Appendix A

Included in the Appendix are the three questionnaires developed and used for experimental validation of the Edutool diabetes simulator.

A.1 Diabetes *Edutool* questionnaire 1

Please answer the following questions by circling the correct answer.

Example

Which organ(s) are used for hearing?

eyes	nose	ears	lungs

Questions

1. You are a _____.

male	female

2. How old are you?

_____ years

3. Do you have a close friend or family member with diabetes?

Yes	No

4. How often do you use a computer?

everyday	a few times a week	once a month	never

5. What is the most difficult task you use your computer for?

playing games	browsing the internet	doing school projects	using scientific programs

6. Glucose is a _____.

simple protein	simple fat	simple sugar	simple hormone

7. Which organ produces something to lower blood glucose levels?

liver	tonsils	kidneys	pancreas

8. People with diabetes most frequently measure their _____.

blood pressure	glucose allergies	glucose level	glucose storage

9. How is glucose moved throughout the body?

by the lungs	by the blood	by the liver	by the bladder

10. People with type 1 diabetes use mainly _____ to lower their blood glucose level.

diabetes pills	aspirin	insulin	warfarin

11. What is the main reason why people with diabetes should exercise?

It builds muscle	It increases fitness levels	It helps control glucose levels	It prevents low glucose levels

12. Which beverage will raise the blood glucose of a person with type 1 diabetes the most?

glass of apple juice	coffee with sugar	can of cola	glass of water

13. Which beverage will raise the blood glucose of a person with type 1 diabetes the least?

glass of milk	coffee with sugar	can of cola	glass of soda water

14. Which snack will require the most insulin?

cheeseburger	slice of cake	apple	two slices of bread

15. Which snack will require the least amount of insulin?

cheeseburger	slice of cake	Apple	Two slices of bread

16. Insulin is measured in _____.

atoms	units	molecules	teaspoons

17. Blood glucose is measured in _____.

mmol/L	glucose units	glucose molecules	atoms

18. Which of the following will raise the blood glucose level of a person with type 1 diabetes?

drinking a glass of diet cola	writing a stressful exam	drinking glass of water	listening to classical music

A.2 Diabetes *Edutool* Questionnaire 2

Insulin question

Please use the *Edutool* diabetes simulator to complete the following question:

Arnold has a starting blood glucose value of 8 mmol/L.

He is hungry and eats a medium burger.

Afterwards he goes for a 20 minute run.

Question: How much insulin must Arnold use to lower his blood glucose to 5 mmol/L after the burger and exercise?

Answer:

_____ Units of insulin

Please answer the following questions by circling the correct answer.

Example

Which organ(s) are used for hearing?

eyes	nose	ears	lungs

Questions

1. How did you find the Edutool program to use?

very easy	easy	I managed	difficult	very difficult

2. Do you think the *Edutool* is appropriate for school children?

Yes	No

3. How did you find the food and exercise database to use?

very easy	easy	I managed	difficult	very difficult

4. How did you find using the arrows (e.g. dragging them) ?

very easy	easy	I managed	difficult	very difficult

5. Would you recommend Diabetes *Edutool* to your friends or family?

Yes	No

6. Glucose is a _____.

simple protein	simple fat	simple sugar	simple hormone

7. Which organ produces something to lower blood glucose levels?

liver	tonsils	kidneys	pancreas

8. People with diabetes most frequently measure their _____.

blood pressure	glucose allergies	glucose level	glucose storage

9. How is glucose moved throughout the body?

by the lungs	by the blood	by the liver	by the bladder

10. People with type 1 diabetes use mainly _____ to lower their blood glucose level.

diabetes pills	aspirin	insulin	warfarin

11. What is the main reason why people with diabetes should exercise?

It builds muscle	It increases fitness levels	It helps control glucose levels	It prevents low glucose levels

12. Which beverage will raise the blood glucose of a person with type 1 diabetes the most?

glass of apple juice	coffee with sugar	can of cola	glass of water

13. Which beverage will raise the blood glucose of a person with type 1 diabetes the least?

glass of apple juice	coffee with sugar	can of cola	glass of water

14. Which snack will require the most insulin?

cheeseburger	slice of cake	apple	two slices of bread

15. Which snack will require the least amount of insulin?

cheeseburger	slice of cake	apple	two slices of bread

16. Insulin is measured in _____.

atoms	units	molecules	teaspoons

17. Blood glucose is measured in _____.

mmol/L	glucose units	glucose molecules	atoms

18. Which of the following will raise the blood glucose level of a person with type 1 diabetes?

drinking a glass of diet cola	writing a stressful exam	drinking glass of water	listening to classical music

A.3 Diabetes Questionnaire 3

Insulin question

Please use the AIDA simulator to complete the following question:

Arnold has a starting blood glucose value of 3 mmol/L.

He is hungry and eats a slice of cake.

Afterwards he plays basketball with his friends for 30 minutes.

Question: How much insulin must Arnold use to lower his blood glucose to 5 mmol/L after the burger and exercise?

Answer:

_____ Units of insulin

Please answer the following questions by circling the correct answer.

Example

Which organ(s) are used for hearing?

eyes	nose	ears	lungs

Questions

1. How did you find the AIDA program to use?

very easy	easy	I managed	difficult	very difficult

2. Do you think the AIDA is appropriate for school children?

Yes	No

3. Would you recommend the AIDA simulator to your friends or family?

Yes	No

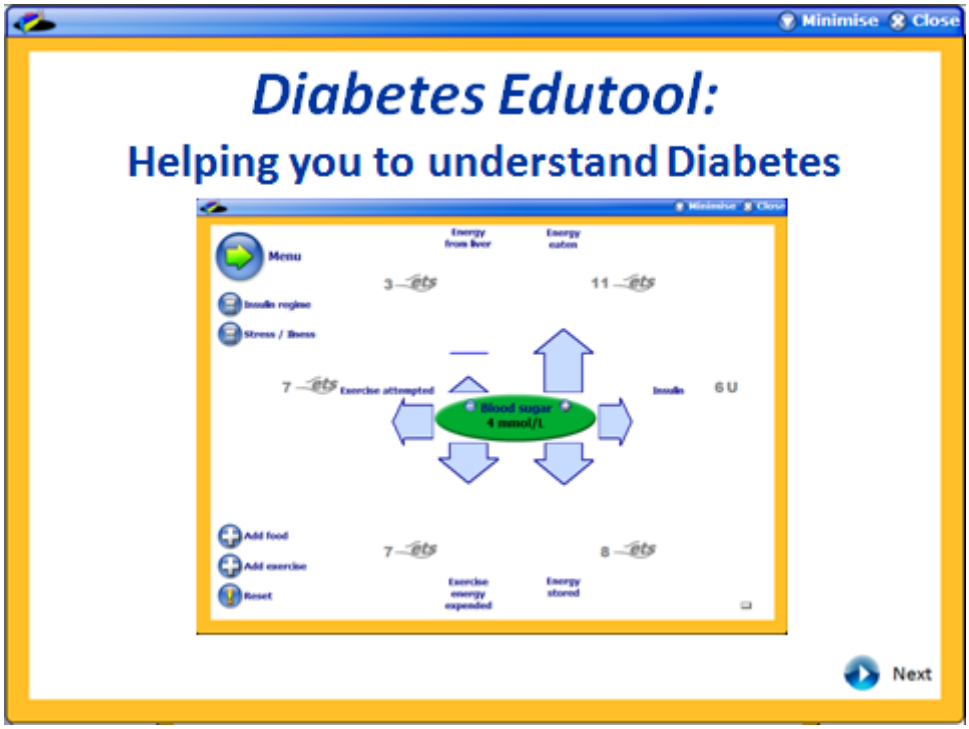
4. Which program do you prefer?

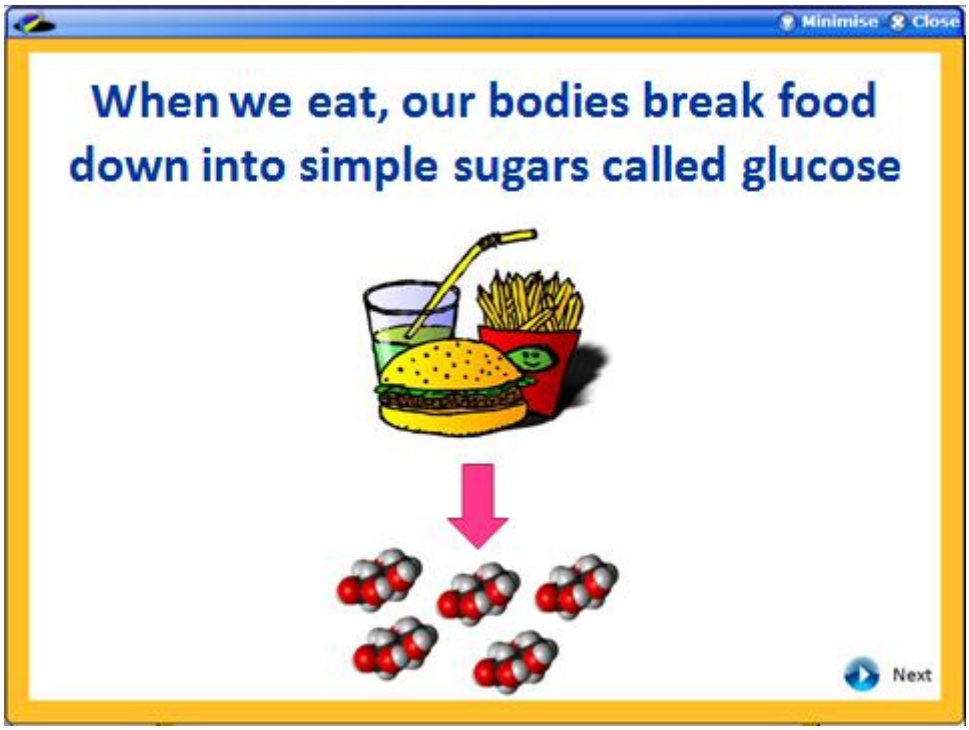
Edutool	AIDA

Appendix B

Appendix B presents the quick start guide presentation. This presentation will also be included on the enclosed electronic appendix so the videos and voice clips can also be viewed.

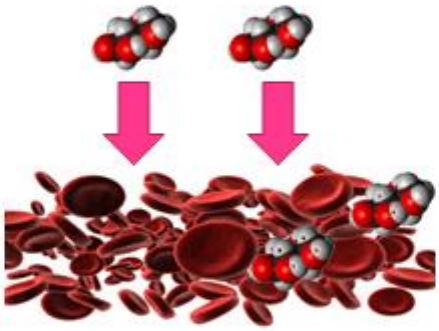
B.1 *Edutool* quick start guide presentation





Minimise Close

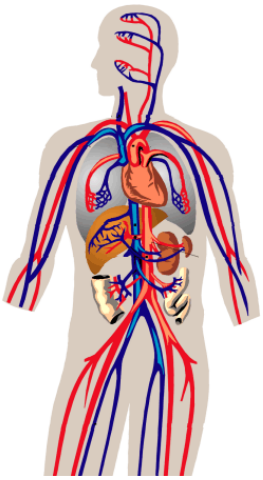
The glucose is first put into our bloodstream



Next

Minimise Close

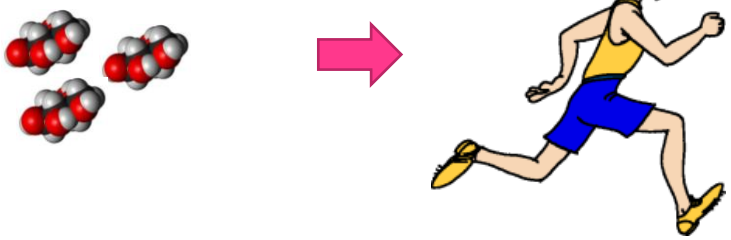
Blood moves the glucose around in our bodies



Next

Minimise Close

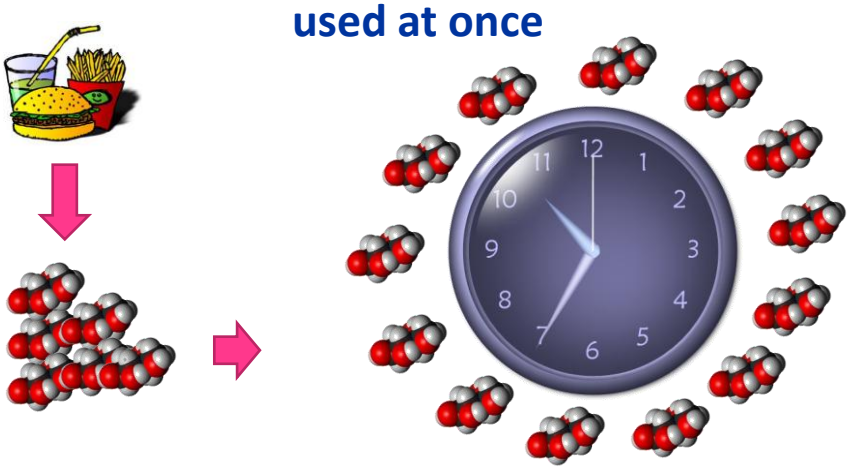
Our bodies use the glucose for energy



Next

Minimise Close

All the glucose after a meal cannot be used at once

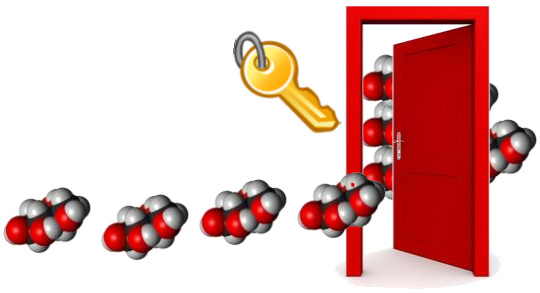


The body must store some for later

Next

Minimise Close

To store glucose, the body produces insulin

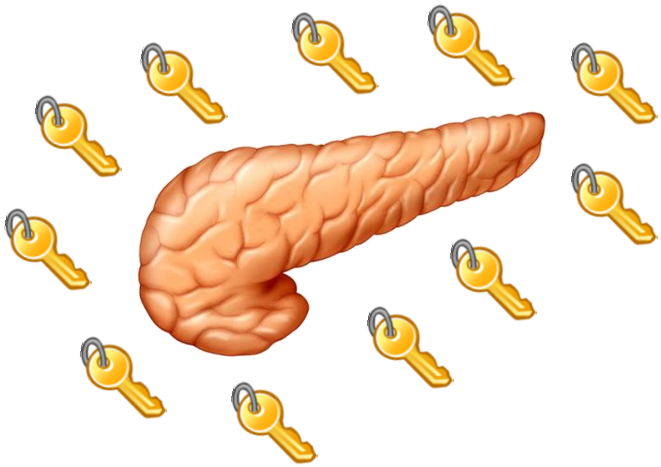


Insulin works like a key that unlocks the door of our cells to let the glucose in

Next

Minimise Close

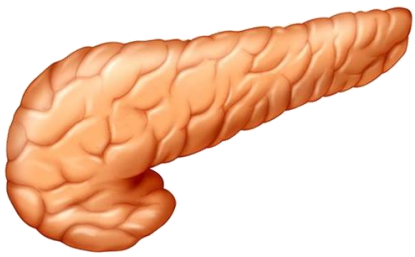
Our pancreas makes insulin



Next

Minimise Close

In some people the pancreas is not able to make insulin



This condition is called type 1 diabetes

Next

Minimise Close

Without insulin, the glucose in our blood cannot be stored

This causes high blood glucose levels

Next

Minimise Close

To prevent this, people with type 1 diabetes inject insulin when they eat

Next

Minimise Close

Food, stress and exercise change our blood glucose levels.

We must first learn more about this, before working out how much insulin to use.

Next

Minimise Close

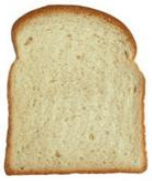
We call one teaspoon of sugar one ets

1  = 1 ets

Next

Minimise Close

Using ets for food makes it easy.

 = 3 ets

 = 10 ets

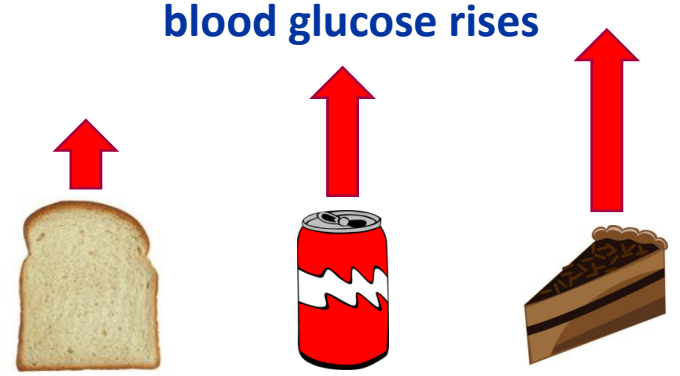
 = 3 ets

 = 8 ets

Next

Minimise Close

The more ets we eat, the higher our blood glucose rises



3 ets 8 ets 10 ets

Next

Minimise Close

When we stress, our blood glucose also rises

Next

Minimise Close

We also use ets to see how much energy we use during exercise

Running for one hour

= 20 ets

Next

Minimise Close

The more ets we exercise, the lower our blood glucose goes.

5 ets

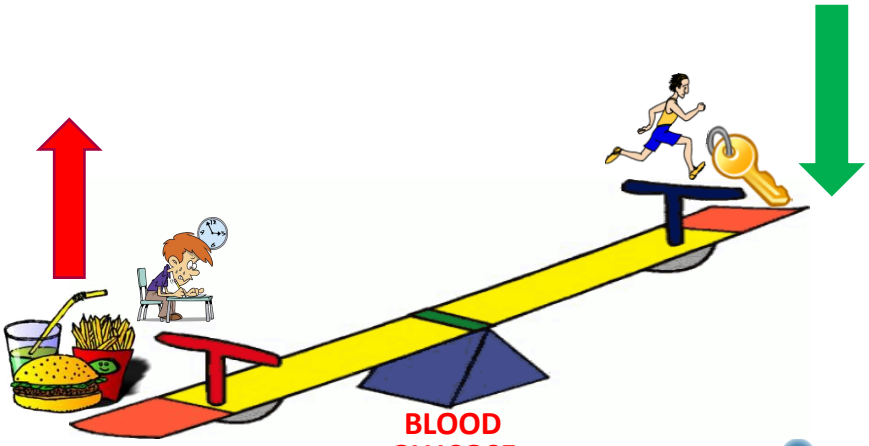
10 ets

15 ets

Next

Minimise Close

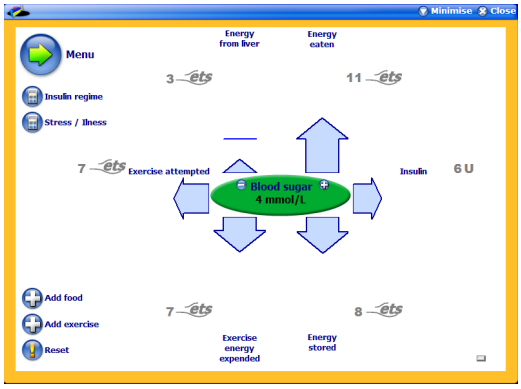
We need to balance food and stress with exercise and insulin



Next

Minimise Close

To show you how, we will use *Diabetes Edutool.*

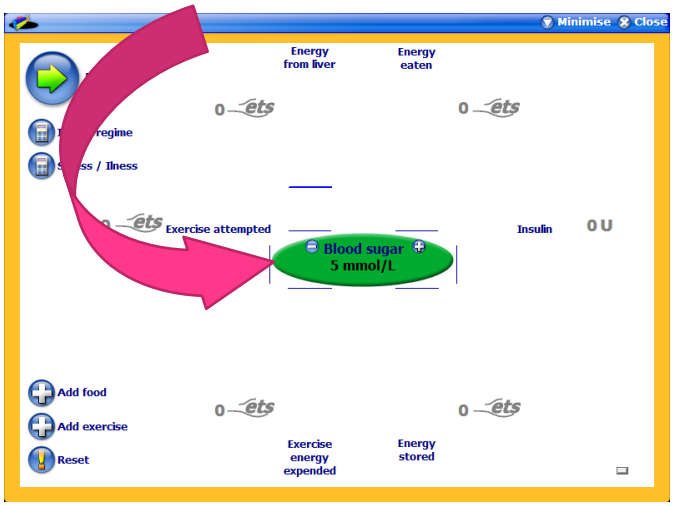


It shows you how the **blood glucose** of people with type 1 diabetes **changes**

Next

Minimise Close

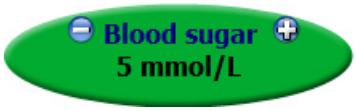
The oval shape in the middle shows the blood glucose level.



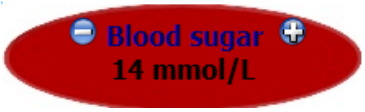
Next

Minimise Close

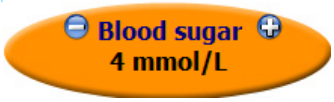
The colour of the oval means:



Blood glucose normal



Blood glucose too high or too low



Blood glucose slightly high or slightly low

Next

Minimise Close

Lets look at an example:

Arnold has type 1 diabetes.

What happens to his blood glucose after…


+


How much insulin will he need?

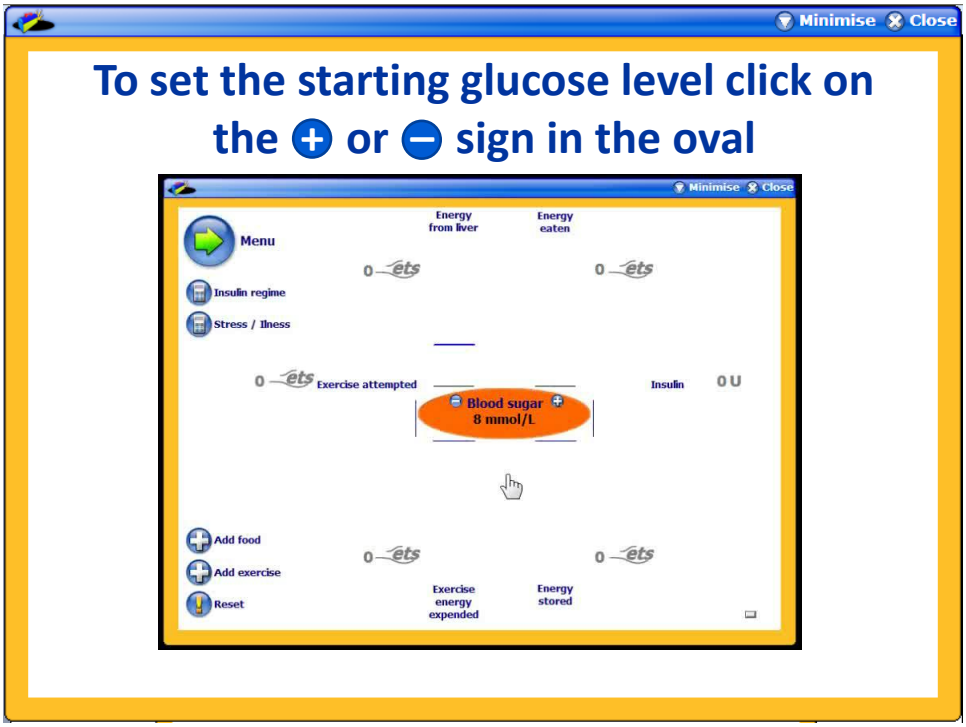

?

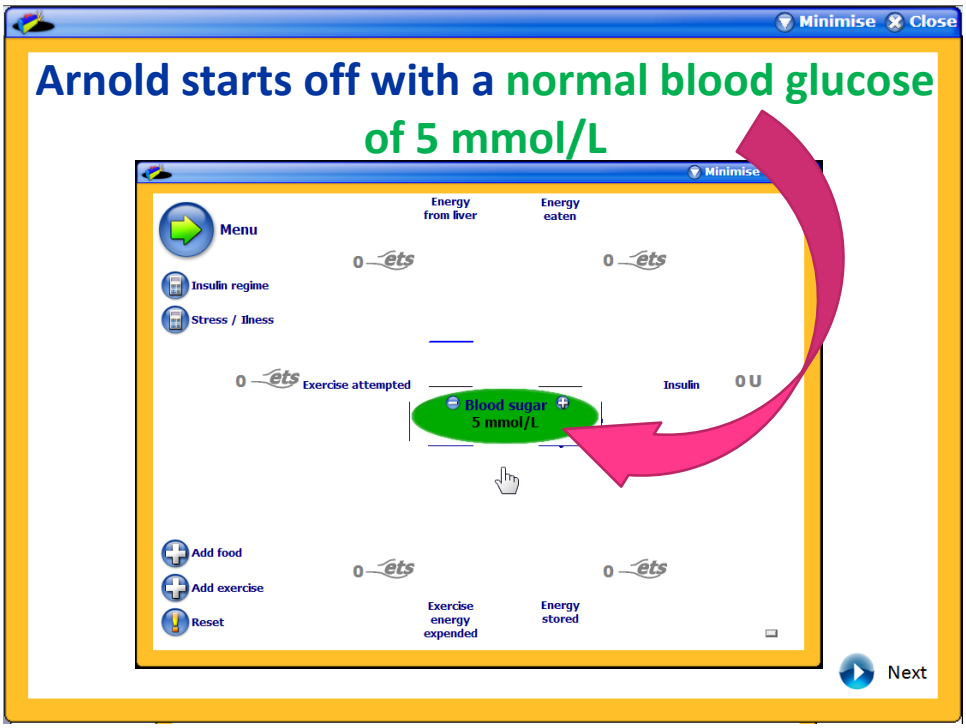
Next

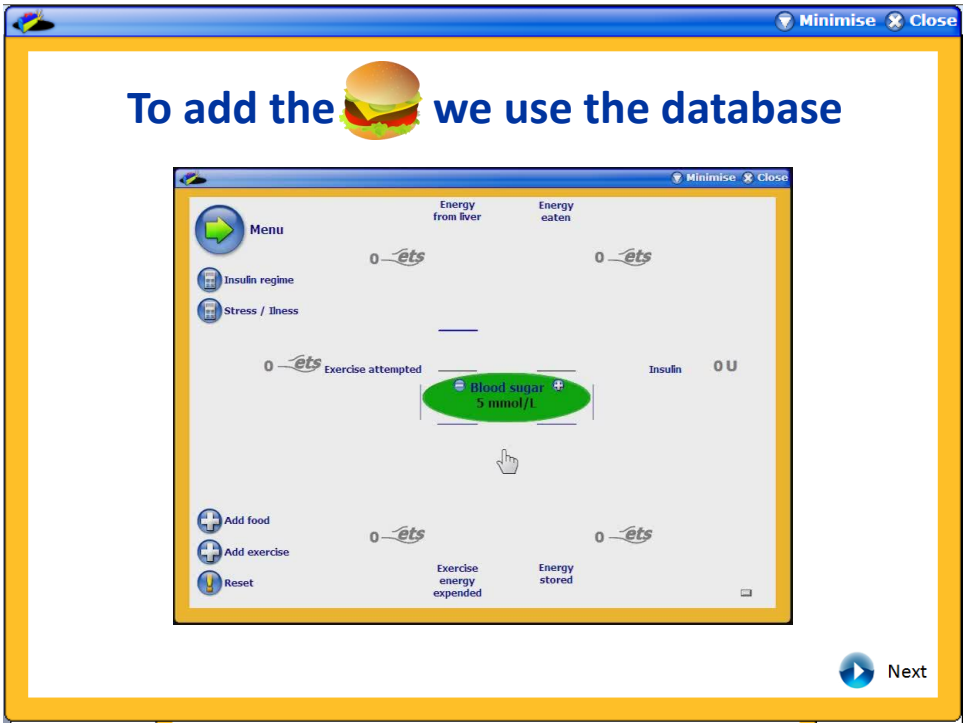
Minimise Close

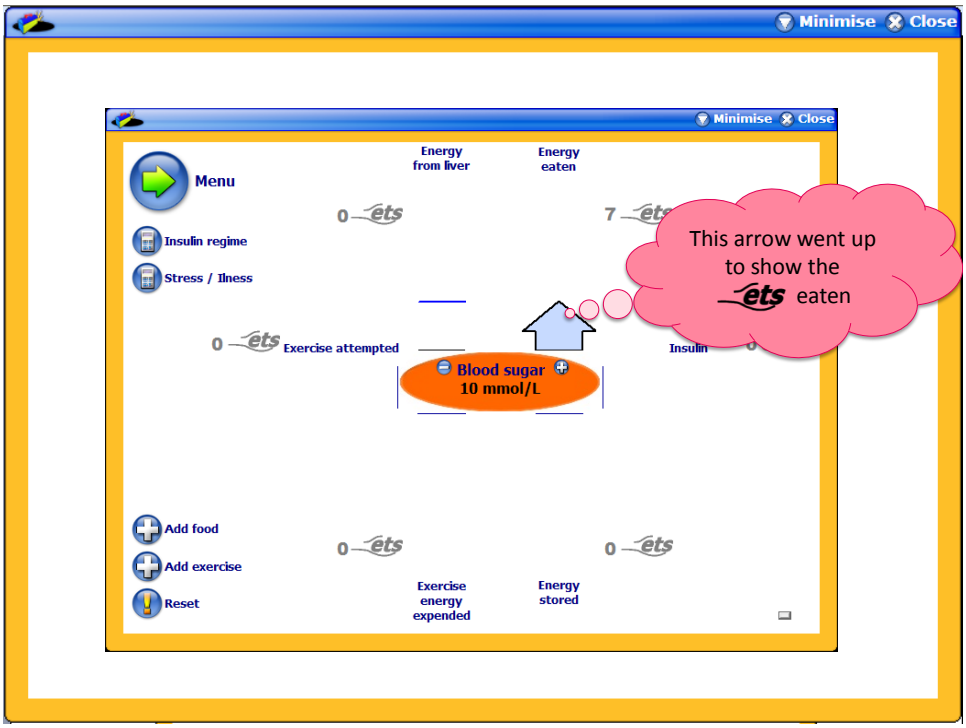
Before we start, we must first measure Arnold's blood glucose level

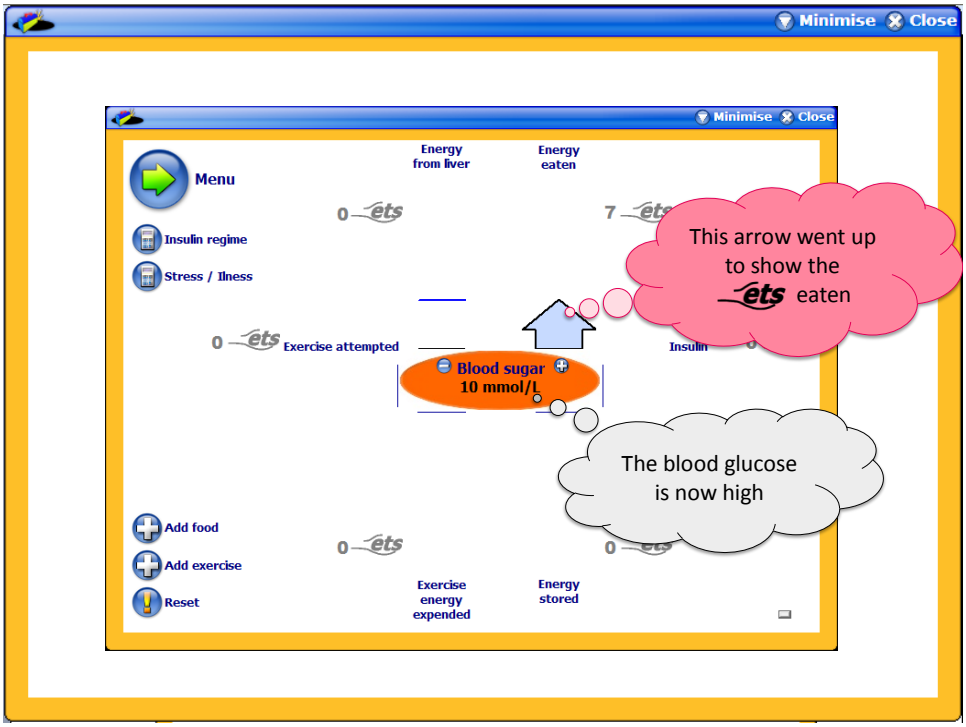
It is 5 mmol/L

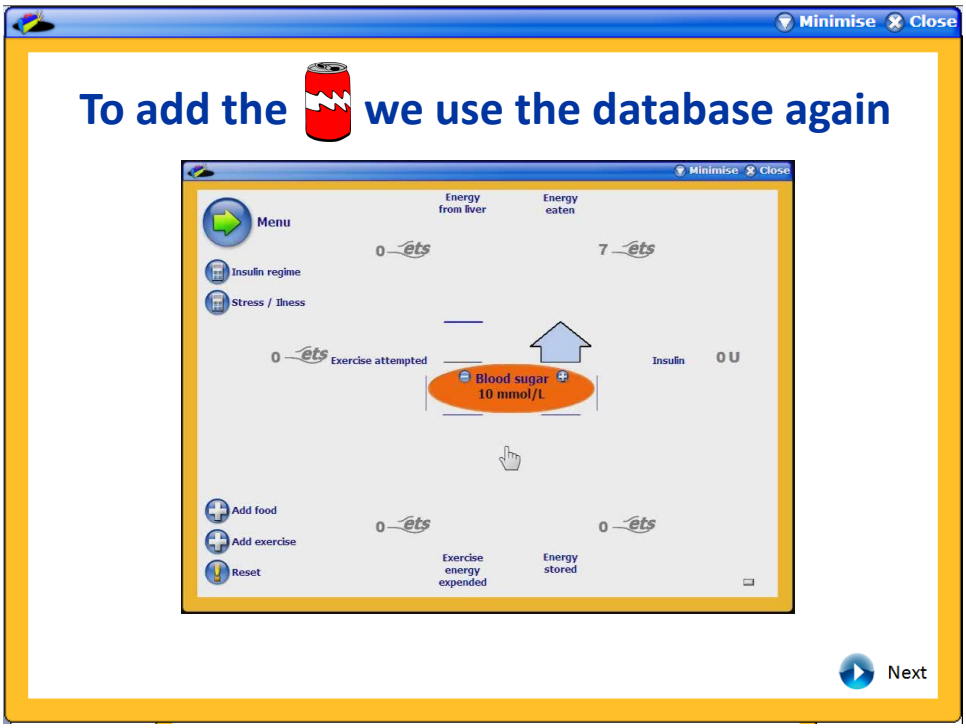

Minimise
Close
To set the starting glucose level click on the ⊕ or ⊖ sign in the oval
Menu
Energy from liver
Energy eaten
Insulin regime
Stress / Illness
Exercise attempted
Insulin
0 U
Blood sugar
8 mmol/L
Add food
Add exercise
Reset
Exercise energy expended
Energy stored

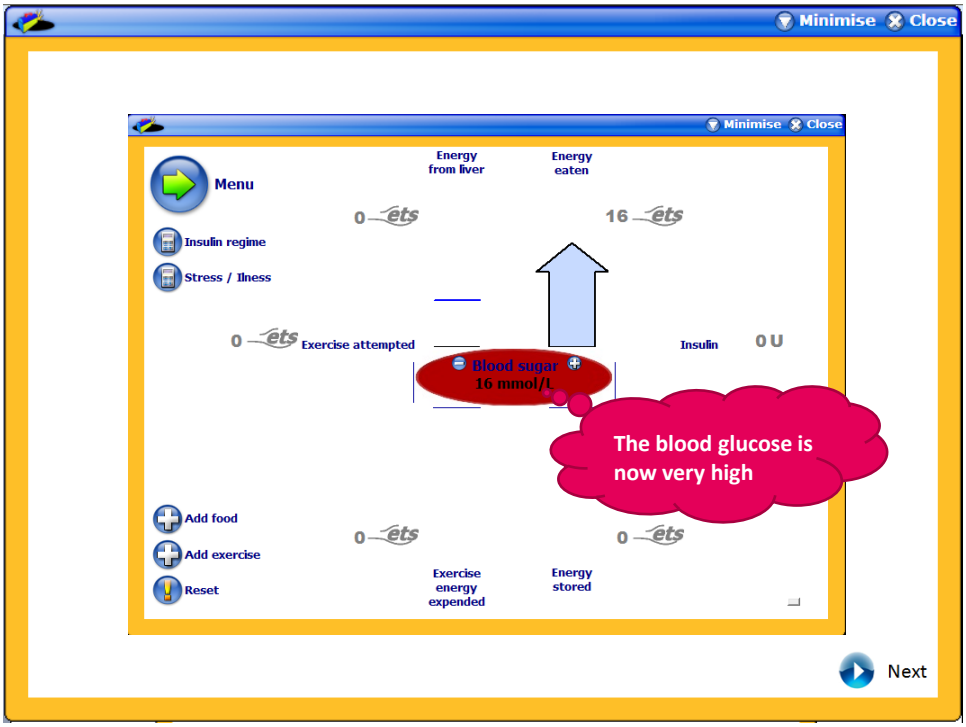

Minimise
Close
Arnold starts off with a normal blood glucose of 5 mmol/L
Menu
Energy from liver
Energy eaten
Insulin regime
Stress / Illness
Exercise attempted
Insulin
0 U
Blood sugar
5 mmol/L
Add food
Add exercise
Reset
Exercise energy expended
Energy stored
Next

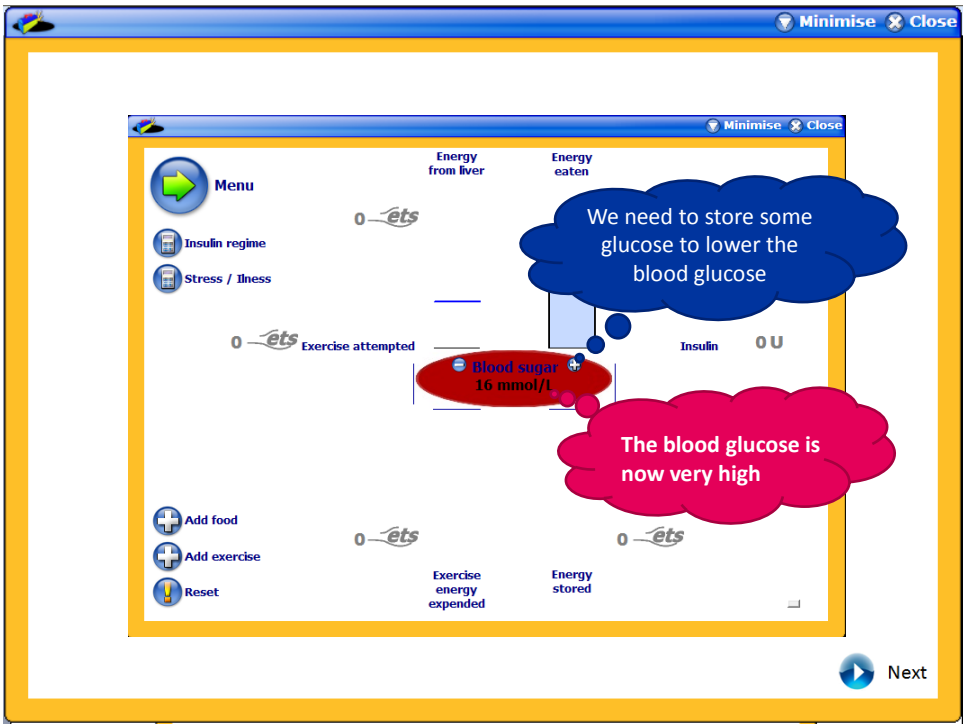

Minimise
Close
To add the
we use the database
Minimise
Close
Energy from liver
Energy eaten
Menu
0
0
Insulin regime
Stress / Illness
0
Exercise attempted
Insulin
0 U
Blood sugar
5 mmol/L
Add food
0
0
Add exercise
Reset
Exercise energy expended
Energy stored
Next

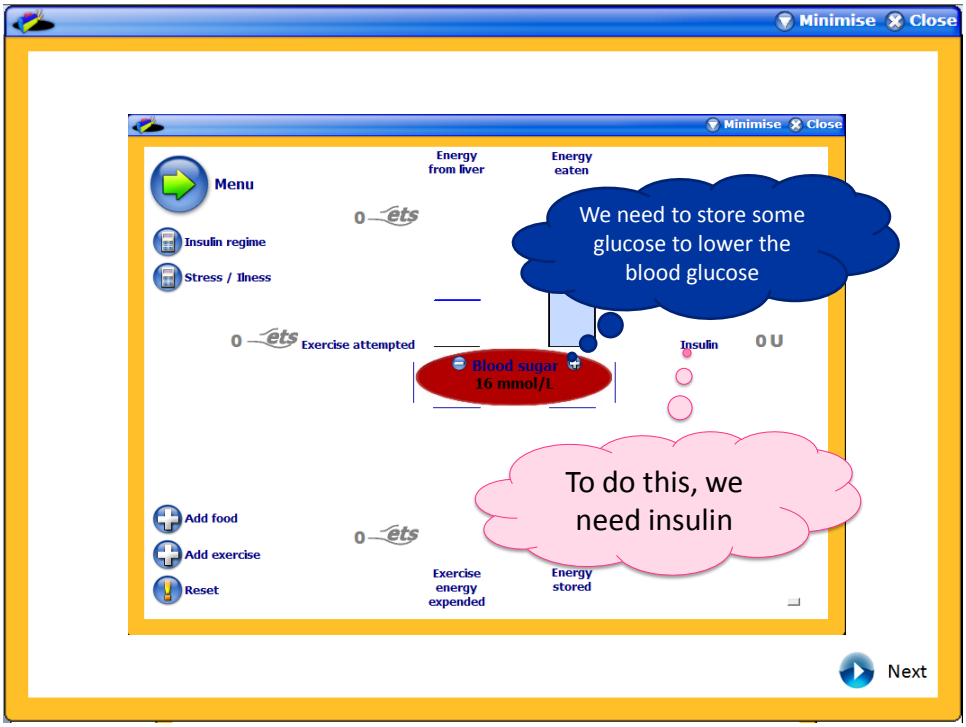

Minimise
Close
Minimise
Close
Energy from liver
Energy eaten
Menu
0
7
This arrow went up to show the
eaten
Insulin regime
Stress / Illness
0
Exercise attempted
Insulin
Blood sugar
10 mmol/L
Add food
0
0
Add exercise
Reset
Exercise energy expended
Energy stored

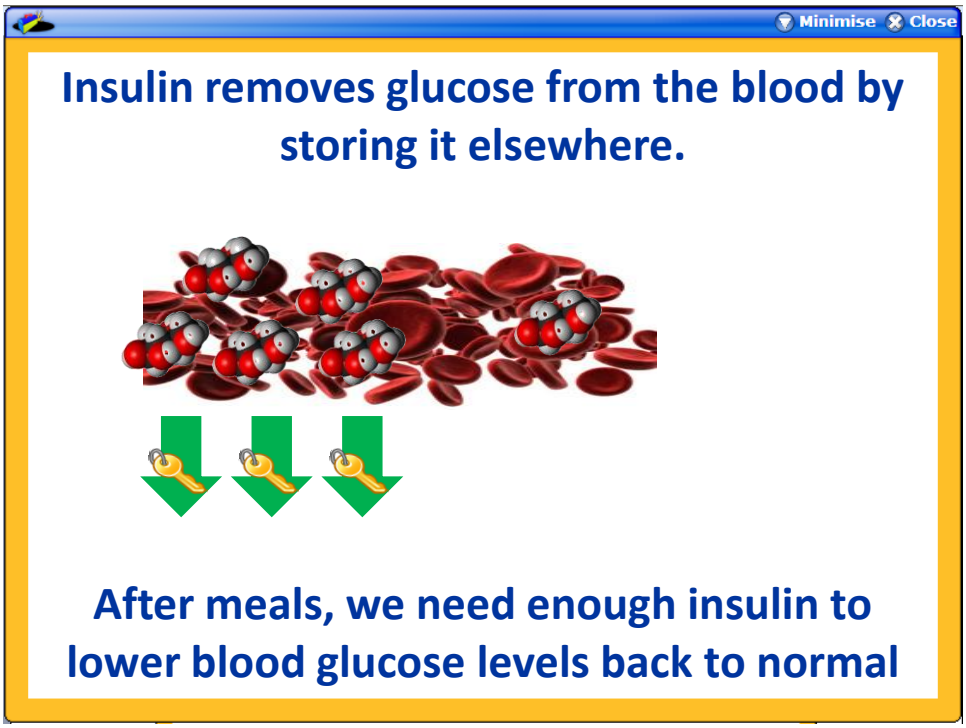

Minimise
Close
Menu
Energy from liver
Energy eaten
0
7
Insulin regime
Stress / Illness
0
Exercise attempted
Blood sugar
10 mmol/L
Insulin
This arrow went up to show the ets eaten
The blood glucose is now high
Add food
Add exercise
Reset
0
0
Exercise energy expended
Energy stored


Minimise
Close
To add the
we use the database again
Menu
Energy from liver
Energy eaten
0
7
Insulin regime
Stress / Illness
0
Exercise attempted
Blood sugar
10 mmol/L
Insulin
0 U
Add food
Add exercise
Reset
0
0
Exercise energy expended
Energy stored
Next


Minimise
Close
Menu
Energy from liver
Energy eaten
0 ets
16 ets
Insulin regime
Stress / Illness
0 ets
Exercise attempted
Insulin
0 U
Blood sugar
16 mmol/L
The blood glucose is now very high
Add food
Add exercise
Reset
0 ets
0 ets
Exercise energy expended
Energy stored
Next

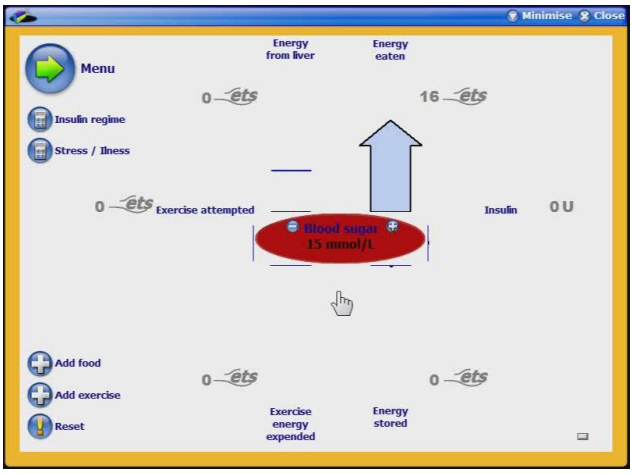

Minimise
Close
Menu
Energy from liver
Energy eaten
0 ets
We need to store some glucose to lower the blood glucose
Insulin regime
Stress / Illness
0 ets
Exercise attempted
Insulin
0 U
Blood sugar
16 mmol/L
The blood glucose is now very high
Add food
Add exercise
Reset
0 ets
0 ets
Exercise energy expended
Energy stored
Next


Minimise
Close
Minimise
Close
Energy from liver
Energy eaten
Menu
0 ets
Insulin regime
Stress / Illness
We need to store some glucose to lower the blood glucose
0 ets
Exercise attempted
Blood sugar 16 mmol/L
Insulin
0 U
To do this, we need insulin
Add food
0 ets
Add exercise
Reset
Exercise energy expended
Energy stored
Next


Minimise
Close
Insulin removes glucose from the blood by storing it elsewhere.
After meals, we need enough insulin to lower blood glucose levels back to normal

Minimise Close

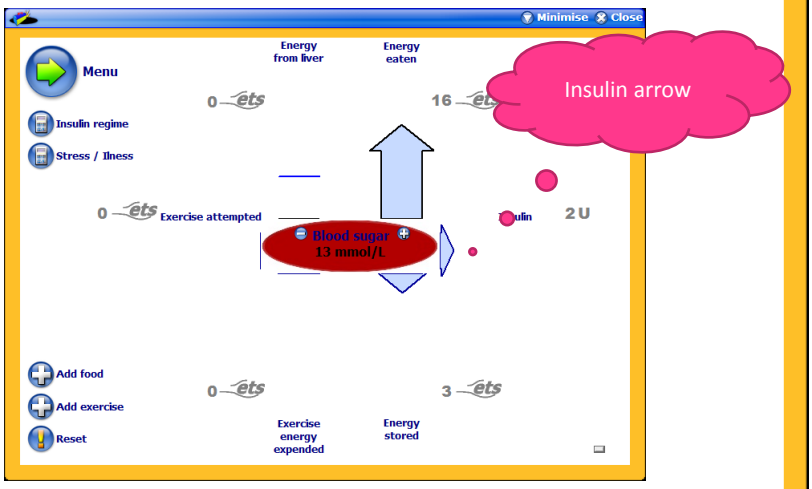
To add the insulin, we drag the insulin arrow to the right until the blood glucose is normal



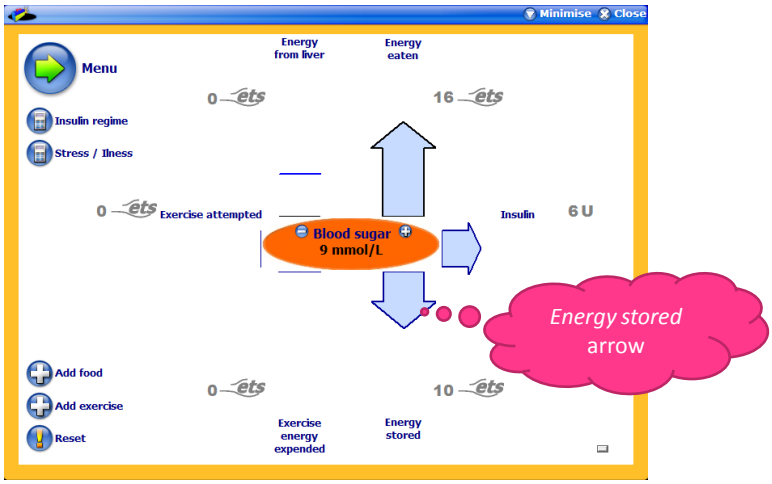
Next

Minimise Close

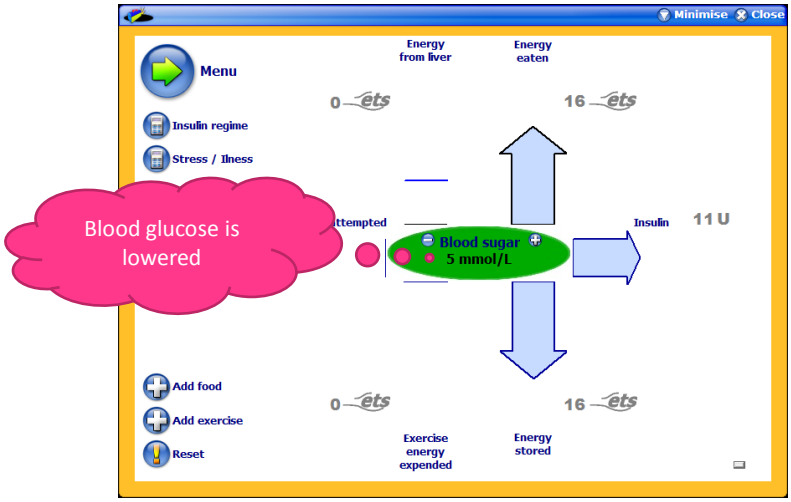
Lets recap.
1 – We increase the insulin



2- The insulin stores the glucose

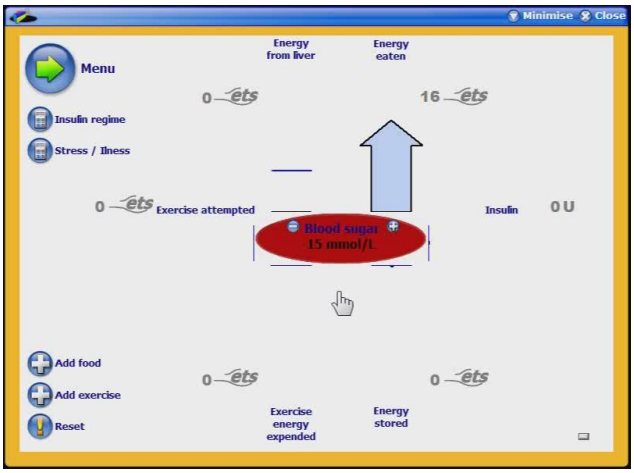


3 - The blood glucose decreases as the glucose is stored



Minimise Close

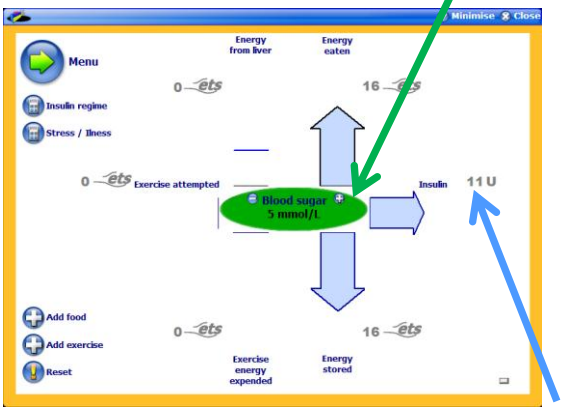
Lets see the insulin in action again:



Next

Minimise Close

The blood glucose is now normal again.



11 units of insulin was needed to lower Arnold's blood glucose to a normal level.

Next

Minimise Close

Question:

Arnold starts off with a blood glucose level of 7 mmol/L

What happens to his blood glucose after…


+

for 30 minutes

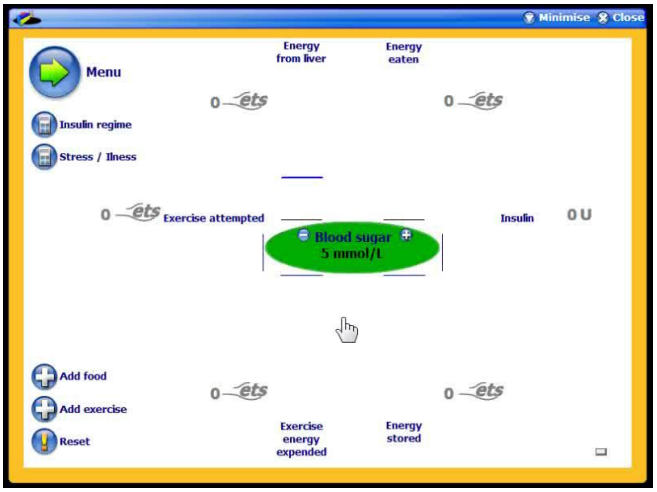
How much insulin will he need?


?

Next

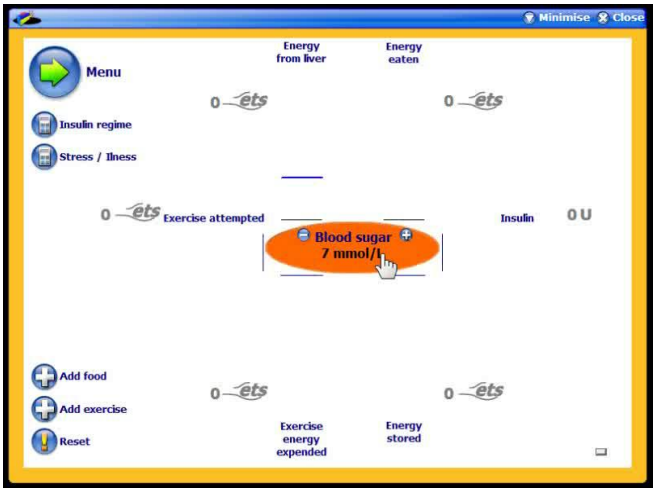
Minimise Close

Set the blood glucose level to 7 mmol/L



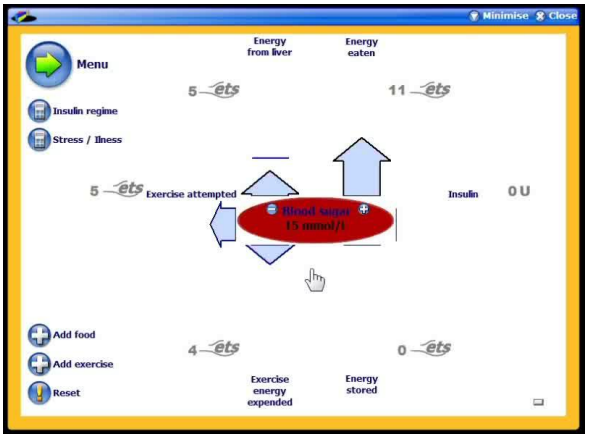
Minimise Close

Use the database to add the cake and exercise

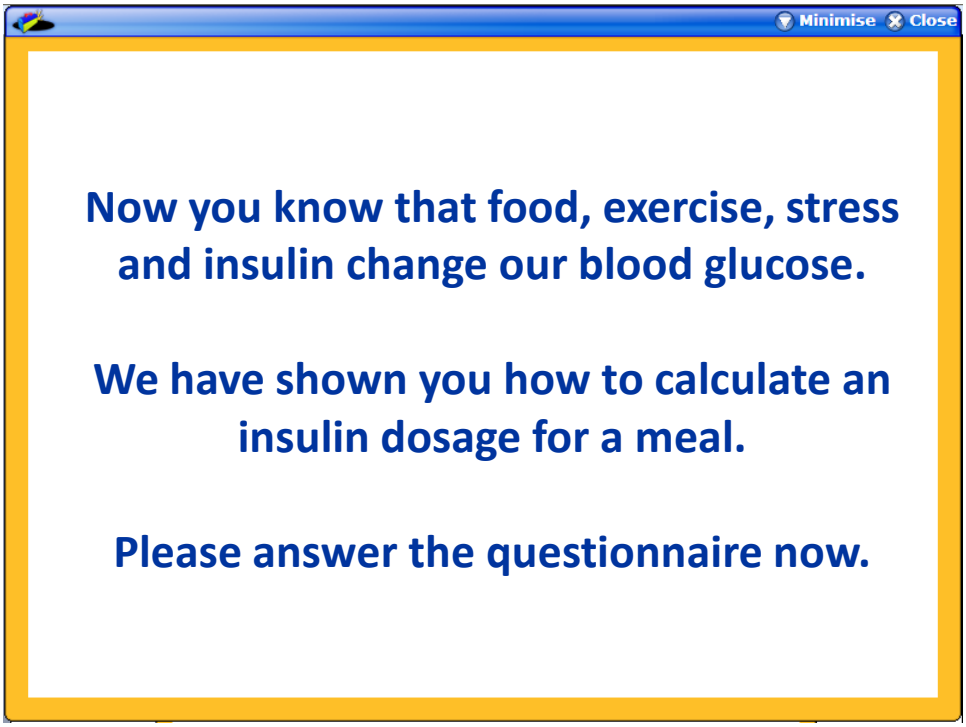


Minimise Close

Drag the insulin arrow to lower his blood glucose to 5 mmol/L



7 units of insulin was needed


Minimise
Close
Now you know that food, exercise, stress and insulin change our blood glucose.
We have shown you how to calculate an insulin dosage for a meal.
Please answer the questionnaire now.

Appendix C

Statistical analysis for results presented in Chapter 5.

C.1 Statistical analysis

This section will discuss the statistical analysis of the trial results presented in Chapter 5. Firstly, the primary school trial's results analysis will be done followed by the secondary school trial's results analysis.

Primary school trial

Statistical p-value calculation

The *p*-value of the trial with a sample size (n) of 17 and a chosen confidence interval of 95% will now be determined. This trial can be classified as a dependent *t*-test for paired samples. If the *p*-value is smaller than 0.05, it indicates a statistical significant improvement in results from questionnaire 1 to questionnaire 2.

This trial has a small sample size with a normal distribution. Therefore, it will no longer be true that for any sample size, n, the sampling distribution of is also normal. Another probability distribution for the small sample size is needed: the t-distribution with the standardised test statist, t, and (n – 1) degrees of freedom (df).

For a dependent *t*-test for paired samples, the test statistic can be calculated from

$$t = \frac{\bar{d} - \Delta}{s_d / \sqrt{n}}$$

Where $\bar{d}$ = the sample mean difference

$\Delta = \mu_1 - \mu_2$

s_d = sample standard deviation of the differences

n = number of sample differences

Using this t value, the *p*-value of the trial can now be determined. Table 26 was obtained from Dr Suria Ellis from the Statistical department at the North-West University. The values are obtained from a statistical calculator used by the department.

Table 26: The *p*-value calculation for the primary school trial (Ellis, 2011).

Variable	T-test for Dependent Samples (Power calculations) Marked differences are significant at p < .05000									
	Mean	Std.Dv.	N	Diff.	Std.Dv. Diff.	t	df	p	Confidence -95.000%	Confidence +95.000%
PQ #2	0.882353	0.118913								
PQ #1	0.628959	0.180882	17	0.253394	0.155674	6.711281	16	0.000005	0.173354	0.333434

PQ #1 and PQ #2 represent the primary school trial questionnaire 1 and 2 data, respectively. Mean and Std.Dv are the mean standard deviation for each questionnaire's overall test scores. N is the sample size. Diff and Std.Dv.Diff are the difference in mean values and the standard deviation of the differences, respectively. The t and *p* values are also given and also the upper and lower limits for the 95% confidence interval.

The *p*-value obtained ($p = 0.000005$) is significantly smaller than the required $p < 0.05$ (Stang *et al.*, 2010). This indicates a significant improvement in the overall test score results between questionnaire 1 and questionnaire 2.

References:

Devore J, Farnum N: Applied Statistics for Engineers and Scientists, 2nd Edition. Thomson Brooks/Cole, Belmont, 2005.

Dr Suria Ellis, School of Computer, Statistical and Mathematical Sciences of the North-West University, Potchefstroom campus. Tel: 018 299 2016, email: suria.ellis@nwu.ac.za. [Personal communication: 18/11/2011]

Stang A, Poole, Kuss O: The ongoing tyranny of statistical significance testing in biomedical research. European Journal of Epidemiology 2010; 25: 225-230.

Pre-trial questionnaire total test score analysis:

Participants	**Total test score**
1	84.62%
2	53.85%
3	76.92%
4	84.62%
5	46.15%
6	69.23%
7	46.15%
8	46.15%
9	69.23%
10	46.15%
11	69.23%
12	61.54%
13	38.46%
14	38.46%
15	61.54%
16	76.92%
17	100.00%
Average	**62.90%**

The mean for the pre-trial questionnaire total test score is 62.90%. The standard deviation for this set of results is calculated as follows:

Where —. Therefore, $\sigma = 18.09\%$ and the variance, σ^2, is 3.27%.

Post-trial questionnaire total test score analysis:

Participants	**Total test score**
1	100.00%
2	100.00%
3	92.31%
4	92.31%
5	84.62%
6	76.92%
7	92.31%
8	76.92%
9	76.92%
10	69.23%
11	92.31%
12	92.31%
13	61.54%
14	92.31%
15	100.00%
16	100.00%
17	100.00%
Average	**88.24%**

The mean for the post-trial questionnaire total test score is 88.24%. The standard deviation for this set of results is calculated as follows:

Where —. Therefore, $\sigma = 11.89\%$ and the variance, σ^2, is 1.42%.

Secondary school trial

Statistical p-value calculation

The *p*-value of the trial with a sample size (n) of 16 and a chosen confidence interval of 95% will now be determined. This trial can be classified as a dependent *t*-test for paired samples. If the *p*-value is smaller than 0.05, it indicates a statistical significant improvement in results from questionnaire 1 to questionnaire 2.

This trial has a small sample size with a normal distribution. Therefore, it will no longer be true that for any sample size, n, the sampling distribution of is also normal. Another probability distribution for the small sample size is needed: the t-distribution with the standardised test statist, t, and (n – 1) degrees of freedom (df).

For a dependent *t*-test for paired samples, the test statistic can be calculated from

$$t = \frac{\bar{d} - \Delta}{s_d / \sqrt{n}}$$

Where $\bar{d}$ = the sample mean difference

$\Delta = \mu_1 - \mu_2$

s_d = sample standard deviation of the differences

n = number of sample differences

Using this t value, the *p*-value of the trial can now be determined. Table 27 was obtained from Dr Suria Ellis from the Statistical department at the North-West University. The values are obtained from a statistical calculator used by the department.

Table 27: The *p*-value calculation for the secondary school trial (Ellis, 2011).

Variable	T-test for Dependent Samples (Power calculations) Marked differences are significant at p < .05000									
	Mean	Std.Dv.	N	Diff.	Std.Dv. Diff.	t	df	p	Confidence -95.000%	Confidence +95.000%
SQ #2	0.870192	0.096154								
SQ #1	0.644231	0.131371	16	0.225962	0.144508	6.254632	15	0.000015	0.148959	0.302965

SQ #1 and SQ #2 represent the primary school trial questionnaire 1 and 2 data, respectively. Mean and Std.Dv are the mean standard deviation for each questionnaire's overall test scores.

N is the sample size. Diff and Std.Dv.Diff are the difference in mean values and the standard deviation of the differences, respectively. The t and *p* values are also given and also the upper and lower limits for the 95% confidence interval.

The *p*-value obtained ($p = 0.000005$) is significantly smaller than the required $p < 0.05$ (Stang *et al.*, 2010). This indicates a significant improvement in the overall test score results between questionnaire 1 and questionnaire 2.

References:

Devore J, Farnum N: Applied Statistics for Engineers and Scientists, 2nd Edition. Thomson Brooks/Cole, Belmont, 2005.

Dr Suria Ellis, School of Computer, Statistical and Mathematical Sciences of the North-West University, Potchefstroom campus. Tel: 018 299 2016, email: suria.ellis@nwu.ac.za. [Personal communication: 18/11/2011]

Stang A, Poole, Kuss O: The ongoing tyranny of statistical significance testing in biomedical research. European Journal of Epidemiology 2010; 25: 225-230.

Pre-trial questionnaire total test score analysis:

Participants	**Total test score**
1	53.85%
2	38.46%
3	61.54%
4	61.54%
5	76.92%
6	61.54%
7	76.92%
8	76.92%
9	76.92%
10	76.92%
11	46.15%
12	53.85%
13	61.54%
14	84.62%
15	53.85%
16	69.23%
Average	**64.42%**

The mean for the pre-trial questionnaire total test score is 64.42%. The standard deviation for this set of results is calculated as follows:

Where —. Therefore, $\sigma = 13.14\%$ and the variance, σ^2, is 1.73%.

Pre-trial questionnaire total test score analysis:

Participants	**Total test score**
1	76.92%
2	76.92%
3	84.62%
4	84.62%
5	84.62%
6	76.92%
7	84.62%
8	84.62%
9	84.62%
10	92.31%
11	100.00%
12	100.00%
13	100.00%
14	100.00%
15	69.23%
16	92.31%
Average	**87.02%**

The mean for the post-trial questionnaire total test score is 87.02%. The standard deviation for this set of results is calculated as follows:

Where —. Therefore, $\sigma = 9.62\%$ and the variance, σ^2, is 0.92%.

Appendix D

Electronic appendix

Included in the electronic appendix is the install file for the Edutool diabetes simulator and the quick-start guide presentation. An Acrobat Reader .pdf file of the dissertation is also included.