1500	2625	3469	4102	4576	4932
toename werkend medicijn (mg)	-	1125	844	633	475	356

dus:

$2000 \cdot 0{,}75^{x} = 4$

x = dagen
4 = toename werkend medicijn (mg)

DAGEN	26	27	28	29	30	31
werkend medicijn (mg)	5996	5996,3	5996,9	5997,4	5997,8	5998,1
toename werkend medicijn (mg)	1	0,8	0,6	0,5	0,4	0,3

Met het slikken van een vaste dagelijks dosis zal een eindpeil boven 6000 mg niet bereikt worden. Dat blijkt uit de bovenstaande tabel.

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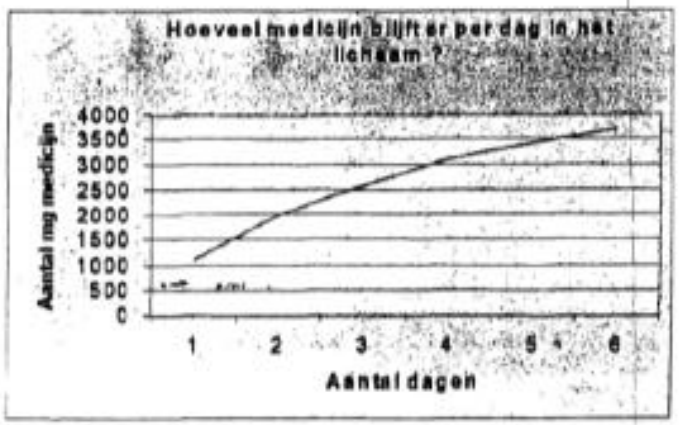
Solution 3

de Medicijnspiegel

Als je eenmaal per dag naar het toilet gaat verlaat 25 % van de door jou ingenomen medicijnen je lichaam
Dat betekent dat als je eerste dag van je medicijngebruik 3 keer 500mg slikt er daarvan 1500 * 0,75 = 1125mg in je lichaam overblijft

Als je elke dag 3 keer 500mg van het medicijn zou slikken krijg je het volgende resultaat

Dag	totaal (mg)	Vn1	Vn2	Vn3
1	1125			
2	1986,75	843,75		
3	2601,5625	632,8125	210,9375	
4	3076,2	474,6375	158,175	52,7625
5	3432,1	355,9	118,7375	39,437
6	3699,09	266,99	88,91	29,8275



De verschilrijen worden niet constant dus is het ook niet mogelijk bij deze rij een directe formule te geven. Wel is er een recusieve formule die luidt : $tn+1 = (1500 + tn) * 0,75$
Dit betekent dat het aantal medicijn in je lichaam geleik is aan het aantal van de vorige dag, daarbij komt 1500 mg en na het plassen blijft er nog 75 % van de totale hoeveelheid over in je lichaam

Het kan gebeuren dat je een dag vergeet je medicijnen in te nemen
Kun je dan zomaar de volgende dag de dubele dosis innemen en heeft dit gevolgen voor het eindpeil ?
Dat is in een tabel duidelijk weer te geven

Dag	Constant	1 keer overslaan
1	1125	1125
2	1986,75	843,75
3	2601,5625	2882,8125

Tussen de eindhoeveelheden zit niet zo een groot verschil, ongeveer 281,25 mg
Maar als je meerdere dagen overslaat en het later compenseert wordt het verschil steeds groter en krijgt het weldegelijk invloed op het eindpeil. Het is dan ook niet aan te raden dit te doen want hierdoor krijg je een veel te hoog eindpeil

Het kan natuurlijk ook voorkomen dat je een ander eindpeil hebt dan gewenst als je elke dag constant de medicijnen neemt. Dit kan komen doordat je gemiddeld meer of minder dan 25% uitscheid
Maar ook door hoe snel het lichaam de stoffen opneemt e.d

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Source

Mathematics and Science for Life

www.mascil-project.eu

Dutch project 'Profi ', 'discrete analyse' (1997). Vervolgopdracht is verwerkt in pakketje DDM (1998, 2e experimentele versie):
http://www.fisme.science.uu.nl/toepassingen/00669/
Also published in: Wageningse methode VWO4, deel 2 (p. 23, versie 2000)

Dutch version (medicijnspiegel):
http://www.fisme.science.uu.nl/toepassingen/28001/

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