Next-Lab

Next Generation Stakeholders and Next Level Ecosystem for Collaborative Science Education with Online Labs

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Deliverable 3.4

First releases of the ePortfolio and modelling app

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Executive Summary

The actual D3.4 deliverable consists of the first software releases of the ePortfolio features of Graasp (http://graasp.eu) and of the Modelling app called Gomodel (https://www.golabz.eu/app/gomodel). Hence, this document is just providing a general description of the releases and some complementary information.

The ePortfolio features of Graasp and the Modelling app have been defined in D3.1 (Specifications, mock-ups and/or prototypes of 21st century apps, self- and peer assessment apps, ePortfolio, and Modelling app), delivered in M9.

The core part of the document is written in a form very close to a user guide to be refined later and to be distributed to teachers. Additional sections (4.1 and 4.2) are describing the features and planning towards the final releases.

The final releases will be described in D3.6 (Final releases of the 21st century apps, self- and peer assessment apps, and modelling app) and D3.7 (Final releases of the ePortfolio and modelling app), which will be released in M36.

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1. Introduction

1.1 ePortfolio

1.1.1 General ePortfolio concept

As stated in the Grant Agreement, the ePortfolio features that are developed in the framework of Task 3.3 enable the learner to select, organise, and highlight artefacts as results and outcomes of learning activities. Thanks to these features, the learner should be able to decide on various privacy levels for his/her artefacts to build a representative collection of artefacts and/or to allow peers to re-use his/her documents. The different artefact types in the learner's ePortfolio may include (but are not limited to) lab configurations, data sets, models (cf. Task 3.4 and Section 1.2 Modelling app), reports, as well as teacher and peer feedback. Due to the nature and the way the learning activities are supported, these artifacts are embedded in the inquiry learning spaces used to create or gather them. Lifelong access to these inquiry learning spaces by the students in their ePortfolio should be guaranteed, independently of the existence of their original versions owned by the teachers. Dedicated persistent spaces can be freely created in Graasp as ePortfolios to collect the artifacts listed above.

1.1.2 ePortfolio features

The specifications of the ePortfolio have been defined in Section 4 of D3.1 delivered in month 9 and published at the World Engineering Education Forum in November 2017[1]. It has been shown that such an ePortfolio can be offered to the users of the Go-Lab ecosystem simply as additional or strengthened features of the Graasp authoring and learning platform. A short summary of these features is given below.

- The first core feature is **easy export** in standard formats for backup and archiving. The selected formats are PNG, PDF and eBook EPUB3. This work has been completed during the first 18 months of the Next-Lab project and a description written in a form very close to a user guide on how to use the current initial version is provided in Section 1.3.
- The second core feature is **lifelong access and control** for students over their learning outputs and activity traces within the platform itself. This feature will be implemented in the last 18 months of the project and will be reported on D3.7 in M36.
- The last core feature is **full archiving** of the resources provided by the teachers, the personal learning outcome, as well as individual activity traces. This work is in progress.

Any personal collection of inquiry learning spaces stored in Graasp can be considered as an ePortfolio for its owner, as it is persistent and can be freely shared with other users for temporary or permanent consultation or presentation.

[1] D. Gillet, M.J. Rodríguez-Triana, A. Vozniuk, A. Holzer, R. Matsuba, “Beyond ePortfolios Creating, Exploiting, and Archiving Activities, Learning Outcome, and Learning Analytics as Personal Shareable Online Spaces”, World Engineering Education Forum, WEEF 2017, Kuala Lumpur, Malaysia. November 2017.

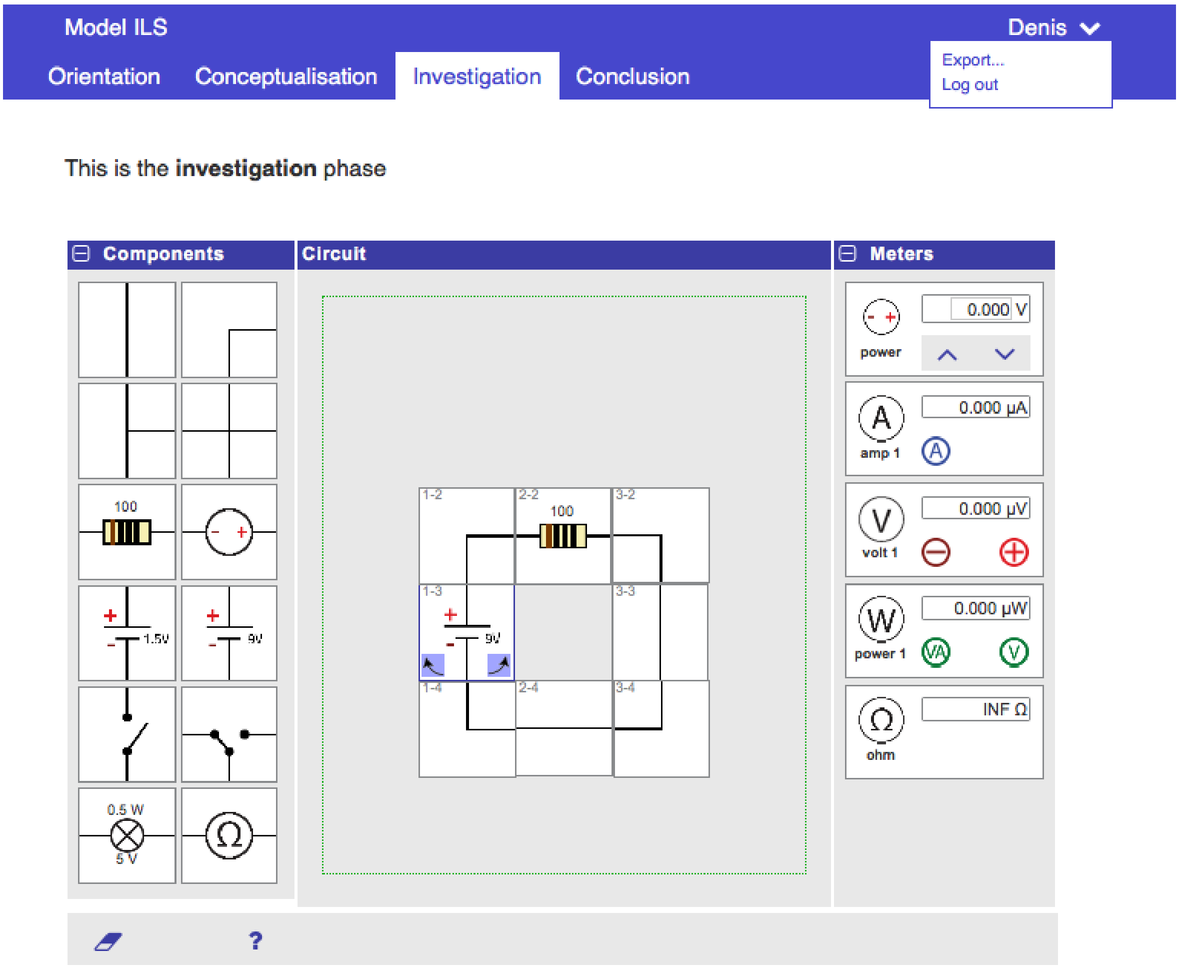
1.2 Modelling app

The Modelling app Gomodel can be used to construct and simulate models of scientific phenomena in various domains (e.g., biology, physics, chemistry, economics). There are three different interfaces offered by the app. In the *Model interface*, model creation is based on the graphic modelling language of the System Dynamics modelling approach (see Section 5.1 of D3.1). To simulate each model, a set of equations and initial values need to be given, which are derived from the structural configuration of model compartments and interrelations between compartments. This is operationalized in the *Model interface* and an overview is provided in the *Equations interface*. Upon valid insertion of each value or relation between structural compartments, the red space provided to the user turns into green colour (see Section 3.2, Figure 12), which allows the user to move on to the *Graph interface* and have an overview of the graph of the modelled system and observe the time trends of core variables (these are given by the app itself; see Section 3.2, Figures 14, 16, 19). All requirements and specifications for the Modelling app have been outlined in Section 5.1 of D3.1. For more information on Gomodel and its application, Section 3.1 gives an introductory overview, Section 3.2 presents a comprehensive overview of a model-based inquiry progression from an initial model showcasing exponential population growth (partial and full model), through logistic growth, to a more complex model depicting a prey-predator system. Section 3.3 refers to an instructional video for the initial model.

2. ePortfolio features of Graasp

2.1 Easy export feature

As mentioned above, the first release of the ePortfolio features focuses on easy export. At any stage during the usage of the standalone version of an Inquiry Learning Space (ILS), a student can decide to export the current state of his or her work. To do so, the user has to use the popup menu located in the top right hand corner of the user interface, which appears when clicking on the triangular shape next to the nickname (Figure 1).

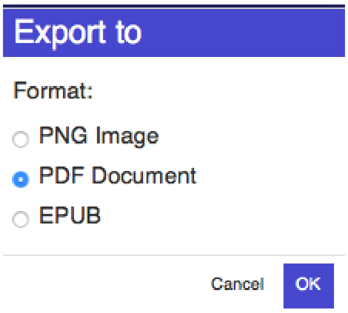


This is the **investigation** phase

Figure 1: Export menu in the standalone student view of an ILS

The user can choose between 3 export formats (Figure 2), namely:

- a single PNG image integrating all phases in a single document (Figure 3),
- a paginated PDF document (Figure 4), or
- a chapterised EPUB3 eBook (Figure 5) with a table of content and one Chapter per phase.



Export to

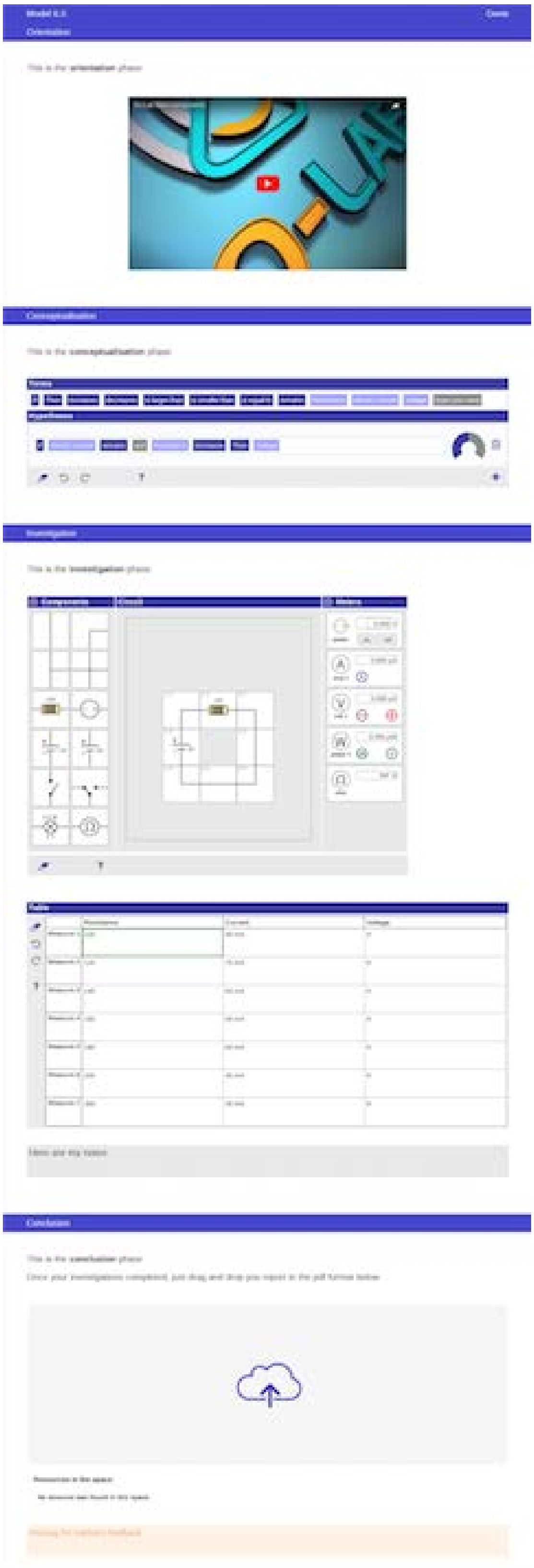
Format:

○ PNG Image

● PDF Document

○ EPUB

Fig. 2: The export options for users



Model ILS — Denis

Orientation

This is the **orientation** phase

Conceptualisation

This is the **conceptualisation** phase

Investigation

This is the **investigation** phase

Table

	Resistance	Current	Voltage
Measure 1	[illegible]	[illegible]	[illegible]
Measure 2	[illegible]	[illegible]	[illegible]
Measure 3	[illegible]	[illegible]	[illegible]
Measure 4	[illegible]	[illegible]	[illegible]
Measure 5	[illegible]	[illegible]	[illegible]
Measure 6	[illegible]	[illegible]	[illegible]
Measure 7	[illegible]	[illegible]	[illegible]

Here are my notes

Conclusion

This is the **conclusion** phase

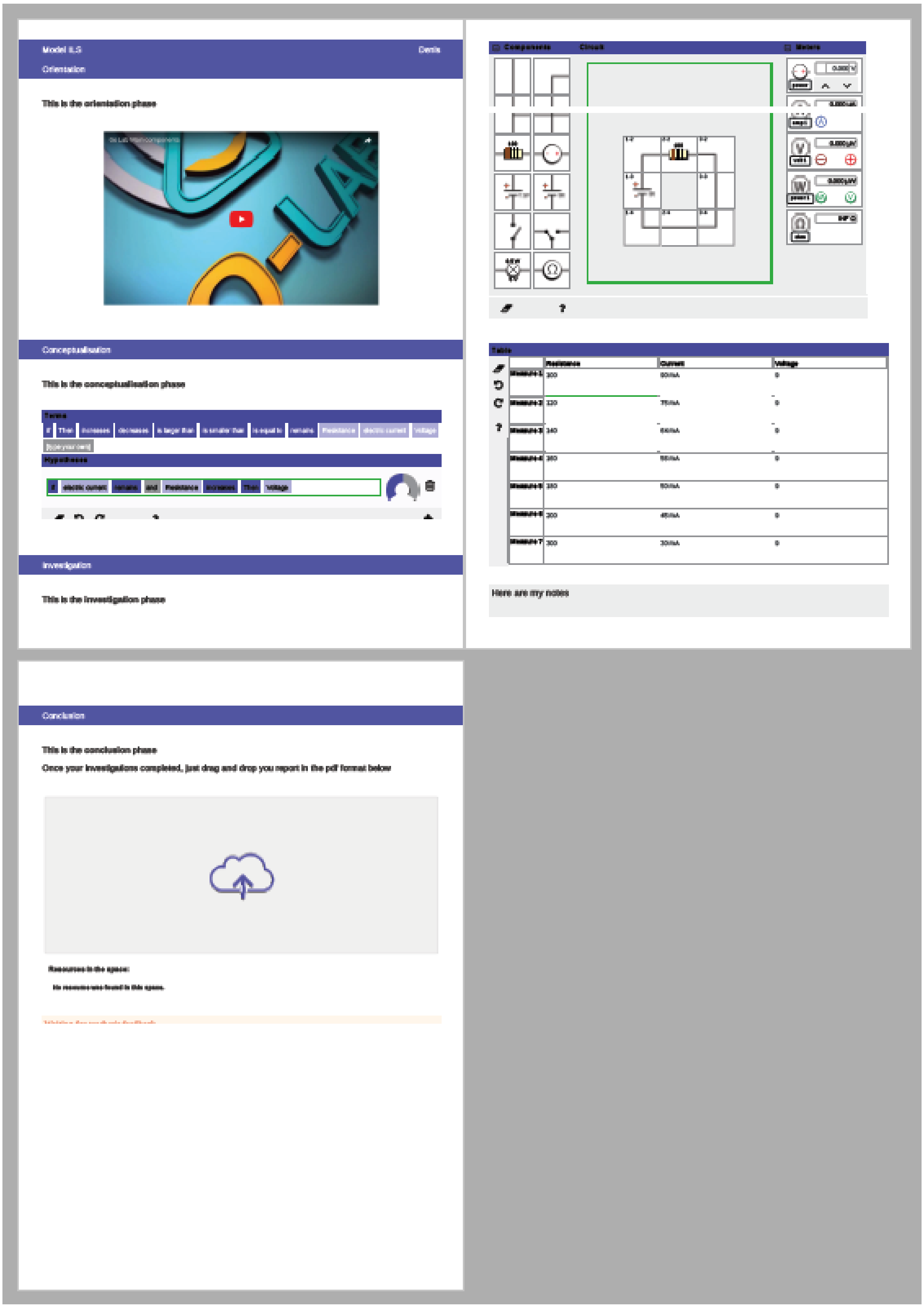
Once your investigations completed, just drag and drop you report in the pdf format below

Resources in this space

No resource was found in this space

Waiting for teacher's feedback

Figure 3: The exported PNG image (single file) of his *Model ILS* for the student *Denis*



Model ILS Denis

Orientation

This is the orientation phase

Conceptualisation

This is the conceptualisation phase

Terms

If | Then | increases | decreases | is larger than | is smaller than | is equal to | remains | Resistance | electric current | Voltage | [type your own]

Hypotheses

If | electric current | remains | and | Resistance | increases | Then | Voltage

Investigation

This is the investigation phase

Table

	Resistance	Current	Voltage
Measure-1	100	90mA	9
Measure-2	120	75mA	9
Measure-3	140	65mA	9
Measure-4	160	55mA	9
Measure-5	180	50mA	9
Measure-6	200	45mA	9
Measure-7	300	30mA	9

Here are my notes

Conclusion

This is the conclusion phase

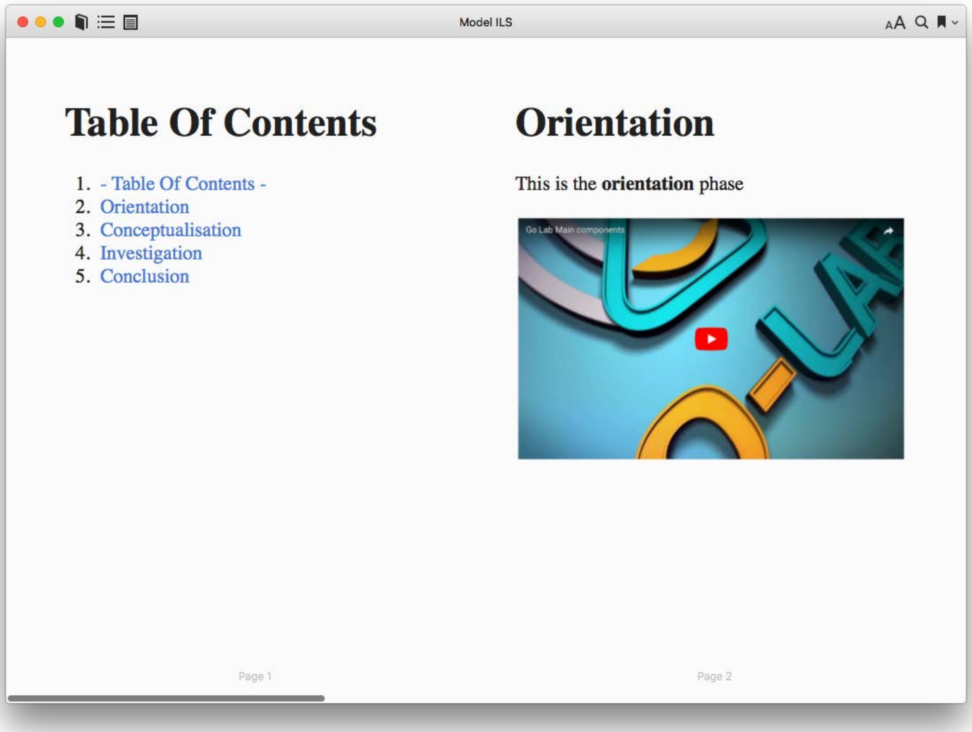
Once your investigations completed, just drag and drop you report in the pdf format below

Resources in the space:

No resources was found in this space.

Waiting for teacher's feedback

Figure 4: The exported PDF document (single file) of his *Model ILS* for the student *Denis*



Model ILS

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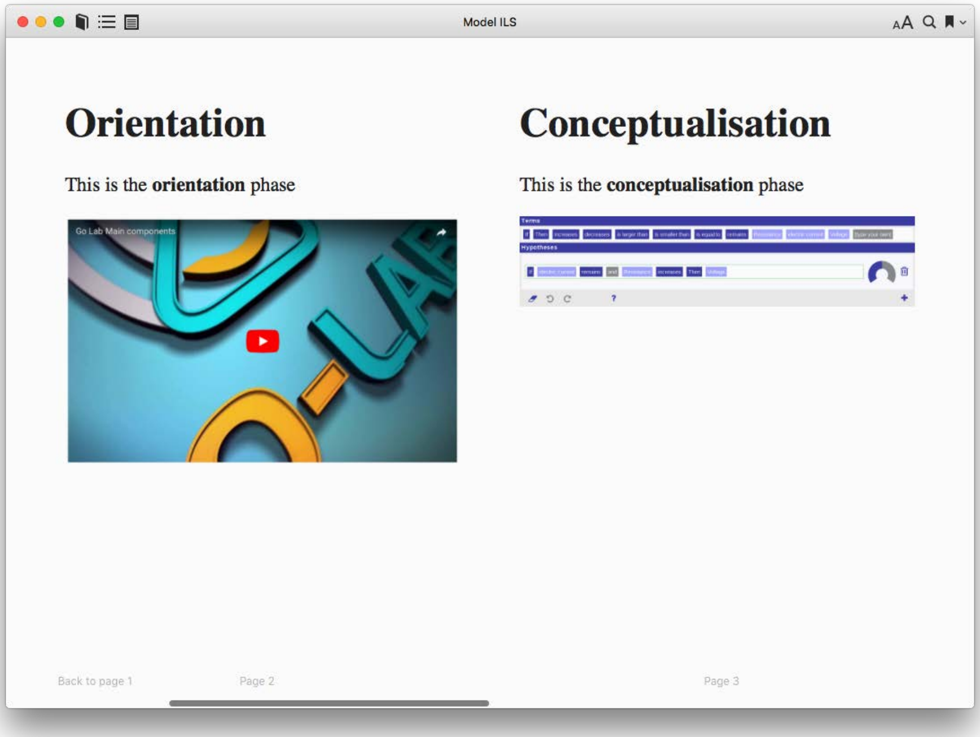
3. Conceptualisation
4. Investigation
5. Conclusion

Orientation

This is the **orientation** phase

Page 1

Page 2



Model ILS

Orientation

This is the **orientation** phase

Conceptualisation

This is the **conceptualisation** phase

Back to page 1

Page 2

Page 3

Figure 5: The exported EPUB3 eBook (single file) of his *Model ILS* for the student *Denis (as displayed on Mac OS using the Apple iBooks app)*

Although interactive content is supported by the EPUB3 standard[2], not all eBook readers incorporate this feature. In order to provide a consistent experience, the current state of the apps and labs are exported as images. This is also the case with video content. In the final release of the ePortfolio, if possible, some interactive resources will be exported as such.

2.2 Full archiving feature

Any space in Graasp can be saved as a zip archive for storage or further exploitation in another context. This will be especially true with personal copies of learning spaces once this option will be available to students.

To create a zip archive from the Graasp view provided to registered users with access to an ILS space, the "Download as zip" option of the popup menu located next to the name of the ILS has to be selected ("Model ILS" is the name of the ILS in Figure 6).

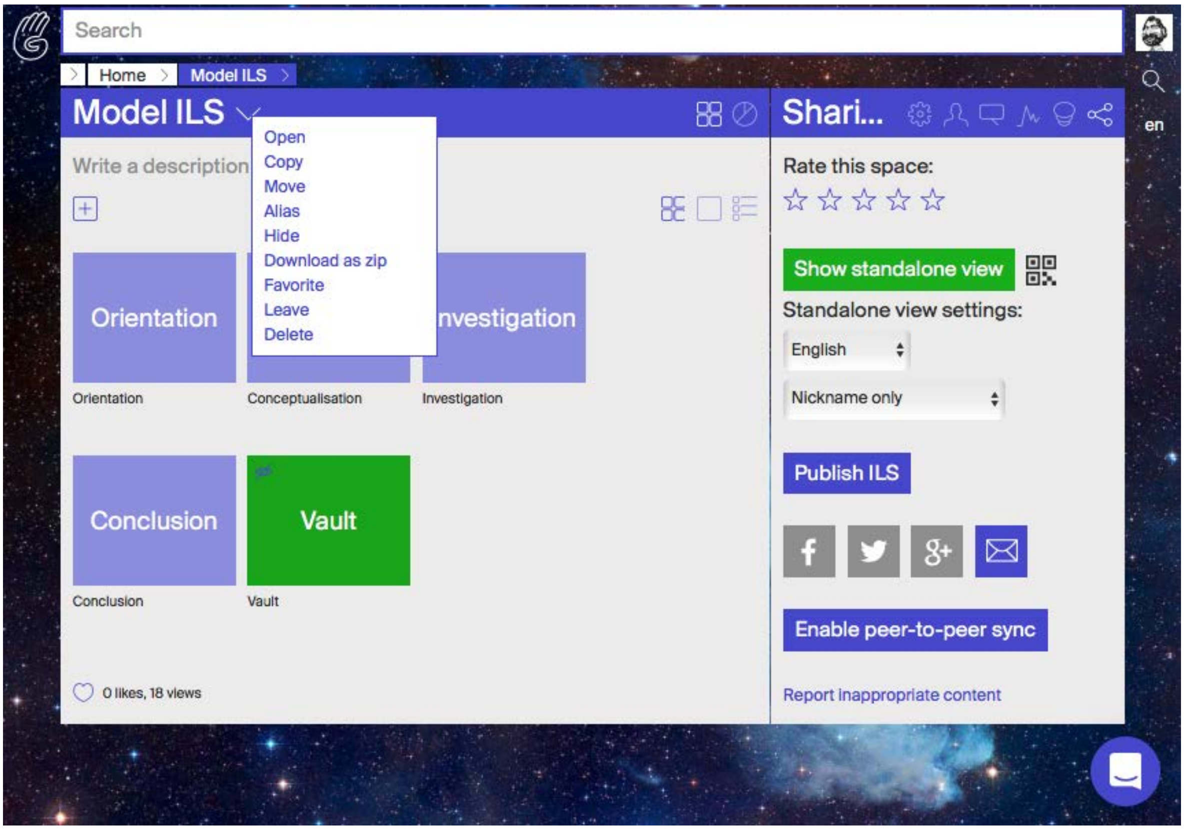
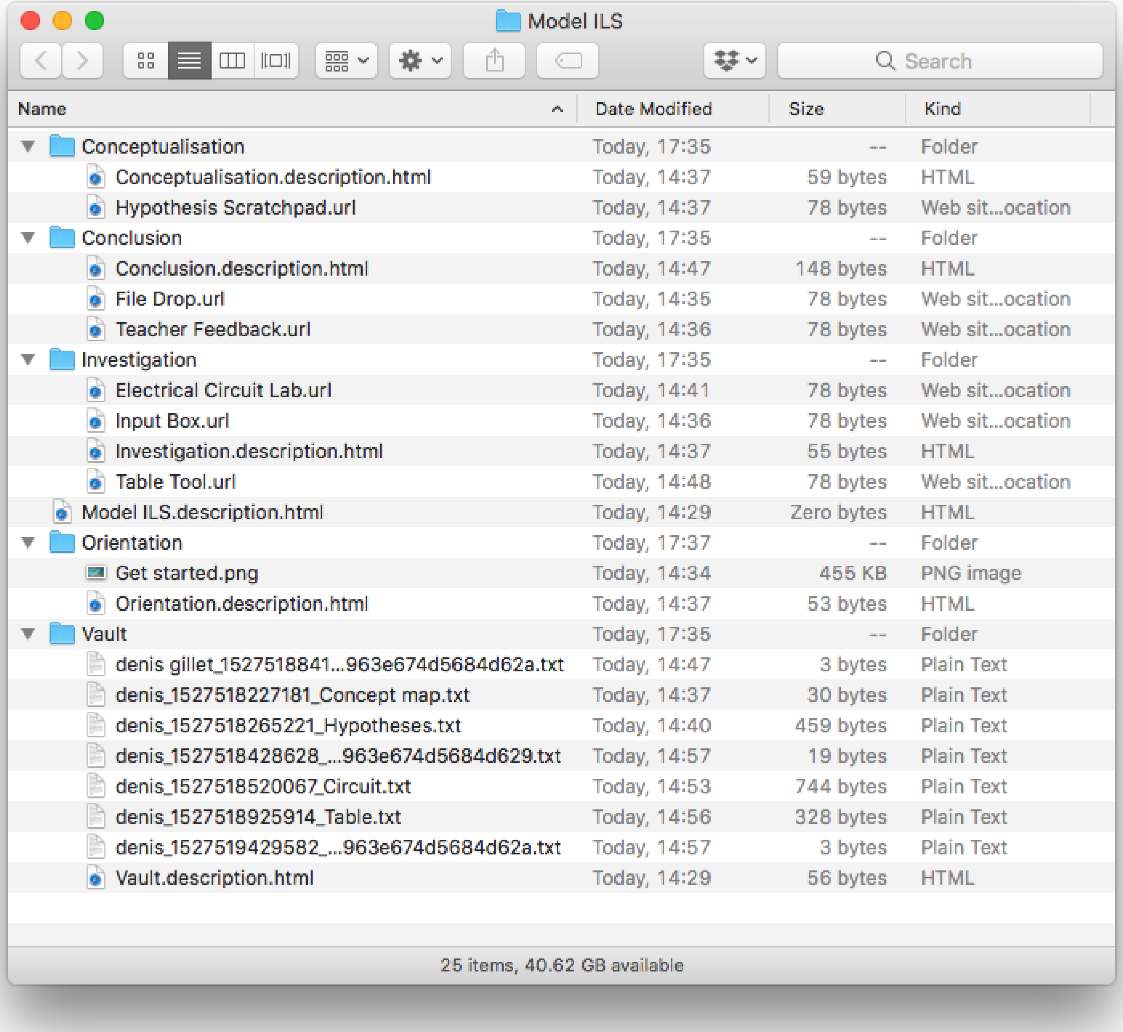


Figure 6: Full archiving of inquiry learning spaces in Graasp

The downloaded archive includes the resources located in each phase (as subfolders), as well as the description of each phase as a html file (Figure 7). The subfolder corresponding to the Vault includes all the configurations and the learning outputs of the students. In the final version of the ILS export for students, only the outputs of the student owning the copy of the ILS will be present. Currently, the archive belongs to a teacher and, hence, includes the outputs of all his or her students.

[2] http://www.idpf.org/epub/30/spec/epub30-overview.html



Name	Date Modified	Size	Kind
▼ Conceptualisation	Today, 17:35	--	Folder
Conceptualisation.description.html	Today, 14:37	59 bytes	HTML
Hypothesis Scratchpad.url	Today, 14:37	78 bytes	Web sit...ocation
▼ Conclusion	Today, 17:35	--	Folder
Conclusion.description.html	Today, 14:47	148 bytes	HTML
File Drop.url	Today, 14:35	78 bytes	Web sit...ocation
Teacher Feedback.url	Today, 14:36	78 bytes	Web sit...ocation
▼ Investigation	Today, 17:35	--	Folder
Electrical Circuit Lab.url	Today, 14:41	78 bytes	Web sit...ocation
Input Box.url	Today, 14:36	78 bytes	Web sit...ocation
Investigation.description.html	Today, 14:37	55 bytes	HTML
Table Tool.url	Today, 14:48	78 bytes	Web sit...ocation
Model ILS.description.html	Today, 14:29	Zero bytes	HTML
▼ Orientation	Today, 17:37	--	Folder
Get started.png	Today, 14:34	455 KB	PNG image
Orientation.description.html	Today, 14:37	53 bytes	HTML
▼ Vault	Today, 17:35	--	Folder
denis gillet_1527518841...963e674d5684d62a.txt	Today, 14:47	3 bytes	Plain Text
denis_1527518227181_Concept map.txt	Today, 14:37	30 bytes	Plain Text
denis_1527518265221_Hypotheses.txt	Today, 14:40	459 bytes	Plain Text
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denis_1527518925914_Table.txt	Today, 14:56	328 bytes	Plain Text
denis_1527519429582_...963e674d5684d62a.txt	Today, 14:57	3 bytes	Plain Text
Vault.description.html	Today, 14:29	56 bytes	HTML

25 items, 40.62 GB available

Figure 7: The file and folder structure integrated in the zip archive of the *Model ILS* example as seen by the teacher after downloading it in his or her computer

3. Gomodel Modelling app

3.1 Description

Gomodel can be used to explore and understand complex scientific phenomena, which may come from various domains (e.g., biology, physics, chemistry, economics). Complexity is introduced by the fact that these scientific phenomena present non-linear trends and dynamics, meaning that they do not always include proportional or inversely proportional relations between variables examined.

The modelling procedure is operationalized in Gomodel in a three-step approach by:

(1) constructing a model of the phenomenon under reference;

(2) defining the relations between structural compartments and their starting values; and

(3) simulating the phenomenon based on the model we have constructed.

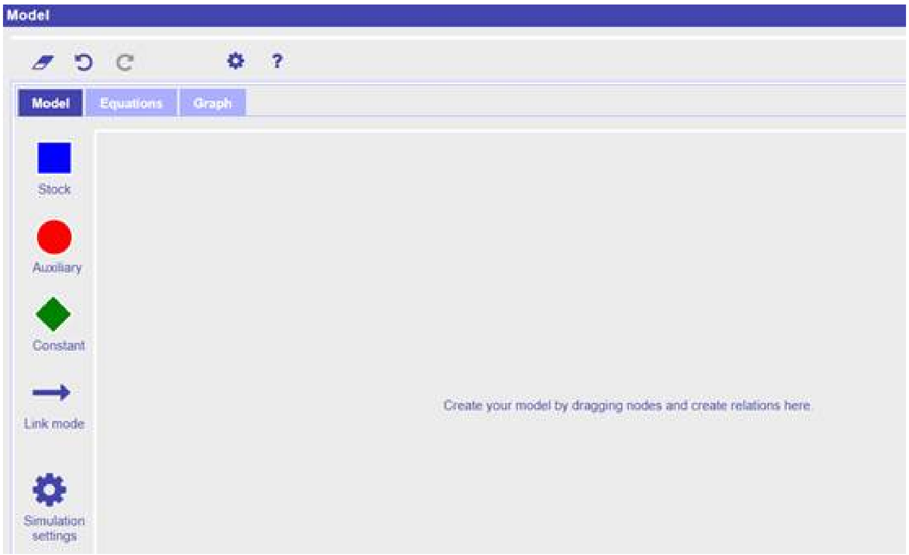
This last step involves an examination of the basic variables of the phenomenon and how they develop over time. The structural depiction of a phenomenon is usually called a “system” and since we are mainly interested in studying time trends related to systems, this field of inquiry is characterized as “system dynamics”.

For example, students can use Gomodel to model a population of a species (e.g., rabbits) and see how the population size evolves over time. In addition, students can modify model parameters or remodel the system and run the simulation again afterwards to examine the effect of their revision. In our example of a rabbit population, we can change the birth rate and investigate the effect of this change in the time trend of the rabbit population. Remodelling the rabbit population system may take the form of adding deaths in addition to births. Moreover, populations of different species (e.g., a fox population) may need to be modelled differently. We can use Gomodel to not only compare between different modelling parameters within a single model, but also investigate modelling requirements of different populations. We can go on to further add complexity in modelling, for instance, by modelling a prey-predator system, a system with two populations, one prey population (e.g., rabbits) and one predator population (e.g., foxes).

On startup Gomodel shows an empty modelling space (Figure 8). The app includes two toolbars, one on the left, which depicts the basic structural components for constructing a model (“Stock”, “Auxiliary”, “Constant”, “Link mode”) and another toolbar on the top, which provides access to three different interfaces (“Model” for constructing a model, “Equations” for having an overview over relations between model variables and starting values, and “Graph” for observing time trends of variables).

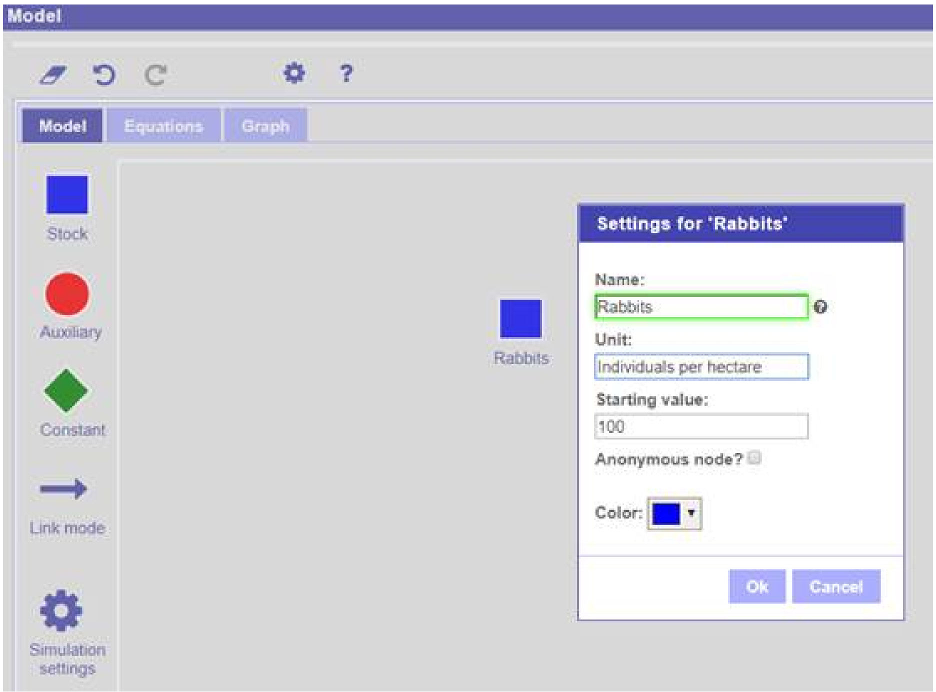
3.2 Example steps to create a model

The following section will provide an example on how to start a model-based inquiry by modelling a rabbit population using Gomodel. We will begin the modelling procedure by dragging a blue rectangular-shaped Stock variable into the modelling space. Stock variables are the main variables to be studied and these are the ones for which we will examine time trends later on. By double clicking on the stock variable, we can name it and define its settings (Figure 9). Since we will model a rabbit population, we will name the stock variable “Rabbits” and give its unit as individuals per unit of area (e.g., individuals per hectare), which is the scientific depiction of the population size. We will also define an indicative starting value (e.g. 100 individual rabbits per hectare). Depending on our assumptions, we may define a lower or higher starting value as the initial population size.



Create your model by dragging nodes and create relations here

Figure 8: Empty modelling space in Gomodel



Settings for 'Rabbits'

Name: Rabbits

Unit: Individuals per hectare

Starting value: 100

Anonymous node? □

Color:

Figure 9: Naming the stock variable ("Rabbits"), setting its unit (individuals per hectare) and defining its starting value (100)

The next steps we will perform are necessary to indicate that the rabbit population is changing over time according to an inflow of individuals into the population through births. To do so, we drag another stock variable and place it in the modelling space on the left of "Rabbits". We double click on this second stock variable and activate the "Anonymous node" in its settings to denote that it will serve as an inflow. The new stock variable is now depicted in the modelling space as a white cloud. Then, we click on the "Link mode" in the left toolbar and connect the cloud with the stock variable ("Rabbits") by clicking our mouse within the cloud and moving the mouse cursor from there over to the stock variable. We will get an arrow with a valve depicting the inflow (Figure 10).

Our next step is to further define the inflow. We will now use a red Auxiliary and drag it under the valve. We do that because auxiliary variables allow us to define relationships between model parameters. Since the inflow represents individuals added in the rabbit populations through births, we can rename the auxiliary to “Births”, by double clicking on it and specifying its new name in the settings. In the settings of “Births”, there is an input box for an “Expression”. It is currently highlighted in red, because we have not yet specified the input for this auxiliary. This means that we will need to define the relationship between model parameters, which is why we have added the auxiliary in the first place. To do so, we first need to click on the Link mode and link Births to the valve; this means that the relationship to be specified in the auxiliary variable (“Births”) will describe the inflow into the rabbit population. Then, we need to add a Constant (for which the value remains the same over time) and link it via the Link mode to the auxiliary (“Births”). We will name the Constant variable “Birthrate” by double clicking on it and we will give it an indicative value of 0.5. The total number of births is dependent on the ability of the average individual in the population to contribute to the growth of the population. Since not all individuals are expected to be equally capable in doing so, birth rate can be expressed as a number between 0 and 1, let us say 0.5. Further, the total number of births will vary according to the population size itself. For a lower number of individuals, total births will be lower as compared to a higher number of individuals. To denote this dependence of Births (red auxiliary) on the population (the Stock variable we have named “Rabbits”), we need to click on the Link mode and link “Rabbits” to “Births”. The final setup up to this point is shown in Figure 11.

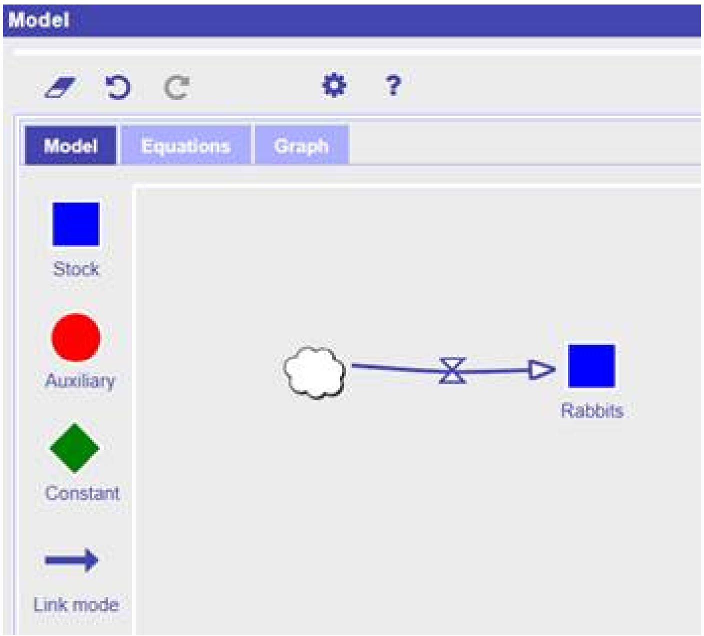


Figure 10: Inflow with valve directed to the Stock variable (“Rabbits”)

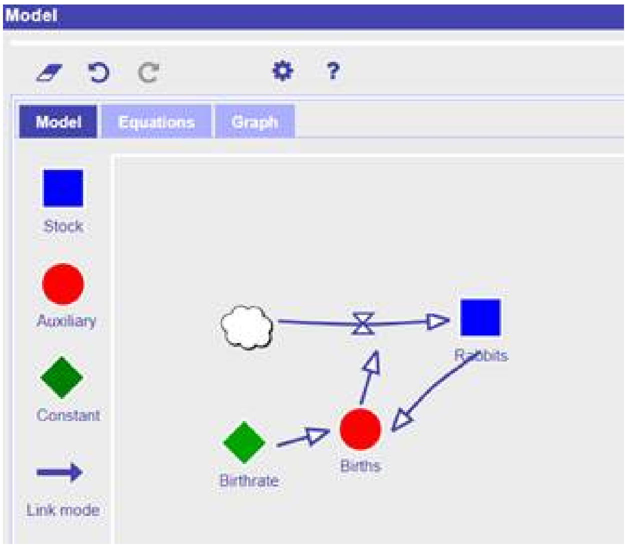
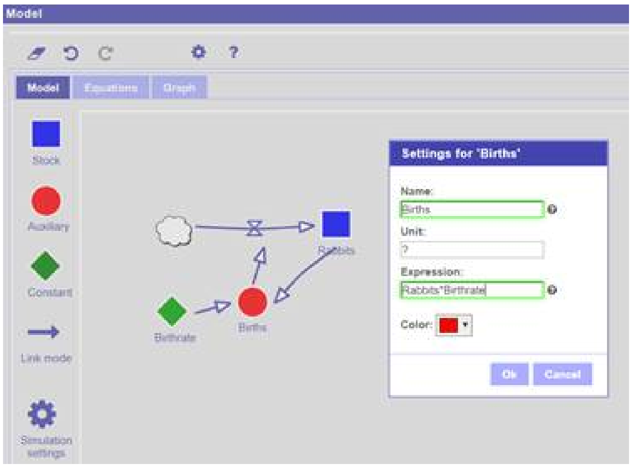


Figure 11: Completed setup for the inflow, including the cloud and the arrow with the valve, the auxiliary (“Births”), the constant (“Birthrate”) and all necessary linkages (“Births” to valve; “Birthrate” to “Births”; “Rabbits to Births”)

Now we will need to return to Births and double click on this red auxiliary once again. We can insert in the Expression box the relationship we have already defined in our model by means of the arrows we have inserted. Specifically, we have defined “Births” as the product of “Rabbits” (population size) times “Birthrate” (the Constant depicting the average capacity of the individuals in the population to contribute to population growth). If we do so, and if we have correctly written the names of all our variables in the Expression box of the red auxiliary (“Births”), then it will turn green, meaning that we have correctly described in writing what we have already indicated in the modelling space by means of the arrows which link model parameters (Figure 12).


Settings for 'Births'

Name: Births

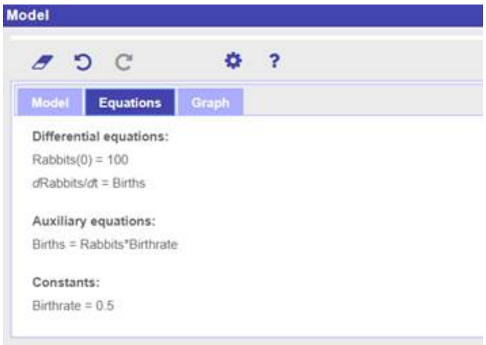
Unit: ?

Expression: Rabbits*Birthrate

Color: 🟥

Figure 12: When the relationships denoted by arrows in the modelling space have been correctly inserted in the Expression box of the auxiliary variable (“Births”), then the border around the Expression box turns green color and we can move on

If we now navigate to Equations in the top toolbar, we can have an overview of all our values and relations between model parameters, as we have previously defined them in our modelling interface (Figure 13).



Differential equations:
Rabbits(0) = 100
dRabbits/dt = Births

Auxiliary equations:
Births = Rabbits*Birthrate

Constants:
Birthrate = 0.5

Figure 13: Overview of all values and relations between model parameters in the "Equations" interface

We have now concluded the first two steps in our procedure, namely, we have constructed our model and we have defined the relations between model parameters and their starting values. It is time to observe the time graph of the population in the "Graph" interface, which depicts the population dynamics of our modelled rabbit population. Gomodel automatically computes the necessary mathematical calculations from our input in the "Model" interface (overview in "Equations" interface) and shows the outcome as graphs. The graph depicted in Figure 14 is a typical exponential population growth observed for species closer at the r extreme of the r-K continuum of the selection theory in population dynamics ("r" corresponds to rate of growth; "K" corresponds to *Kapazitätsgrenze* in German or *capacity limit*). The closer to the r extreme, the more populations invest in reproduction with increased number of offspring and lower parental investment. The opposite is valid for populations at the K extreme of the r-K continuum.

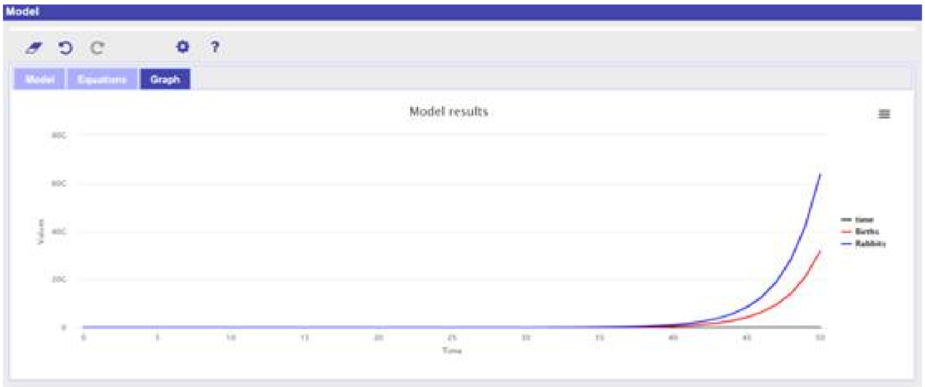


Figure 14: Exponential population growth depicted in the time graph of Gomodel for the modelled rabbit population

We may go on with our model-based inquiry by adding deaths of rabbits to our model (Figure 15). Model parameters in this case involve an outflow, which is modelled in the same manner as we have done for the inflow, just the other way around. However, for the outflow we name the new auxiliary "Deaths" and associate it with a "Deathrate". Population dynamics will be determined on the basis of a comparison of birth and death rates: If the birth rate is higher than the death rate, then we will receive an exponential growth like the one depicted in Figure 14. If the death rate is higher than the birth rate, then there will be an exponential decrease of the population over time (Figure 16).

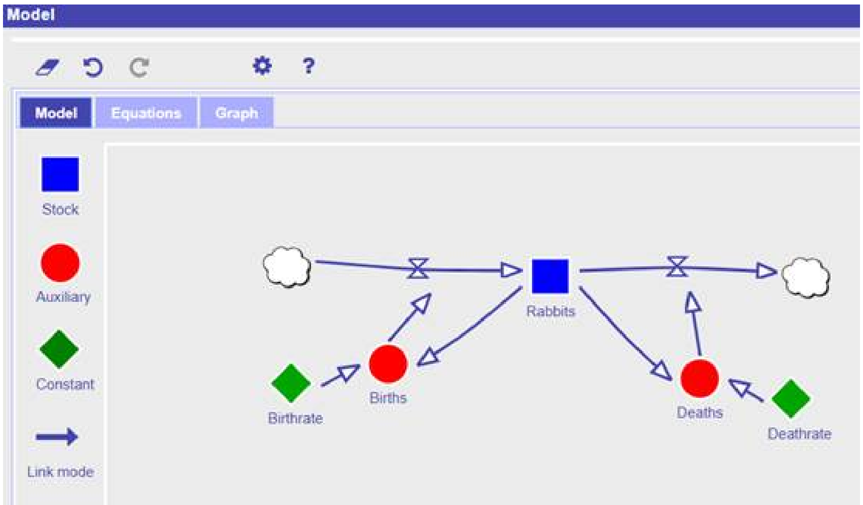


Figure 15: A model of our rabbit population depicting both "Births" and "Deaths"

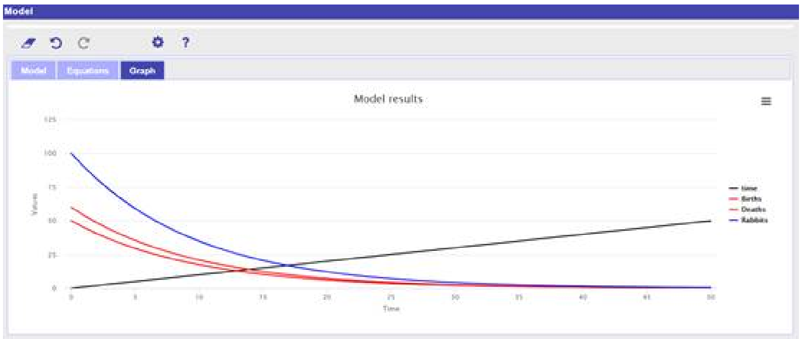


Figure 16: Exponential decrease for the rabbit population, when the death rate is higher than the birth rate ("Birthrate" = 0.5; "Deathrate" = 0.6)

Model-based inquiry may proceed with modelling a population of another species ("F" in Figure 17) that follows an investment strategy focusing less on reproduction and more on parental care. This is usually expected for predators such as foxes. In this case, population change (red auxiliary) is influenced by birth rate (Constant r) as well as by another constant which denotes the maximum number of individuals of the species the biotope is capable of sustaining given its available resources (Constant K). This second constant specifies the carrying capacity of this biotope for this species, which cannot be overridden due to limited resources and intraspecific competition developed among the individuals of the population. Intraspecific competition subtracts energy from reproduction and a percentage of the total energy budget available to the population is redirected towards overriding intraspecific competition (density dependence due to intraspecific competition).

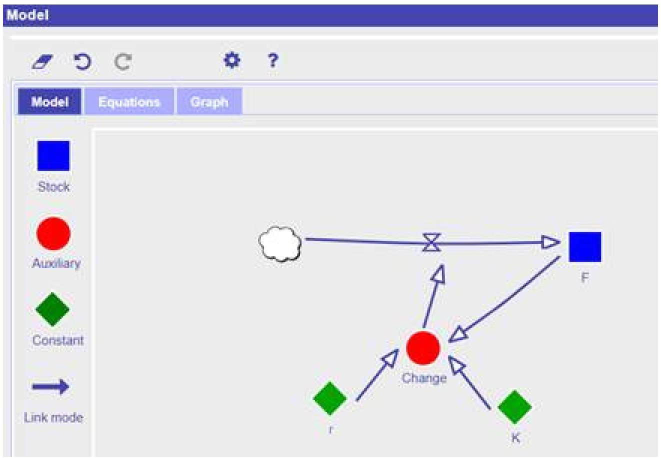
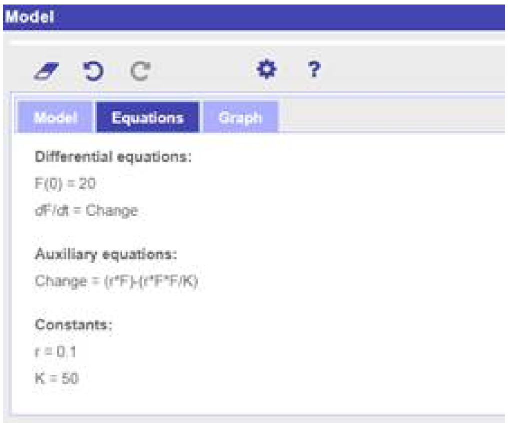


Figure 17: Structural model of a population closer at the K extreme of the r-K selection theory continuum

The equations describing our new population are depicted in Figure 18: Population change is given as r*(1-F/K)*F: The closer F (population size of a population regulated by density dependence due to intraspecific competition) to K (carrying capacity of this species for this biotope), the lower the growth potential of the population.



Differential equations:

F(0) = 20

dF/dt = Change

Auxiliary equations:

Change = (r*F)-(r*F*F/K)

Constants:

r = 0.1

K = 50

Figure 18: “Equations” interface for population “F”; “K” (carrying capacity is set at an indicative value of 50 individuals, meaning that the modelled population is found in a biotope that cannot sustain more than 50 individuals of that species

The time graph of this simulation depicts the increase of the population (the initial population size = 20 individuals) until it reaches the carrying capacity level (K = 50 individuals), after which the population size remains constant in time (Figure 19).

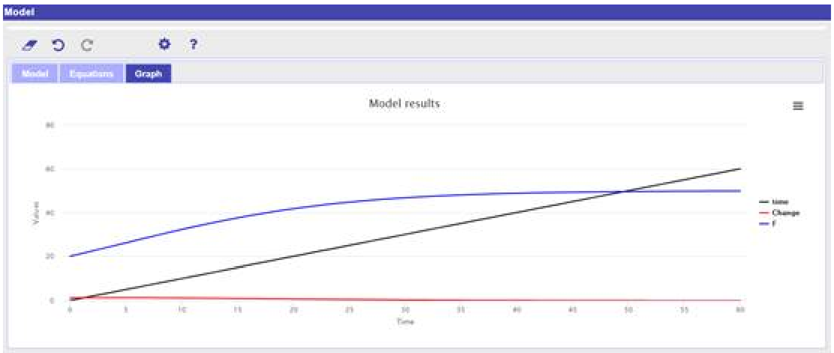


Figure 19: Time graph of a population regulated by density dependence due to intraspecific competition (blue graph)

More complex models may include interactions between two populations, for instance, prey-predator interactions (Figure 20). Deaths of the prey population are mainly conditioned by predation, which is denoted by a link of “Foxes” to “Deaths_R” for “Rabbits” (Deaths_R = Rabbits*Foxes*Predationrate; “Predationrate” denotes the ability of the predator to remove individuals from the prey population through predation). In addition, “Births_F” for “Foxes” are mainly conditioned by prey consumption, which is indicated by the link between “Rabbits” and “Births_F” (Births_F = Foxes*Rabbits*Consumption; “Consumption” denotes the ability of the predator to convert prey biomass into predator biomass). To be simulated, these systems need an elaborate account of differential equations, which are not currently available in Gomodel.

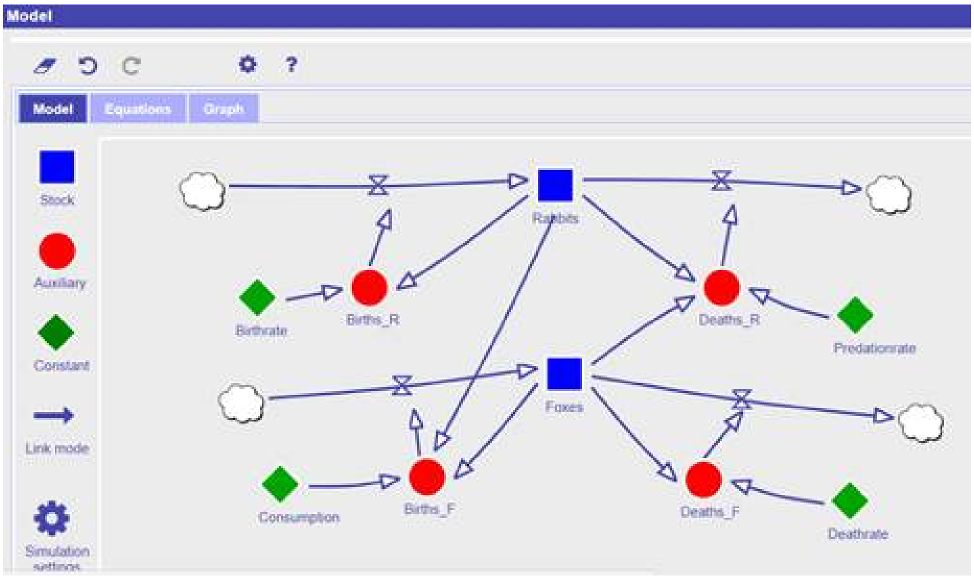
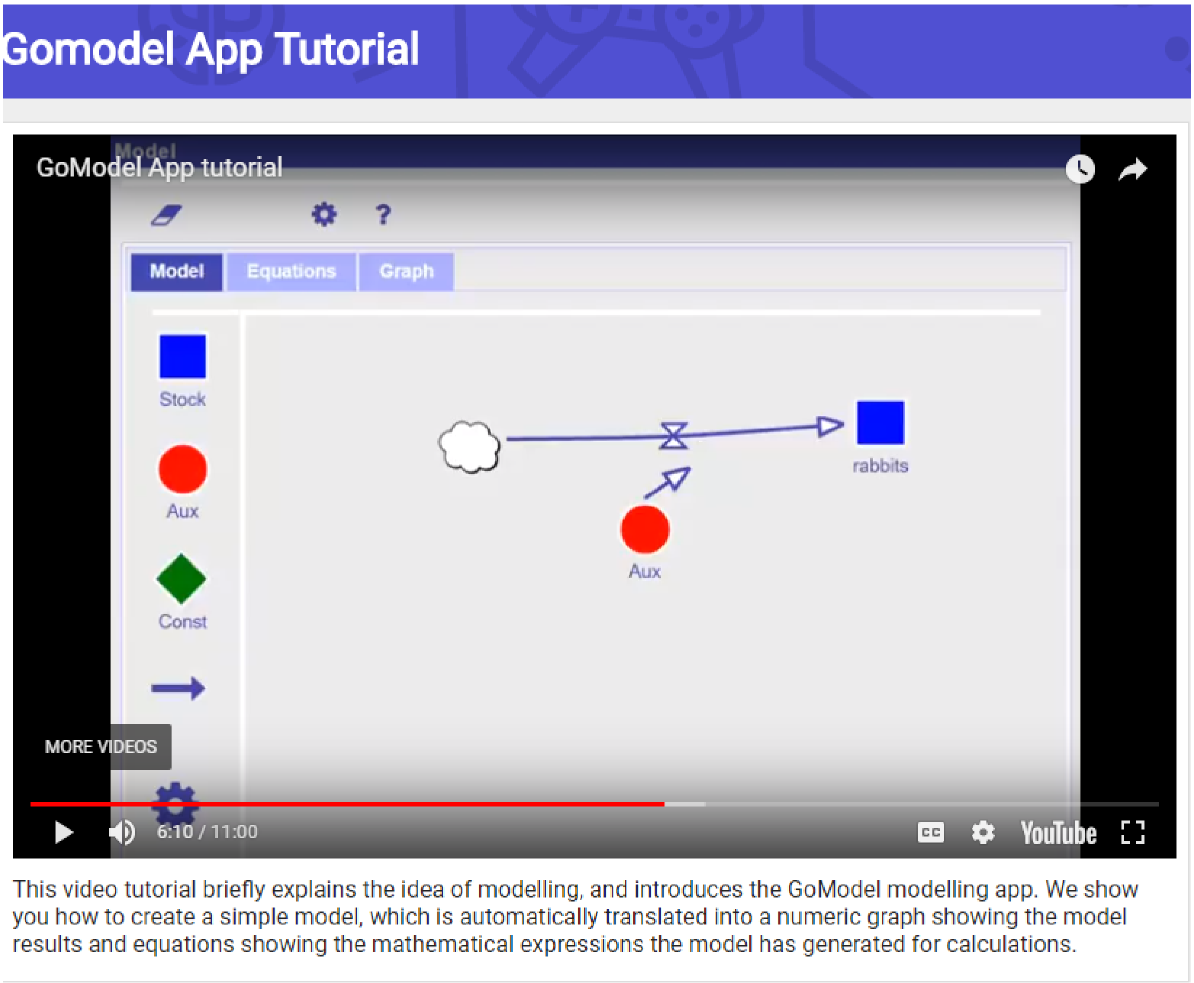


Figure 20: Prey-predator system modelled in Gomodel

3.3 Instructional video for GoModel

The Gomodel manual/tutorial can be found at http://support.golabz.eu/video/gomodel-app-tutorial. The 11 minutes video contains an explanation of the modelling principles using System Dynamics and an explanation of the usage of the app.



Gomodel App Tutorial

This video tutorial briefly explains the idea of modelling, and introduces the GoModel modelling app. We show you how to create a simple model, which is automatically translated into a numeric graph showing the model results and equations showing the mathematical expressions the model has generated for calculations.

Figure 21: Gomodel video tutorial

4. Towards the final releases

This section describes the features which will be implemented in the final releases of the ePortfolio integrated in Graasp and in the Modelling app.

4.1 Features of the upcoming final release of the ePortfolio

In the final release of the ePortfolio features, the following improvements will be implemented:

- The links in the zip archive will be made independent of the original content of the corresponding Graasp ILS. Also, if a user decides to drag and drop back the content of the zip archive into Graasp, the content will be recognized as an ILS and new instances of the apps and labs will be created to make it functional.
- A “Copy…” option will be added in the popup menu offered to students in the standalone view. The selection of this option will display a dialog asking the student to sign up or sign in in Graasp with a personal account. Once logged in, a copy of the ILS with the learning outputs and activity traces belonging to the student will be copied as an ILS owned by the student. The two challenging parts here which we will address through participatory design are a) the question of enabling or not a student to create a personal account in the authoring platform, which would require approval by parents and / or teacher; b) The removal of vault content from other students; c) the creation of a new instance of the apps and labs with link to content in the vault associated with the instances of the original ILS belonging to the teacher. d) the reassignment of the activity traces from the original to the copied ILS for a given student, which raises the question of having the traces of the same activities in two separate contexts (the original and the copied space).

The compliance of the second item with respect to the usage of online platforms by children and with GDPR will be investigated carefully.

4.2 Features of the upcoming final release of the Modelling app

4.2.1 Erase option

In the current version of the Gomodel, one can erase the whole model, but not parts of it. This can lead to a loss of significant time if a serious mistake has happened and this is only realized later on by the students (i.e. when undo and redo actions are not possible anymore). Therefore, an option needs to be included to delete variables and links separately.

4.2.2 Differential equations for complex models

For complex models, such as the prey-predator system in Figure 20, a selection of specific differential equations will be needed so that these may be computed properly (4th order Runge-Kutta differential equation for the prey-predator system). These options need to be added in an updated version of Gomodel to support these kinds of systems.

5. Conclusion and outlook

This deliverable is an accompanying document for the software releases of the ePortfolio features in Graasp and the Modelling app. The core part is presented in a form very close to a user guide to ease the use of these new tools by the users (teachers and students), as well as to support their dissemination and promotion by national expertise centre representatives and by ambassadors.

As these two releases are recent, experiences still need to be gained and feedback to be collected in order to understand their adoption by teachers and students, as well as on the school level in which they can be utilized effectively.