Next-Lab

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

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Deliverable 2.9

Sustainable implementation of the teacher-empowering facilities and activities

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Executive Summary

This deliverable presents the work of the consortium to provide teachers and other Go-Lab Users with a training, help and support infrastructure that will allow them to continue creating high-quality ILS for their students even after the Next-Lab project ends. This report describes

- In section 2 the key findings of the Next-Lab Case Studies that were undertaking over the past 10 months, and offers a SWOT (Strengths, Weaknesses, Opportunities, Threads) Analysis regarding the more systematic introduction of Go-Lab on a school level.
- In section 3 the three distinctly structured Go-Lab courses and links to the corresponding material that offer teachers a complete set of workshops to become Go-Lab Experts. The training covers all relevant corresponding to the most likely Go-Lab user profiles and expertise levels.
- In section 4 the Go-Lab Support Infrastructure, starting with a chapter about the ongoing work to update, enhance and improve the instruction for the Go-Lab Scenarios. It will further present the work to revise and enhance the complete support platform on the Golabz Portal.
- The work of the Go-Lab Self-Learning Training Modules - online modules with the purpose for teachers to learn the most important pedagogical and technical aspects that enable them to use efficiently the Go-Lab Ecosystem.
- Lastly, it provides a brief update on the number of exemplary ILSs that have been co-created with members of the project team and serves as outstanding examples of an efficient ILS.
- The Annexes entail the detailed reports of the case studies, as well as the programs of the past and upcoming Go-Lab International Training Events.

To support the reading process a glossary has been created that can be found here: http://bit.ly/nextlab-glossary

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1. Introduction

The work in WP2 has always been based on our deep belief that **the only way to improve an educational system is to improve instruction,** and by doing so **empower the teachers.** Hence the title of Next-Lab Work Package 2 which has set the objectives for all WP tasks: to empower teachers at different levels to create, implement and exploit inquiry learning spaces. Without sufficient and sustainable support and training, teachers will not be able to fully understand or apply neither the concepts of Inquiry Based Science Education (IBSE), nor recognize the array of possibilities or opportunities of the various tools available as part of the Go-Lab Ecosystem.

Therefore, for the past months our goal for the activities has been to prepare and leave behind a sustainable support structure with the necessary tools and material to allow schools and teachers to discover and understand the benefits of Go-Lab as well as learn how to use the system with as little as face-to-face support as possible. To achieve this goal, we have focused on providing and sharing

- A set of **Go-Lab School case studies** that were prepared to understand the challenges and benefits of introducing Go-Lab more systematically in a school. In the remaining months of the project we are planning to turn this into a promotional leaflet presenting the different cases that will encourage other schools to take up Go-Lab.
- **Go-Lab training material** and workshops that can be used by NECs, TTIs, ambassadors and expert teachers to offer **three specific Go-Lab courses**, each of them focusing on different expertise and user profiles,
- **Go-Lab Self-Learning Training Modules** which are online modules with the purpose for teachers to learn the most important pedagogical and technical aspects that enable them to use efficiently the Go-Lab Ecosystem. The self-learning training modules are using the Graasp platform infrastructure to place the Self-Learning Training Modules in the Graasp platform which already allows teachers to get an insight to the students' perspective.
- A revised, enhanced and updated the **Go-Lab Support Page** with more and better targeted instructions as well as videos for all relevant aspects of Go-Lab. The Support page includes also the possibility to custom-made a user manual that can be downloaded and shared (e.g. among colleagues).
- A set of **more than 60 ready-made and exemplary ILSs** in various languages that apply the quality criteria we have defined for ILS in D2.5 and that can guide and help teachers create more effective ILSs.

We stated so in the beginning of the project and we still believe that this is true: There are no quick fixes in the world of education. Instead, education policy makers must support and commit to the laborious task of incrementally **improving the competences of the teachers** we train and the environment in which they teach, whilst providing teachers with a respect and trust commensurate according their critical societal roles.

Teachers are the key players in the improvement and renewal of science education. Outstanding teaching activities are taking place in European science classrooms every day. But they are only taking place because of **devoted, extraordinary teachers that go beyond conventional practices** and that insist on implementing their vision of innovative STEM (school) education. We are convinced that we have created the necessary set of

tools that will motivate as many teachers as possible to work with Go-Lab, and that will hopefully spark the interest of numerous young students to follow a career in STEM (Science, Technology, Engineering, and Mathematics).

2. Empowering Schools – The Next-Lab Case Studies

One of the central recommendations for WP2 of last year's review was to "*identify a significant sample of schools (8-12 at different levels) where multiple teachers use the Go-Lab Ecosystem and implement a case study approach (..).*"

Consequently, as presented in Deliverable 2.8, every WP2 partner has identified and introduced (at least) one case study school. For this deliverable, the aim was to investigate how Go-Lab is being used in these schools to gain a better understanding: What does it take to introduce Go-Lab more systematically in a school? What are the key challenges? Given the limited time and effort available, we chose to conduct interviews that includes two perspectives, 1) the teacher using Go-Lab and 2) the headmaster of the school. Both are the most crucial persons for deciding to introduce new methodologies or tools for teaching.

Our intention was to better identify the processes, and the obstacles but also potential of introducing Go-Lab more systematically in schools in Europe. In order to ensure that all contributions were following the same model and covering the same type of information, each country report has been prepared following the same structure. The country reports follow the topics of the questionnaire and focus on the process of how Go-Lab has been introduced.

The questions for the teachers were more detailed and covering the following main thematic blocks:

- Introduction to Go-Lab
- Training / Support used / received
- Implementation of Go-Lab in the classroom / perceived value
- Introduction of Go-Lab at the school level
- Impact on students' learning
- General remarks about Go-Lab

The question for the school heads were covering the following main topics:

- Introduction to Go-Lab
- Go-Lab impact at the school level
- General remarks about Go-Lab

The interviews were conducted between March and June 2019, following the guidelines and questions of the questionnaire (see Annex). Partners were asked to provide summary reports of their discussion. The detailed reports for each school can be found in the Annex. In the following section, we will present the overall main findings in form of a SWOT analysis, followed by a summary for each case study school.

2.1 SWOT Analysis of Go-Lab Based on Case Studies

We have organised the received feedback in a way that summarises the main points and helps us prepare the next steps, e.g. promoting the main advantages of Go-Lab for a school. At the same time, the more critical feedback will help us to understand what areas we need to improve the platform to make it easier for teachers and schools to decide and opt for using Go-Lab in their science teaching.

2.1.1 Strengths – Main Advantages of Go-Lab

Go-Lab delivers for more opportunities for STEM experiments

- Go-Lab allows to do more experiments in the classroom, and most of the experiments conducted with Go-Lab are in addition to the real classroom experiments.
- It enables more experiments especially for topics that otherwise cannot be covered experimentally with the real lab.
- Research activities using Go-Lab are taking less time than doing real experiments at lower costs.

Go-Lab facilitates Inquire Based Science Education (IBSE)

- Go-Lab is a positive way to support the inquiry-based learning approach and is a tool that enables schools to improve and focus on research skills of the students.
- Go-Lab tools affects positively the overall schools' attitude and motivation towards inquiry learning and online labs.
- Go-Lab is an attractive learning environment for the students

Go-Lab positively impacts students learning and interest in STEM subjects

- Students generally enjoy working with Go-Lab and using ILSs.
- It has a positive impact on students' STEM learning, their overall motivation, autonomy and decision making, as well as leads to a faster understanding of scientific concepts.
- Go-Lab speaks to the students' way of learning (e.g. using their own devices).
- Go-Lab provides more structured lesson, with a clearer plan as to how to reach the lessons objectives.
- It is easier for students to use online laboratories in Go-Lab compared to using real labs.

Go-Lab helps introducing complex scientific topics to a broader group of students and facilitates differentiated learning

- Go-Lab makes their lessons more student-centered and is based on the intrinsic motivation of students.
- Go-Lab is very useful when introducing complex concepts.
- Go-Lab supports addressing students with different learning styles and preferences.
- Go-Lab is a valuable tool for multidisciplinary learning approach also beyond the STEM disciplines, e.g. science in conjunction with foreign language (Content and language integrated learning – CLIL).
- Go-Lab makes it easy to find and test new lessons and approaches.

Go-Lab helps saving time in preparation and implementation

- Once familiar with Go-Lab, the efficiency and time saving opportunities are increasing as teachers do not need much time preparing a lesson.
- Go-Lab allows for easy adaptation of published resources or from that have been used before.
- Teachers spent less time to plan their lessons compared to using real labs.
- It enables to conduct more experiments within a typical school lesson than with the real lab.

Go-Lab promotes collaboration among teachers

- Go-Lab promotes the collaboration of teachers who teach different disciplines.
- It provides more opportunities for implementing interdisciplinary activities.
- Go-Lab encourages collaborative work and for teachers to implement the same ILS in their classes in a complementary way.
- It usually takes one or two trained teachers to encourage and train their colleagues in the school effectively and increase the degree of use.

2.1.2 Weaknesses – Main Drawbacks of Go-Lab

(Initial) Time investment / Complexity

- The initial time a teacher needs to invest to become comfortable using Go-Lab is significant.
- Before creating and implementing ILSs teachers need a basic training in IBSE and Graasp. However, one or two physical training sessions are usually enough for teachers to start using Go-Lab.
- Also, students need time at the beginning to understand the use of an ILS, its apps and sometimes the labs, to better understand the structure and keep the overview of what is expected of them during an ILS.
- Graasp is not entirely intuitive and takes too much time getting familiar with it.
- Developing ILSs of good quality that are comparable to all the other digital learning materials that are used within the school takes time.

Availability and suitability of online laboratories

- Teachers cannot always find an adequate lab available on the golabz.eu or labs that are suitable for primary education.

2.1.3 Opportunities – Ideas to Facilitate Go-Lab in Schools

Training teachers is key for the use of Go-Lab

- More individual training sessions and content should to be designed and offered attentively to the teachers' experience and school level.
- Continuous support is needed to introduce Go-Lab in a school more broadly.

- The teacher's communities are valuable for supporting each other's efforts in using Go-Lab.

Make the first lesson a success! Provide more ready-made ILS

- The (positive) experience of the first Go-Lab lesson is highly important, both for teachers and students.
- The creation of more ready-to use ILS for elementary education would enable a broader uptake of Go-Lab.
- A Go-Lab expert group of teachers per the school should be promoted needed. These teachers could co-create ILSs based on the schools' needs and these ILSs will be available for all teachers of the school.

Teachers are the most effective multipliers

- A school is more likely to use Go-Lab if a teacher can convince his/her colleague to use Go-Lab.
- Teachers motivating each other is the preferred and most effective approach to broadening the impact of Go-Lab at the school level.
- Bottom-up approach is usually a more sustainable approach than a top-down directive especially given that in many countries, teachers have a great autonomy to choose their learning and teaching tools.

Getting support from local / regional educational bodies

- Nonetheless, having the "official" support of a ministry of education or the regional educational bodies would facilitate the use of Go-Lab and lead to more efficient multiplication.

2.1.4 Threats – Barriers for a Broader Introduction of Go-Lab in Schools

Teacher attitudes / Lack of motivation

- The unwillingness of teachers to implement new teaching methodologies and tools is the biggest obstacle.
- In other cases, teachers are generally interested in Go-Lab, however they are involved in other programs of innovation in education.
- Some teachers are not willing to share their ILSs without any reward.

Teachers' workload

- The workload of teachers is another significant barrier in broadening the use of Go-Lab.
- Even though the teacher can adopt the ready-made Go-Lab resources rather easily in a classroom, modification and differentiation of the materials are more time demanding.

Insufficient IT infrastructure

- The lack of infrastructures and good internet connection is the main problem when it comes to a larger scale implementation of Go-Lab.

- Technical problems with the infrastructure, labs or apps. If a teacher experiences any failures and is exposed to the students, the teachers is very unlikely to use Go-Lab again in the classroom.

Teachers' ICT skills

- Teachers' professional ICT skills should go beyond the basic ICT tools (e.g. Microsoft Office, Web tools).
- Improving teacher ICT skills and confidence with the Go-Lab learning environment could possibly help implement Go-Lab more broadly at the school.

Use of online labs without the Inquiry Learning Environment

- The Golabz.eu portal is often used to find digital labs that can be used additional to the real-life experiments, but not always as part of an ILS.

2.2 Key findings per case study

2.2.1 G C School of Careers – Cyprus

The G C School of Careers is a private urban school in Nicosia. Inquiry-Based Science Education is applied in the school for the last two years. Go-Lab has been introduced by a Physics teacher and the school administration is positive to the systematic use of innovative ICT tools, such online labs and Go-Lab. The key findings revealed from the interviews with a teacher and the school director of the school are as follows:

- Go-Lab can be used as complementary learning material for the real laboratory activities and help students of different learning styles and preferences to acquire the science content.
- Less motivated teachers prefer ready-made ILSs in order to implement Go-Lab in a more systematic way. Thus, in order to facilitate the implementation of Go-Lab in the school level, a Go-Lab expert group of teachers in the school is needed. These teachers will co-create ILSs based on the schools' needs and these ILSs will be available for all teachers of the school.
- Go-Lab offers a well-structured approach for inquiry learning and definitely has a positive impact on STEM teaching and learning.
- For introducing Go-Lab more broadly, continuous training and support is needed. Moreover, teacher's communities are valuable for supporting each other's efforts in using Go-Lab. However, some teachers might not willing to share their ILSs without any reward.
- The school administration encourages teachers to use Go-Lab whenever they consider it as a beneficial practice for their teaching practice.
- A good training activity would have been to watch and discuss about real classroom implementations, either in real time or afterwards by watching video-recorded lessons with Go-Lab.
- At a national level, teachers' professional development on ICT skills should go beyond the basic ICT tools (e.g. Microsoft Office, Web tools). In the future, Go-Lab proficiency should be considered as an advantage for recruiting a STEM teacher, at least in the private sector.

2.2.2 Tartu Hansa Kool - Estonia

Tartu Hansa Kool (https://www.hansa.tartu.ee) is a public basic school (i.e., grades 1 to 9) in Tartu, Estonia. The city of Tartu has about 100,000 inhabitants and Tartu Hansa Kool has around 750 students and 65 teachers. Inquiry-based science objectives have been listed as required goals in the Estonian National Curriculum since 2011. Two interviews, one with a primary school teacher and another with the school director at Tartu Hansa Kool revealed several ideas related to introducing Go-Lab in schools in a more systematic way. Some major points are as follows:

- Teachers who are motivated to make their lessons more interesting to today's youth by incorporating learning with digital tools are more likely to learn and use Go-Lab. The biggest obstacle to using Go-Lab are teacher attitudes.
- The Go-Lab Summer School was sufficiently intense to compel the teacher to learn how to work with Go-Lab, and especially watching other beginner teachers present their work gave the confidence to use Go-Lab.
- Go-Lab is perceived as a positive way to support the inquiry-based learning approach, an approach that is specifically required in the Estonian national curriculum.
- Teachers who collaborate with each other via Go-Lab can facilitate interdisciplinary learning with Go-Lab.
- The workload of teachers, in addition to teacher attitudes, may be a barrier for broadening the use of Go-Lab. Teachers would benefit from ready-made examples before they begin to adapt, revise or create their own Go-Lab learning experiences.
- Improving teacher ICT skills and confidence with the Go-Lab learning environment could possibly help implement Go-Lab more broadly at the school.
- Teachers motivating each other to use the Go-Lab learning environment is the preferred approach to broadening the impact of Go-Lab at the school level. The bottom-up approach is a better approach than having the director give top-down directives that such a learning environment must be used in their teaching.

2.2.3 The Finnish case study - Finland

The case school (preferred to remain anonymous in this public deliverable) provides comprehensive education for the grades 7 to 9 (ages 13 to 16). It is profiled in special education which is realized in smaller student groups and a more flexible curriculum compared to usual schools. The school has already implemented inquiry learning in their curriculum, but the usage of ICT in inquiry learning has been low before Go-Lab.

Two teachers started to use Go-Lab in the first phase of early 2019. They were teaching 8th and 9th-grade students (ages 14 to 16). Given their good experiences, we got an opportunity to organize a workshop for the other teachers in their school. This bottom-up approach is a common way to introduce new methods to Finnish schools. Since the national core curriculum gives individual teachers strong autonomy in regard to the teaching methods and materials, there are only a few issues that can be enforced top-down. Usually, the early adopters try something new and if it works, the idea is communicated to the teacher community resulting in broader implementation. The key findings regarding the introduction of Go-Lab to schools in Finland are the following:

- To foster a large-scale implementation, it is insufficient to just add Go-Lab into formal curricula. Training and successful practical experiences are needed to convince individual teachers to adopt Go-Lab in their science teaching repertoire.
- The (positive) experience of the first Go-Lab lesson is highly important. If Go-Lab engages students and supports learning, the teacher is likely to use the platform again. To increase the likelihood of a good start, more ready-made high-quality Finnish materials are needed for different age groups and subjects.
- Even though the teacher can adopt the ready-made Go-Lab resources rather easily in a classroom, modification and differentiation of the materials are more time demanding. Training and (peer / professional) support encourages to more advanced usage of Go-Lab ecosystem.
- Compared to previous science lessons, Go-Lab is giving plenty of possibilities to do "extra experiments" in addition to real labs, for example, when teaching electrical circuits virtually and using physical equipment. In mechanics, it has been a lot easier to do experiments using the virtual skate ramp than to build a real one.
- Once students are familiar with the platform, it is easier for them to learn to use laboratories in Go-Lab compared to using real labs. Since teachers, have used existing, ready-made ILSs, they also spent less time to plan their lessons compared to using real labs.

2.2.4 2nd Primary School of Voutes - Greece

The 2nd Primary school of Voutes is located in the outskirts of the city of Heraklion. It is a relatively large school which has an ICT and physics laboratory and educational robotics equipment. Over the last three years, the school has focused on the development of interdisciplinary, inquiry-based STEM activities using everyday materials, 3D printing and physical computing focused on understanding physics concepts and the development of students' computational thinking. The key findings are:

- Go-Lab is appealing as it is quite user-friendly. Teachers and students can get easily familiar with it and use it without great difficulty. It is useful for students to be able to revisit previous phases and look back at what they've already done check and modify their input.
- Training teachers is a key element to increase the use of Go-Lab. However, one or two physical training sessions (depending on the length of the training) is enough for teachers to start using Go-Lab, but the physical presence of a trainer is essential in the beginning.
- One or two trained teachers can train their colleagues in school effectively and increase the degree of use. This way, Go-Lab promotes the collaboration of teachers who teach different disciplines. More opportunities for implementing interdisciplinary activities are requested.
- Go-Lab has been useful to teachers when it comes to introducing complex concepts, especially in physics and Go-Lab has facilitated the school to implement more complex and challenging projects.
- Go-Lab also help teachers to make their classes more student-centered and to introduce Inquiry-based learning in STEM.

- There is a considerable barrier with regards to the opportunities teachers have to use Go-Lab in school. Limited access to the ICT class / IT equipment is a problem. They can only use Go-Lab during ICT class which is only one or two hours per week. Thus, most of the work needs to be done off-school hours.
- Go-Lab is best used with groups of two students per computer. Larger groups were difficult to handle.

2.2.5 2nd Minority Primary School of Komotini – Greece

The 2nd Minority Primary School of Komotini is situated near the center of Komotini. Komotini is a multicultural and multilingual city which is located in the northeastern part of Greece. The program of the school is bilingual. Inquiry Based Science Education (IBSE) has been applied in the school since 2016.

- Teachers enjoy using Go-Lab and are working collaboratively to implement the same ILS in their classes in a complementary way.
- One “Go-Lab Expert teacher” is transferring his expertise to his fellow teachers and train them in Go-Lab. However, the support of the Go-Lab team is still essential in solving any issues that may come up.
- The perceived impact on students’ learning is generally seen very positive, and students enjoy using ILSs.
- The support of the school administration is very important and has been a key factor for teachers to continue using Go-Lab.
- The lack of infrastructures and good internet connection is the main problem when it comes to a larger scale implementation of Go-Lab.
- The availability of the Go-Lab tools and ILSs in a school affects the schools’ attitudes and motivation towards inquiry learning and online labs positively. But more training and workshops are needed.

2.2.6 Canisius R.K Scholengemeenschap - Netherlands

Canisius is a school in the Eastern part of the Netherlands and has two locations. The first location is situated in the city of Almelo and has now about 1100 students with an age range from 12 till 18 years old. In Almelo the levels of education are VMBO-T, HAVO and VWO. The second location is in a rural area in the village of Tubbergen. This location has about 700 students with an age range from 12 till 16 years old. The school does not have a specific STEM profile and is at the very moment trying to implement Inquiry Based Science Education at the VWO department.

- The school wanted to give more attention to the research skills of the students in the higher levels of education and chose Go-Lab as a tool.
- One of the teachers got initial training, and also participated in a summer school. This teacher trained teachers within the school and helped them with developing ILSs.

- In spite of this support teachers still find it hard and time-consuming to develop ILSs of good quality that are comparable to all the other digital learning materials that are used within the school (which has a “bring your own device” policy).
- The Golabz.eu portal is often used to find digital labs that can be used additional to the real-life experiments, but not always as part of an ILS.
- Generally, the teachers agree that the use of Go-Lab is leading to do more experiments in the classroom and most of the experiments conducted with Go-Lab are additions to real classroom experiments.
- The biggest challenge for the students is understanding all the apps and keeping an overview of what happened during the ILS.
- Go-lab is encouraging more intrinsic motivation of students and will require a different teaching approach, as performing an online experiment in an ILS is about learning without getting a pass or fail.
- To make the Go-lab product to be used more frequently and by more teachers, the building tool Graasp should be more intuitive. The teachers still find it a real struggle to create a good working ILS. Less options and a clearer ILS composer would make it a way better product.

2.2.7 Escola Dr. Horácio Bento Gouveia - Portugal

The case study school is a public middle-school (with10-14-year-old) in Funchal, the capital of the main island of the Archipelago of Madeira. Although it is a low socioeconomic level region, this school has achieved above-average results compared to public schools in the region. The success of introducing Go-Lab in this school and the key findings are:

- An active teacher who is always looking for innovative projects and got interested in the Go-Lab because of the inquiry-based learning methodology and the use of online labs.
- The support of the NEC that has a close relationship with the teachers and gave support, including teacher training at the school. The school headmaster trusts the teachers and supports their work allocating time for new projects in their schedule;
- Teaching staff that has been in the school for some time and collaborate well together and share resources.
- A well-equipped computer rooms with sufficiently good internet and availability when requested in advance.
- The main advantage in adopting Go-Lab, indicated by both the teacher and the headmaster, is the impact on students’ learning, including motivation, autonomy and decision making, faster understanding.
- The biggest barrier to introduce Go-Lab more broadly in the school is that there are still teachers adopting conservative ways of teaching and not willing to try different methods. Changes in the education policy are measures that will help spread the use of Go-Lab in a school.
- The use of the Go-Lab ecosystem has provided more experiments in the science teaching for two reasons: first, there are topics that otherwise cannot be covered experimentally with the real lab; and secondly, the time spent with a Go-Lab activity is much shorter than going to the real lab.

- The teachers do not take much time preparing the lessons with Go-Lab. Usually, they refine or adapt the resources from the previous time used and once in a while try something new.
- Go-Lab serves the Physics & Chemistry curriculum very well.
- Go-Lab activities in the classroom or at home are generally received very enthusiastically by the students. The first ILS that the students experience is the most challenging. Students offer first some resistance in proposing the hypothesis, interpreting the data and making conclusions by themselves; they also need more support on how to use the apps, the tools, the labs, etc. But once they are used, ILSs tend to go smoothly, and the students gain confidence in their work as well as autonomy.
- The positive impact on students' learning has been the most encouraging aspect of using Go-Lab for teachers in this school. However, the most negative aspect is the initial time a teacher needs to invest to become comfortable to use Go-Lab in the classroom, and when something technical doesn't work, eg: if the internet is slow during the lesson with the ILS.

2.2.8 Gallego Gorria Primary School – Spain

This section presents the case study in Juan Ramón Jiménez School, Bilbao, Spain. The Go-Lab story was starting in 2015/2016 school year, when Mr. Mikel Amezaga, the teacher Gallego Gorria primary school in Bilbao, has been heard about the Go-Lab ecosystem first time. Since then, he is an active Go-Lab user and multiplier introducing the IBSE approach to his colleague. Since the 2016/2017 school year, he is the teacher of the Juan Ramón Jiménez School, Bilbao. Both schools are public one with different socioeconomic status students such as from low-income families or financial security, educational attainment, social and cultural backgrounds. The key findings are:

- The Go-Lab ecosystem is attractive learning environment for the students allowing them actively study STEAM subjects, access and explore interesting scientific labs and methods.
- The Go-Lab ecosystem is a valuable tool for multidisciplinary learning approach, e.g. science in conjunction with foreign language.
- Although participants of this case study learned about Go-Lab ecosystem through peer-to-peer teaching, for more efficient multiplication in the Basque region it would be helpful to include it in the official program of the ministry: the Berritzegune – Innovation in Education of the Basque Government. The Berritzegune supports and grants this school program. Therefore, headmasters and representative of Berritzegune organize the inclusion of GoLab as the part of the school program of innovation in education.
- The main challenge is to design or to find good ILSs that fit to the national curricula. The creation of more ready-to-use ILS for elementary education would enable a broader uptake of Go-Lab.
- More training sessions and their content should be designed and delivered taking into account the teachers' experience and school level.

- The adaption process in the case study school is going quite slow. The colleagues knowing about the Go-Lab ecosystem are either too busy, or not motivated. The reason could be in that school, the teachers are involved in other programs of innovation in education supported by Berritzegune.
- For the school, Go-Lab has had a positive impact on the students' learning process since they were inspired by attractiveness of the ILSs and totally new activity in the class. Since teachers can arrange the same ILS with different levels of complexity, the students with different learning styles can work with this ILS in the classroom simultaneously. This is important for the school where students come from a large variety of socioeconomic background.
- From the negative side, there are drawbacks: before designing/creating and implementing ILS the teachers need at least basic training for beginners; in most cases, the level of the laboratories available on the golabz.eu are not adequate or suitable for primary education.

2.2.9 Uppingham School – United Kingdom

Uppingham School (http://www.uppingham.co.uk) is one of Great Britain's leading boarding schools for students age 13 to 18 in Uppingham, United Kingdom. Fifteen boarding houses accommodate almost 800 students, who are taught by two dozen academic departments. The school was founded in 1584 and is reputable for its wide range of activities and 'total curriculum' approach to education. One interview was conducted with the head of physics, resulting in the following major points regarding Go-Lab and Next-Lab:

- Introduction into school starts with one teacher and then spreads to colleagues in the same and different disciplines
- Key obstacles: IT infrastructure, time and workload, curriculum
- Once the students are accustomed to using Go-Lab students are getting a more structured lesson, with a much clearer plan as to how to reach the lessons objectives.
- On the other hand, teachers would probably have to spend more time, although with familiarity with the system the efficiency of using it would increase. Additionally, setting it up for one class means that it can be used for another class or a class next year as well.
- Students generally enjoy working with Go-Lab and using ILSs. The feedback from the evaluation sessions was clear that students found it enjoyable to use the interface.
- The most effective aspect of Go-Lab is that it speaks to the students' way of learning (they want to learn with devices, it is not a new language for them, they are used to computers).

3. Empowering Trainers - Go-Lab Courses

The significant impact and importance of face-to-face Go-Lab training workshops for teachers to use Go-Lab and to act as multipliers in their own school or local region has been highlighted in the previous section. Often time, the training of motivated and outstanding teachers has been the impetus for teachers to start their Go-Lab Teacher Journey to become Go-Lab Expert teachers and trainers. The vast majority of multipliers, i.e. teachers that are introducing and training their peers in the use of Go-Lab, have participated in longer training courses, such as the international training activities (e.g. Go-Lab Summer Schools) or in courses organised by NECs and Ambassadors over a longer period of time. Therefore, the provision of Go-Lab training workshops and courses and to facilitate the activation of the teacher community to enable peer-to-peer training and support has always been a key strategy. Teachers are more willing to try out new methodologies and tools if they have been used by colleagues. If colleagues can convincingly speak about the benefits for their work and their students' achievements it is more likely that other teachers will follow their path.

NECs and Next-Lab Ambassadors conducted hundreds of workshops and trainings over the past years, ranging from 2 hours introductions in many national and international training events, to implementing Go-Lab courses lasting several weeks or even months. The purpose of the training was initially focused on introducing as many new teachers to Go-Lab and Inquiry Based Learning in STEM as well as to increase the availability of ILSs at the Golabz website. Later the focus was shifted to producing and introducing additional training subjects that would provide teachers with essential and deeper knowledge in closely related issues that support or go beyond IBSE, e.g. the use of new apps to support 21st century skills, other pedagogical methodologies that could be used and tested with the tools Go-Lab is offering.

Based on the user profiles and on the combined experience of NECs and Ambassadors, we tried to identify the key training needs that would allow teachers to advance in the Go-Lab teacher's journey. A key goal in WP2 was to create and implement workshops and training material in a modular format that support teachers in creating effective Go-Lab learning spaces and help them to design and implement ILSs in their classrooms.

In the following sections we present the three main teacher training Go-Lab courses that have been tested in the various international training events, addressing different proficiency levels and linking to the corresponding workshop material, presentation and guidelines that are available at Graasp to NECs, Go-Lab Ambassadors and Teacher Training Institutes.

3.1 Go-Lab Basic Course

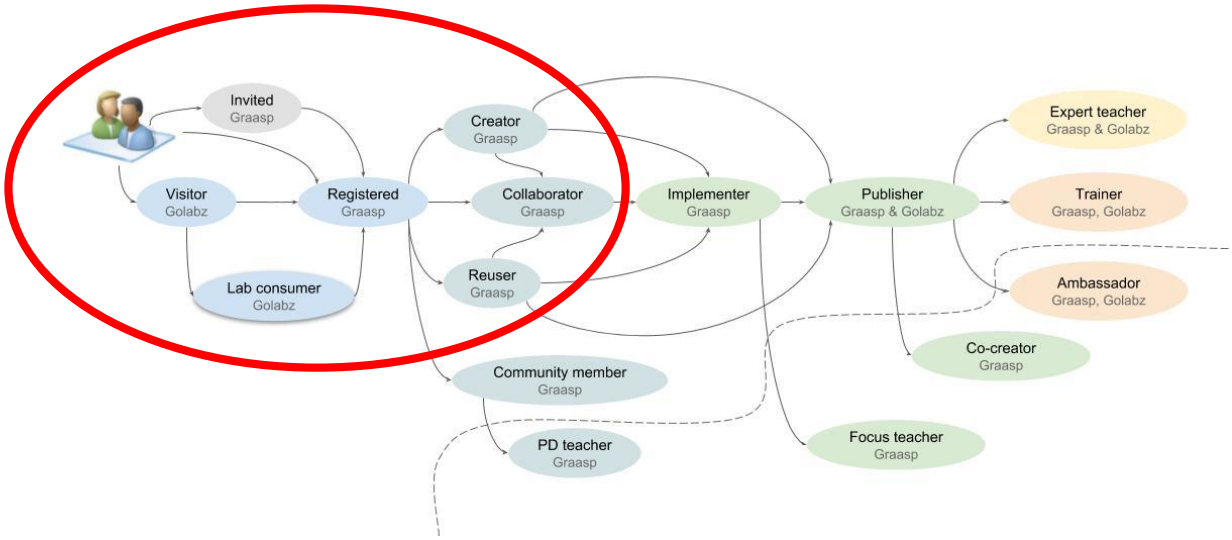


Figure 1: Targeted user profiles of the Go-Lab Basic Course

3.1.1 Course Description

This course is the basic Go-Lab course, designed for teachers who are interested in introducing inquiry-based learning and online or virtual labs in their teaching. The overall aim is to introduce them to the concept of Inquiry-Based Learning (IBL) and the Go-Lab Ecosystem, enabling them to use the basic functions of the authoring platform Graasp to adapt existing or create their own ILSs. The concept and methodology of the course was successfully implemented and tested in the Marathon Summer School 2018.

The Go-Lab Basic course is first and foremost for STEM teachers with no Go-Lab expertise. However, the course is also beneficial for teachers that have attended a first Go-Lab training and are keen to practice and depend their knowledge about IBL, the Go-Lab Ecosystem and especially the range of applications.

This course carefully aims to balance the need for the pedagogical aspects of Inquiry Based Science Education (IBSE) and offers specific workshops on this topic. However, a significant part of the course is also devoted to the technical aspects of the authoring platform and the Golabz website, so participants in the course are comfortable with using or navigating through the authoring platform and Go-Lab Ecosystem. The proposed methodology for this course is to create and work in their own ILS, choosing a topic and lab/experiment that they are familiar with to enable its application in their classroom as soon as possible. Generally, the course is designed to be hands-on, meaning that a significant amount of time has to be dedicated to test, try out and work on Graasp individually and with the support of the participating tutors.

Nonetheless, the Go-Lab Basic course aims to offer a wide overview and first introduction to the pedagogical opportunities that can be integrated within Go-Lab and their various didactic applications, especially to 21st century skills. By the conclusion of the training, participants will be capable of adapting published ILSs or create ILSs using the Basic Scenario and is based on the main principles of good ILS design.

3.1.2 Main Objectives and Desired Outcomes

At the end of the course, participants will be able to:

- Understand the significance and opportunities of inquiry-based science education (IBSE) through the use of online and remote labs in STEM classrooms
- Know the Go-Lab Ecosystem and its structure well to navigate and find its existing educational resources, apps and support material
- Set up and work in learning spaces that can be personalized, how to navigate through digital resources and on-line labs, and how to browse through existing educational scenarios and work on them.
- Successfully work with the Graasp authoring platform and provided tools of the Go-Lab Ecosystem that will help them create attractive science lessons and foster the interest of their students in science topics
- Apply the basic principles of ILS design to create STEM lessons based on the Go-Lab Inquiry Cycle
- Adapt existing published ILSs or create their own ILS using the authoring environment Graasp
- Prepare, uploading and share digital learning resources and activities using the Go-Lab authoring environment and online labs.

3.1.3 Prerequisites

All participants must have

- First knowledge of the Go-Lab Ecoystem and the Graasp Authoring Platform, i.e. are familiar with the structure of the portal
- Computer with internet connection
- Registered to Graasp and have a Graasp account

3.1.4 Modules and Workshops

The Go-Lab Beginner course is designed to be a highly engaging and interactive course. Participating teachers should be allowed plenty of time to test, experience and work in Graasp and the Go-Lab Ecosystem.

Ideally, the course will be delivered in 5-6 consecutive days, consisting in total of at least 25 hours of workshop-based training, such as presentations followed by hands-on sessions (10 hours of lectures and demonstrations as well as 15 hours of hands-on workshops and time to work on creating or adapting an ILS). However, this course can also be implemented over a course of 4-6 weeks with 1-2 workshops per week and ample time for practice at home.

At the end of the course each participant should ideally have created their own first ILS, either from scratch or using a published ILS which then has been adapted during the workshops.

Module	Workshop	Summary description	Key Learning Goals	Material
Module 1 – Pedagogy	The Mystery Boxes: What is Inquiry?	The Mystery Box exercise is meant to increase the learners' ability to be inquisitive, ask questions, and solve problems and this activity helps with some of the basic building blocks to learn these skills.	Learners will be able to • distinguish between observations and inferences or interpretations • illustrate how data can be obtained by making non-visual observations, explain that scientists pose questions, test and revise hypotheses based on evidence, • recognise that science is uncertain because it is a human activity, • understand that science does not prove or conclude – it is always a work in progress, • demonstrate that science is a collaborative enterprise and that scientific uncertainty can be reduced through collaboration	Link to Graasp Space 1h exercise + 0.5h of reflection & discussion
	Inquiry Learning	This group exercises are an additional example to understand the phase of inquiry. It provides several hands-on activities, where learners will have to design	By the end of this workshop learners can	Link to Graasp Space

Module	Workshop	Summary description	Key Learning Goals	Material
	and School Education	a research activity based on the materials available to them. The learners will have to go through the steps of exploring, conceptualizing / designing their research, experimenting, and presenting their results. At the end, the learners will be introduced to labs available on Golabz where they can do the same experiments they have just implemented in real life with online labs. It is the segue to introducing the Go-Lab Ecosystem and the Go-Lab Inquiry Cycle	• identify and explain the process of the scientific inquiry and link them to the 5 phases of the Go-Lab Inquiry Cycle. • distinguish between the terms of the process • understand the main features and how it connects to the basic scenario in Go-Lab.	1h presentation + 1h of practical (group exercise)
	The Big Ideas Of Science	This activity is designed in order to introduce the added value of interdisciplinary learning and to engage teachers in thinking what the Big Ideas of Science are they could focus on with their students. The hands-on activity is the so-called tangram challenge which is designed practice interdisciplinary learning using a simple analogy. This workshop has 3 parts, and 6 participants or 6 teams (ideally of two or three people) are needed in order to do the workshop.	The learners will • understand the basic idea of interdisciplinary learning and teaching. • be familiarised with the organization scheme for concepts and principles that goes beyond traditional curriculum organization • be able to identify the connections between the different disciplines as well as to everyday life.	Link to Graasp Space 1h presentation + 1h workshop
Module 2 – The Go-Lab Ecosystem	Introduction to the Go-Lab Ecosystem	This session intends to be a Go-Lab Introduction Workshop. It outlines all the basic components that need to be addressed while introducing beginners to the whole ecosystem of the project. This session navigates from the teacher's needs towards what Go-Lab can offer to improve their daily experience as educators and facilitators of learning. The various components of the portal and authoring	Course participants will be able to • Identify and find the main components of the Go-Lab Ecosystem (Golabz Portal, Authoring Tool, Support Area, etc.) • search for domain specific labs, according to the subject domain, topic and age of the students • Find apps and their instructions	Link to Graasp Space 1h presentation +

Module	Workshop	Summary description	Key Learning Goals	Material
		tool are briefly presented and a short introduction to Inquiry Based Learning integrates this document.	• Create and log in to their Graasp account and create spaces • Create / duplicate the space of an ILS • Preview ILS and apps and add them to their ILSs	1h of practical exercises

	An Introduction to Graasp Authoring Platform	The goal of this workshop is to implement a few if the most important actions within the authoring platform to make the learners feel comfortable navigating and using Graasp.
		There are three guided exercises and activities that show how to add/remove files, spaces labs and apps in an ILS, change the language settings, add collaborators, find the Go-lab community spaces, etc.
			Participants will be able to
			• Navigate through the main user menu of Graasp and are familiar with the most important terms and functions
			• Create and log in to their Graasp account
			• Know the basic functions for ILS adaptation and creation, e.g.
			  ○ Distinguish between “Spaces” and “ILS”
			  ○ Upload and add material to their working spaces, add and alter text, videos and pictures, change the language, etc.
			  ○ Understand how to include and configure apps and labs
				Link to Graasp Space
				1h presentation
				+
				1h of practical exercises

	Go-Lab Apps – The most popular apps in an ILS	Introduction to the most used (and most important) apps in Go-Lab. Ideally, the apps are being introduced not by a PPT but directly online using the Golabz website. This workshop is a demonstration by tutor. Ideally this would be implemented as an interactive workshop, in which (group of) teachers are assigned an app, which they need to understand its purpose, use and configuration and then have to present to each other what it can be used for.	Learner will be able to • Find, include and configure the most important apps on Golabz and include them in their Graasp working space and ILSs • Know where to find additional instructions and support for each of the apps	Link to Graasp Space 2h workshop

Module	Workshop	Summary description	Key Learning Goals	Material
		It is important to allow enough time for participants to explore the apps, its functions, configuration and the related support material.		
Module 3 – 2st Century Skills & Learning Analytics	An Introduction to 21st Century Skills and Learning Analytics in Go-Lab	The main objective of the workshop is to make teachers familiar with the principles of 21st Century Skills and their connection to Go-Lab. It will introduce some of the Go-Lab Apps that can be used to develop or improve student's 21st century skills. The workshop demonstrates the teaching and learning features of existing Apps, their benefits, scenarios of their use and implementation in ILS in the format of the 21st century skills and competences.	At the end of this workshop, teachers • Have a good understanding of what skills we define as 21st century skills in Go-Lab • Will be able to identify how to enable and include LA apps in the Go-Lab authoring platform, for both teachers and students	Link to Graasp Space 1h presentation + 0.5h use & demonstration of selected LA apps
Module 4 – Principles of effective ILS design	What makes a good ILS	This workshop aims to provide the basic knowledge on how to build an effective ILS. It gives an insight to how theories as e,g, Gagné's nine events of instruction; Motivational theories; Cognitive load theory; Experiential learning, etc. guide the design of "good" ILSs. As practical exercise, participants will get a checklist and some pre-selected ILS to evaluate to what extend the ILSs adhere to the introduced principles, or where and what improvements need to be done.	Learners will • Know the key aspects and be able to identify good practices based on the theoretical starting points that help shape a good ILS such as ○ Inquiry based learning ○ Motivational theories ○ Cognitive load theory ○ Experiential learning	Link to Graasp Space 1h presentation + Discussion and practical examples of ILSs

3.2 Go-Lab Advanced Course

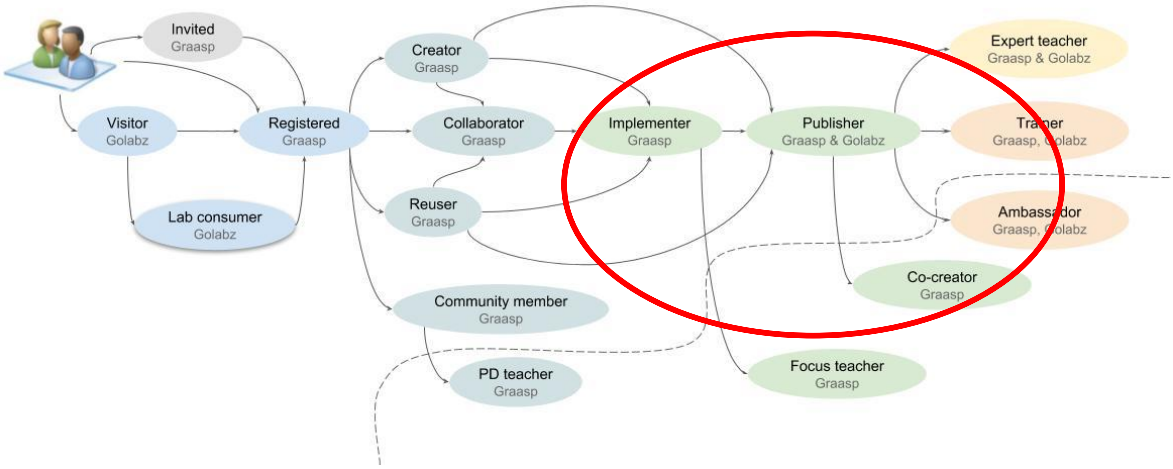


Figure 2: Targeted user profiles of the Go-Lab Advanced course

3.2.1 Course Description

The advanced Go-Lab course is designed for STEM teachers who are already familiar with the basic features and skills regarding Inquiry Learning, the use of the Go-Lab Ecosystem and Learning Analytics in Go-Lab. The overall goal of the advanced course is to make users even more confident and familiar with the Go-Lab Ecosystem, and to facilitate (increased) classroom implementation of ILSs. Furthermore, additional learning methodologies are being introduced in form of introducing the other Go-Lab Scenarios. The overall concept and methodology of this course was successfully implemented and tested in the Marathon Summer school 2017 and has been further developed in the Bilbao Spring School 2018.

The Go-Lab Advanced course is first and foremost for STEM teachers that have previously worked with Go-Lab before and have first experience in creating ILSs and/or implementing (published) ILSs in learning settings. To safeguard the learning experience of the participants the course organisers should ensure that the minimum expertise level is ensured (e.g. by asking participants to provide a self-evaluation form during the registration process).

This course is still focused on creating the environment for teachers to practice their skills in using the authoring platform Graasp, while deepening their knowledge and competences in Inquiry Based Learning with online labs and effective ILS design including the use of Learning Analytics while broadening their scope to introduce other pedagogical forms of ILS lesson design.

The proposed methodology for this course is to facilitate group work by asking them to collaborate and co-create or adapt an existing ILS using another one of the pedagogical Go-Lab scenarios (https://www.golabz.eu/scenarios) other than the “Basic Scenario”. As a matter of principle, also this course is designed to be hands-on, meaning that a significant amount of time has to be dedicated to test, try out and work on Graasp individually and with the support of the participating teachers and tutors.

3.2.2 Main Objectives and Desired Outcomes

At the end of the course, participants will be able to:

- Deepen the knowledge of STEM teachers (of both primary and secondary education) in the concepts and skills of inquiry learning and demonstrating its various applications in inquiry-based learning activities in the science classroom taking into account different teaching and learning styles;
- Familiarise participants to the various Go-Lab Scenarios beyond the "basic scenario" to being able to create challenging and innovate learning resources;
- Practice participants in the use of the Go-Lab portal and its apps and functions to confidently navigate and find its existing educational resources, apps and support material;
- Develop teacher's ICT skills through the use and application of the Go-Lab tools and services to co-create with colleagues ILSs and publish these digital learning resources and activities on Golabz;
- Practice the application of the "Big Ideas of Science" as means of building inter-disciplinary science activities related to the science curriculum;
- Apply the principles of ILS design to create STEM lessons based on the Go-Lab Inquiry Cycle;
- Learn how to effectively include Learning Analytic apps that will help support building more effective STEM lessons and that could support differentiation in pupils learning progress.

3.2.3 Prerequisites

All participants must have

- Be familiar with the basic principles of Inquiry Based Science Education and the Go-Lab Inquiry Cycle
- Basic knowledge of the Go-Lab Ecosystem and the Graasp Authoring Platform, i.e.,
  - Be able to navigate www.golabz.eu to find labs, apps, and published ILSs, as well as familiarity with the support page
  - Be comfortable to use Graasp to create / adapt ILSs
- Computer with internet connection
- Registered to Graasp Training Event Space in the Go-Lab Community

3.2.4 Modules and Workshops

The Go-Lab Advanced course is designed to be a highly engaging and interactive course. Participating teachers should be allowed plenty of time to test, experience and work in Graasp and the Go-Lab Ecosystem.

Ideally, the course will be delivered in 5-6 consecutive days, consisting in total of at least 25 hours of workshop-based training, such as presentations followed by hands-on sessions (5 hours of lectures and demonstrations as well as 20 hours of hands-on workshops and time to work on creating or adapting an ILS). However, this course can also be implemented over a course of 4-6 weeks with 1-2 workshops per week and ample time for practice at home.

At the end of the course each participant should ideally have created their own first ILS, either from scratch or using a published ILS which then has been adapted during the workshops.

Module	Workshop	Summary description	Key Learning Goals	Material
Module 1 – Pedagogy	A Brief Introduction to Go-Lab	This workshop serves as an introduction into the overall program. It aims to ensure that all learners are familiar with the basic terms and functions of the Go-Lab Ecosystem. While the course is targeted at advanced users, it has proven to the helpful and necessary to briefly summarize the most important points to ensure that there is a common understanding among participants. The workshop includes a few hands-on sessions where participants actively need to work on Graasp.	At the end of the workshop participants will: • Be reminded about the main aspects, section and components of the Go-Lab Ecosystem • Be aware and have discussed the main principles of Inquiry Learning in Schools and the phases of the Go-Lab Inquiry Cycle • Have refreshed their knowledge of how to work in Graasp, adapt and create ILSs, integrate apps and labs, etc.	Link to Graasp Space 1h presentation + 1h use & demonstration of Golabz & selected apps
	The Go-Lab Scenarios	This session introduces the six different Go-Lab scenario that describe, in a domain independent way, all activities, materials, and interactions for teachers and learners that comprise a complete (online and offline) Go-Lab inquiry learning experience.	Workshop learners will: • Understand and know the different scenarios are described that can be used to shape the didactical structure of an ILS. • Be able to identify the advantages, needs and disadvantages of each scenario type	Link to Graasp Space 1h presentation +

Module	Workshop	Summary description	Key Learning Goals	Material
		Scenarios differ in activities included and in the combination of a) offline and online activities b) individual or collaborative actions c) distribution of activities over teachers and system, and c) sequencing of activities.	• Understand the importance to choose the right scenario based on a number of considerations, such as educational objectives, the characteristics of the students, students' prior knowledge level and their level of inquiry skills	2h of practical exercises to understand the structure and concept of each learning scenario
	Flipping the classroom using Go-Lab	This workshop is part of the overall effort of the advanced course to showcase and introduce the application of different learning methodologies based on Go-Lab. The topic is a methodology most teachers are somewhat familiar: Flipping the classroom. The workshop will present the main aspects of "Flipping" and encourages workshop participants to identify or adapt their own / published ILSs to accommodate this approach.	At the end of this workshop, teachers • Will know the main features and prerequisites of "Flipping the Classroom" • Understand the role of the teachers in such a scenario • Will be able to identify the phases that are suitable for students to work in outside the classroom • Can discuss and recognise in existing ILSs activities that can be used / integrated with this pedagogical approach	Link to Graasp Space 0.5h presentation + 1.5h hands-on workshop (preferable in group work)
Module 2 – The Go-Lab Ecosystem	The Go-Lab Ecosystem – All there is to know about the most demanded apps and functions	Groups of learners in the advanced course are often very heterogenous in their expertise of Graasp and Go-Lab Apps. It is therefore highly recommended to assess their expertise level and learning needs before the course using, e.g. online self-assessment questionnaires to find out which apps / functions are known, are requested to learn more about, or should be practiced. Based on the results of the self-assessment this workshop will introduce and practice most relevant apps	Learner will be able to • Find, include and configure the most important apps on Golabz and include them in their Graasp working space and ILSs • Know how to update, enhance the user profile and how to personalise the settings • Apply the co-creation and personalisation features in the Graasp spaces	3h workshop

Module	Workshop	Summary description	Key Learning Goals	Material
		in Go-Lab. Ideally, the apps are being introduced not by a PPT but directly online using the Golabz website. A special focus will be given to more advanced features that include how to publish ILSs, how to enable co-creation and collaboration between teachers to create ILSs, introduction to Go-Lab Community spaces, etc. It is important to allow enough time for participants to explore the apps, its functions, configuration and the related support material.	• Know how to create / organise events in the Go-Lab Community space, including registration functions • Communicate with community members • Apply privacy rules and change settings	
	"Ask an expert"	Toward the end of the course, it is recommended to organise an additional session / time slot for participants to ask about anything they still need to know about working in the Go-Lab Ecosystem. A possible way is to collect during the time of the course all questions that learners have, and devote this time to showcase how to implement it.	At the end of this workshop, learners will • Receive answers to their questions on how to use Golabz, Graasp or any requested function of a lab or app published in Golabz.	2h workshop
Module 3 – 2st Century Skills & Learning Analytics	21st Century skills & Learning Analytics in Go-Lab Awareness, Reflection	The main goal of the workshop is to raise the understanding of how Next-Lab features can be used to facilitate the 21st century skills, emphasizing awareness, assessment and reflection Teachers are expected to know how to use the Go-Lab learning analytics apps so that they will be able to assess their students' skills. Moreover, several learning analytics can be used by the students for reflection purposes.	At the end of this workshop, learners will • Have a profound knowledge about awareness, assessment and reflection opportunities in Go-Lab • Know how and when to use, set-up and configure the LA apps in Go-Lab	Link to Graasp Space 1h presentation + 2x 1h hands-on workshop

Module	Workshop	Summary description	Key Learning Goals	Material
	and Assessment	A second main goal of the workshop is the demonstration of the peer assessment app. Participants are expected to understand the rationale of the peer assessment process and its benefits, and then, to learn how to use the peer assessment app in an ILS.		(preferable in group work)
Module 4 – Principles of effective ILS design	What makes a good ILS	This workshop aims to provide the basic knowledge on how to build an effective ILS. It gives an insight to how theories as e,g, Gagné's nine events of instruction; Motivational theories; Cognitive load theory; Experiential learning, etc. guide the design of "good" ILSs. As practical exercise, participants will get a checklist and some pre-selected ILS to evaluate to what extend the ILSs adhere to the introduced principles, or where and what improvements need to be done. The focus of the advanced course should be put on teachers sharing their experience about ILS design and classroom implementation.	Learners will • Know the key aspects and be able to identify good practices based on the theoretical starting points that help shape a good ILS such as ○ Inquiry based learning ○ Motivational theories ○ Cognitive load theory ○ Experiential learning	Link to Graasp Space 1h presentation + 1h Discussion and practical examples of ILSs
Module 5 – Becoming a Multiplier	How to become an effective Multiplier	This workshop gives some ideas and insights on how to effectively engage colleagues and other teachers to take up the use of o-Lab.	Learners will • Identify ideas and tips how to plan, organise and follow-up training events with colleagues and peers • Understand the role of social media for dissemination	Link to Graasp Space 1h presentation + 1h Discussion and practical examples of ILSs

3.3 Go-Lab Expert Course

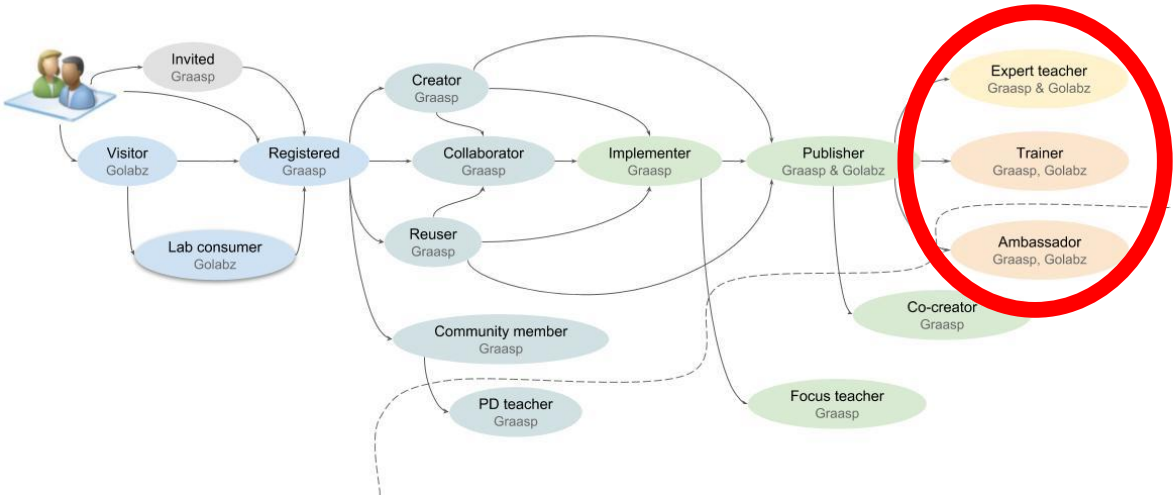


Figure 3: Targeted user profiles of the Go-Lab Expert course

3.3.1 Course Description

To complement the previous courses, another set of workshops was created and tested that are aimed at making teachers **Go-Lab Expert Teachers**. The course methodology is a bit different in its approach and was tested during the Go-Lab [Go-Lab Spring School 2019] in Tallinn, Estonia.

The Go-Lab Expert course is first and foremost for STEM teachers with advanced Go-Lab expertise. However, the course is also a demonstration of the wide possibilities of application of Go-Lab in the school curriculum and educational settings, and therefore particularly interesting for participants that are heads of science departments in schools, policy makers and curriculum developers, so they can see, experience and understand the benefits and possibilities of the Go-Lab Ecosystem.

This course is focusing mainly on the pedagogical aspects of Go-Lab and offers a variety of hands-on workshops. While the previous courses are focused on enabling teachers to create and work on their own ILSs, this course's practical exercises are based on existing ILSs that will be adapted to integrate the pedagogical approaches presented.

The aim of the Go-Lab Expert course is to focus in more depth on the pedagogical concepts that can be integrated within Go-Lab and their various didactic applications, covering topics such as 21st century skills, differentiation, or self-regulated learning. Generally, the school is designed to be hands-on, meaning that topics will be introduced and then used, tested and adapted in existing ILSs. This way, participants will get introduced to the theory and have to apply it on the spot in practical workshops.

Consequently, this training event will require participants to study and work with preselected ILSs chosen by the organizers before arrival, in order to get familiar with the more common pedagogical approaches used in existing ILSs. Then, at the training event, participants are introduced to pedagogical principles associated with 21st century skills and shown how these principles can be supported in Go-Lab. Working in small groups, participants adapt the preselected ILSs to integrate the pedagogical approaches and receive feedback from the organizers and peer groups. By the conclusion of the training, participants will be capable of adapting ILSs to fit a variety of contemporary pedagogies that support developing students' 21st century skills.

3.3.2 Main Objectives and Desired Outcomes

At the end of the course, participants will be able to:

- Explain the basic principles of three pedagogies that support the development students' 21st century skills.
- Demonstrate the ability to adapt existing ILSs to integrate these pedagogies in a meaningful way.
- Discuss the potential of Go-Lab for supporting innovative pedagogies centred around 21st century skills.

3.3.3 Prerequisites

All participants must have very good knowledge of the Go-Lab Ecoystem and the Graasp Authoring Platform, i.e., be able to navigate www.golabz.eu to find labs, apps, and published ILSs, as well as familiarity with the support page; be comfortable to use Graasp to create / adapt ILSs

All participants should be familiar with the pre-selected ILS to be adapted during the workshops. We recommend asking participants to write short summaries describing the content and pedagogical approach for each example ILS and submit these summaries to us before arrival as additional assurance that participants are prepared. No more than three existing ILSs will have to be studied.

3.3.4 Course content and structure

The course will lead participants through a **process of co-creation** where they adapt existing ILSs to apply innovative pedagogies introduced by the training team, it is instructive to first look at the more typical pedagogical structures and approaches used in existing ILSs.

Based on the statistics on the number of ILS copies made, most ILSs follow the basic scenario structure, use text and multimedia to keep students attentive and focused, guide the inquiry lesson and include the hypothesis scratchpad as well as other inquiry apps (e.g., observation tool, experiment design tool or conclusion tool). Thus, the inquiry learning approach and its relation to supporting 21st century skills such as problem solving, and critical thinking is evident in e.g. the three most popular ILSs published on GoLabz:

- Craters on our Earth and Other Planets,
- Sinking and floating
- Series and parallel circuits

However, less evident are connections to other 21st century skills. For this course three pedagogies centred around 21st century skills that deserve more attention, are appropriate for introduction to advanced Go-Lab users. They offer a multitude of options for adapting existing ILSs have been selected. The three pedagogies are:

1. Self-regulated learning and Reflection,
2. Collaborative learning,
3. Differentiation.

The course is divided into three learning modules. Each module is divided into specific units and workshops that support the topic of exploration.

3.3.5 Modules and Workshops

The course is designed to be implemented in three full days, introducing and testing each module as the focus of a single day. In the first session, the presentations/workshops introducing a pedagogical approach are being implemented. Then time should be allotted for groups to brainstorm ideas of how to adapt a preselected ILS to fit the pedagogy. This is followed by a workshop session, where the groups begin implementation of their idea. The adapted ILS should include "teacher notes" explaining in more detail how the ILS aims to fulfil the learning objectives of the pedagogy. At the end of the module groups present their ILSs for feedback and discussion by the organizers and by co-participants.

Module	Workshop	Summary description & Key Learning Goals	Material
Module 1 – Pedagogy	Self-Regulated Learning and Reflection	Learning is more likely to be effective when students think about their learning, assume responsibility and control over it, monitor their progress and reflect on their learning experiences. Go-Lab offers a number of learning analytics apps that support monitoring and reflection of learning. This workshop will demonstrate their application for self-regulated learning and reflection. In this module, participants learn about self-regulated learning and reflection, and adapt an existing ILS to integrate learning analytics apps in such a way to support these pedagogies.	Link to Graasp Space 1h presentation + 3h of workshop
	Differentiation	Go-Lab ILSs are often targeted to the most typical or average student in a class. However, student differences (regarding their cognitive abilities, prior knowledge, interests, motivations, etc.) are important factors that teachers should account for. Go-Lab is a flexible learning environment that makes it easy to accommodate individual learning differences and provide multiple means to tap into learners' interests, challenge them appropriately, and motivate them to learn. In this module, participants learn about differentiation and adapt an existing ILS to provide students with differentiated learning experiences.	Link to Graasp Space 1h+1h presentations + 3h of workshop

Module	Workshop	Summary description & Key Learning Goals	Material
Module 2 – 2st Century Skills & Learning Analytics	Collaborative Learning in the 21st Century	Collaboration is widely considered an essential 21st century skill for confronting societal and workplace challenges in an increasingly interdependent world. Collaborative learning provides opportunities for students to learn valuable interpersonal and teamwork skills by participating in task-oriented learning groups. Although many ILSs are not explicitly structured to follow a collaborative scenario, a variety of Go-Lab apps and instructional design principles can be used to adapt any ILS to follow a collaborative learning approach. In this module, participants learn about collaborative learning and adapt an existing ILS to provide a collaborative learning experience.	Link to Graasp Space 1h+1h presentations + 3h of workshop
Module 3 – The Go-Lab Ecosystem	"Ask an expert"	Toward the end of the course, it is recommended to organise an additional session / time slot for participants to ask about anything they still need to know about working in the Go-Lab Ecosystem. A possible way is to collect during the time of the course all questions that learners have, and devote this time to showcase how to implement it. At the end of this workshop, learners will • Receive answers to their questions on how to use Golabz, Graasp or any requested function of a lab or app published in Golabz.	2h workshop

3.4 Go-Lab Commercial Training

The project partners are currently investigating various ways to create revenue that would allow to continue developing Go-Lab or at least to keep Go-Lab running in its current state for years to come. One of the possibilities is to offer workshops with a fee to schools, teachers and school leaders. The sustainability efforts will be presented and summarised in D.5.5 In this deliverable, the different options are briefly introduced.

The University of Twente has designed and is already offering various compact courses which has been integrated to the Golabz Portal. They comprise of the following:

Basic course (4 hours):

In this course, participants will learn in an interactive and playful way the basic principles of inquiry learning and how Go-Lab can help to introduce inquiry learning in the classroom. This course is **suited for larger groups of teachers** who would like to have a first and basic overview of the principles of inquiry learning and the technologies that can be used to support the inquiry process.

Advanced course 1 (4 hours):

In this course, the knowledge of inquiry processes is deepened, and characteristic problems of students are highlighted. Scientific evidence underlying inquiry learning is presented. During this course, participants will create their first and initial inquiry learning space (ILS) with the Go-Lab ecosystem. This is done in couples or larger groups of teachers collaboratively creating an ILS.

Advanced course 2 (4 hours):

In the second part of the advanced course, advanced design elements of Inquiry Learning Spaces will be discussed and practiced. The topics include how to design an ILS based on principles of cognitive load theory, the use of learning analytics apps for teachers and learners, and inquiry learning and flipping the classroom with Go-Lab. Feedback on the initial ILS designs from the participants is given.

Dedicated course:

If teachers have specific requirements, it is always possible to offer a tailor-made course. This can be an adaptation of an existing course or a newly designed course.

All courses are given in an interactive way by instructors who have a solid background in inquiry learning and who have deep knowledge of the Go-Lab ecosystem. Topics in each course are related to the latest scientific findings from educational research. Courses can be given in English or in your local language.

4. Empowering Teachers - Improved Go-Lab Facilities

4.1 Updated Go-Lab Scenarios

Over the years, most teachers tend to create ILSs that are one-dimensional, i.e. they follow the basic inquiry approach and concentrate solely on content acquisition. Whereas, a goal of the project was to motivate them to create engaging multidimensional lessons that integrate subject-knowledge with 21st century skills-acquisition. Consequently, we found it pertinent to broaden their current outlook of what an ILS could look like and help them create well-rounded guided inquiry.

This was the reasoning behind the introduction of the Go-Lab scenarios. A Go-Lab scenario "describes, in a domain independent way, all activities, materials, and interactions for teachers and learners that comprise a complete (online and offline) Go-Lab inquiry learning experience. Scenarios differ in activities included and in the combination of a) offline and online activities b) individual or collaborative actions c) distribution of activities over teachers and system, and c) sequencing of activities" (see Scenario Handbook). Scenarios are different outlines or storylines for inquiry – ways in which the inquiry cycle may be presented. They prompt teachers to go beyond the basic ILS structure. There are presently six Go-Lab scenarios including the basic approach. While detailed descriptions of these may be found in the handbook , the table below provides a brief overview of each scenario.

Table 1: Overview of existing scenarios

Scenario	Overview
Basic scenario	Basic approach; provides a flexible learning experience for students to solve authentic problems in science by following an inquiry way of thinking
Jigsaw approach	Co-operative strategy; each student needs to collaborate with his or her peers to achieve learning goals
Six thinking hats	Strategy to promote creativity, problem-solving, diversity of thought and empathy; students don 6 coloured hats (that signify different modes of thinking) during the course of the inquiry
Structured controversy	Strategy to prepare students for civic responsibility; inquiry is designed around a socio-scientific controversy that is argued by two opposing sides during a student debate
Find the mistake	Strategy tackles common misconceptions; the inquiry process is organized around spotting mistakes of other (fictitious) students on a specific subject.
Learning by critiquing	Students critique the information provided, validity of ideas, or quality of work based on a set of criteria.

The 5E Scenario

This year, a new scenario, '5E' is being added to the list. The 5E model of learning comprises of 5 stages of inquiry:

1. Students ***'Engage'*** with the new content. This stage is synonymous to the 'Orientation' phase of the Basic Approach.
2. Students make predictions and ***'Explore'*** the topic by means of experiments.
3. Students ***'Explain'*** their understanding of the topic after making sense of their observations. Scientific terminology is introduced in this stage.
4. Students ***'Elaborate'*** on this understanding, deepen their knowledge on the same and/or apply their learning to novel situations.
5. Students ***'Evaluate'*** their own learning.

This is a widely used inquiry approach and is of particular interest to many teachers within and outside Europe.

Gradually releasing responsibility

To be able to create effective ILSs, teachers not only need subject-expertise and pedagogical knowledge, but also technological and design skills. There are several factors that need to be taken into consideration while designing learning for an online environment that are in addition to what one needs to consider for a traditional pen and paper lesson plan – visual aesthetics being just one of these. For this, the training module on Go-Lab scenarios (currently under development) follows a 'gradual release of responsibility' model wherein the guidance we provide teachers decreases with each stage. Teachers will firstly be introduced to each scenario (1), then guided through an example ILS with the help of annotations (2) and will finally be provided with templates to create their own ILS (3) (see figure 4 for the page view).

What apps does one select for the ILS? How does one present enough information in a digital space without overwhelming one's students? How does one provide just enough procedural guidance online to support students to be able to work through a lesson on their own? -There are many questions that need answering and understandably, this can be very overwhelming for teachers, especially those new to Go-Lab. Hence, teachers need a certain extent of hand-holding to be able to start creating ILSs and the confidence to be able to do so independently.

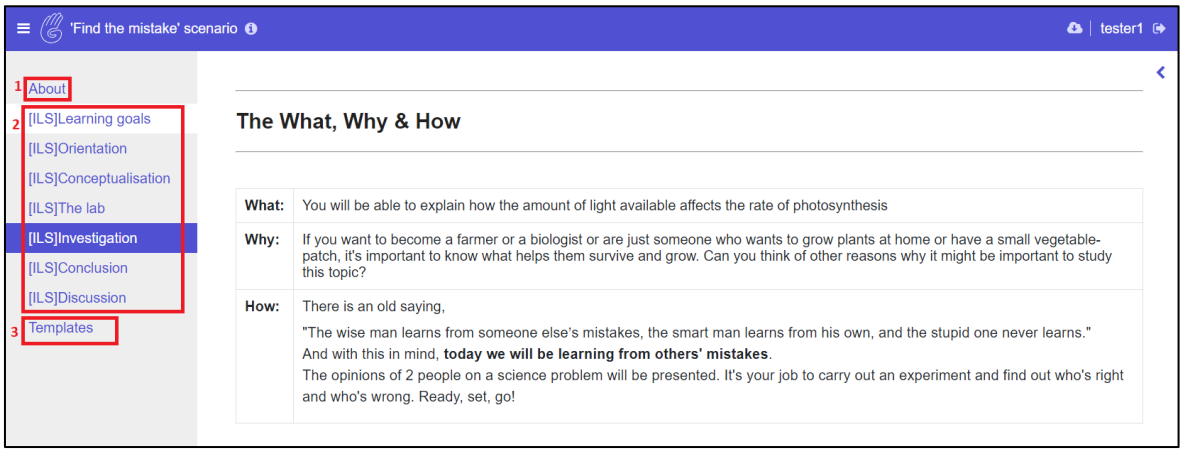


Figure 4: Presentation of training module for each scenario

Annotated examples

Annotations in the example ILSs contain the purpose of the different activities in the inquiry cycle and directions on how to implement each one effectively. Essentially, they guide teachers step-by-step through the examples (see figure 5).

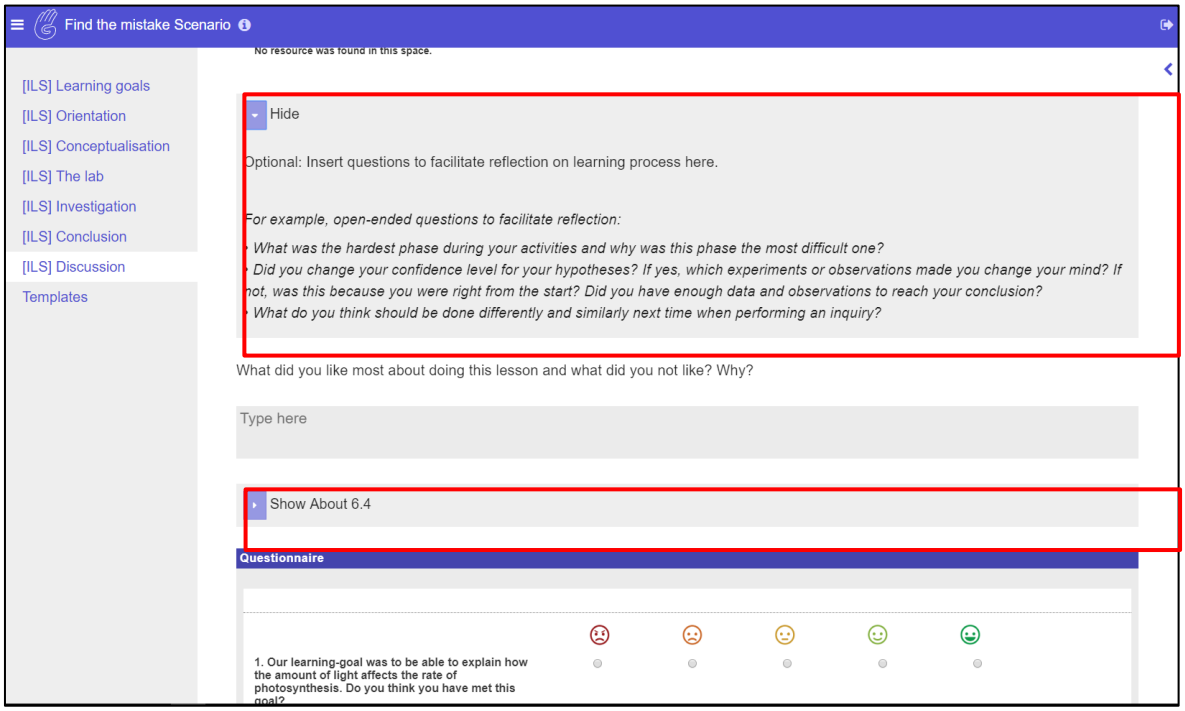


Figure 5: ILS Scenario example with annotations

Amongst the many decisions taken while designing these examples, the following two are worth noting here:

Accessible content

To ensure that the content is comprehensible to the majority of the teachers, all the ILSs cover a basic middle-school concept, 'The effect of the amount of light on the rate of photosynthesis'. The choice of a topic in Biology was also a conscious decision since the majority of the existing ILSs in our repository are for Physics – it was considered important to motivate teachers from other streams of Science to engage with the system.

Look and Feel

For teachers to be motivated to use scenarios in their classrooms, it is of foremost importance that they are able to discern the unique characteristics of each of them. In the past, some teachers have expressed a lack of clarity in this regard. Keeping this in mind, we ensure that the look and feel (colors, layout, character-names, typefaces etc.) of the example ILSs do not vary; only the way the inquiry is crafted does. This makes it easier for teachers to spot key differences.

Templates

It is important to note that a version of scenario-templates already exists on the Go-Lab website. However, most users do not use this. This could be attributed to the way these templates have been designed and presented; users often find them difficult to understand and use. Consequently, it was deemed necessary to replace these with a clearer, easier to

comprehend and more user-friendly format. Therefore, the two types of templates described above will replace these old templates.

Templates typically provide structure to lesson-planning. The aim is not to restrict the creativity of teachers but to give them a starting point and support them through the ILS-creation. There are two types of templates being developed for the Go-Lab scenarios:

The first kind contains scaffolding: a ready-made lesson structure (with relevant apps, tools and position-markers for files to be inserted), the rationale behind each activity, tips on how to frame instruction and provide support for different steps, and instructions on offline and collaboration activities (see figure 5). These templates simply require teachers to follow step-wise instructions and fill in gaps and are aimed at novice users of the system or scenarios. It goes without saying that the example ILSs are built using these templates.

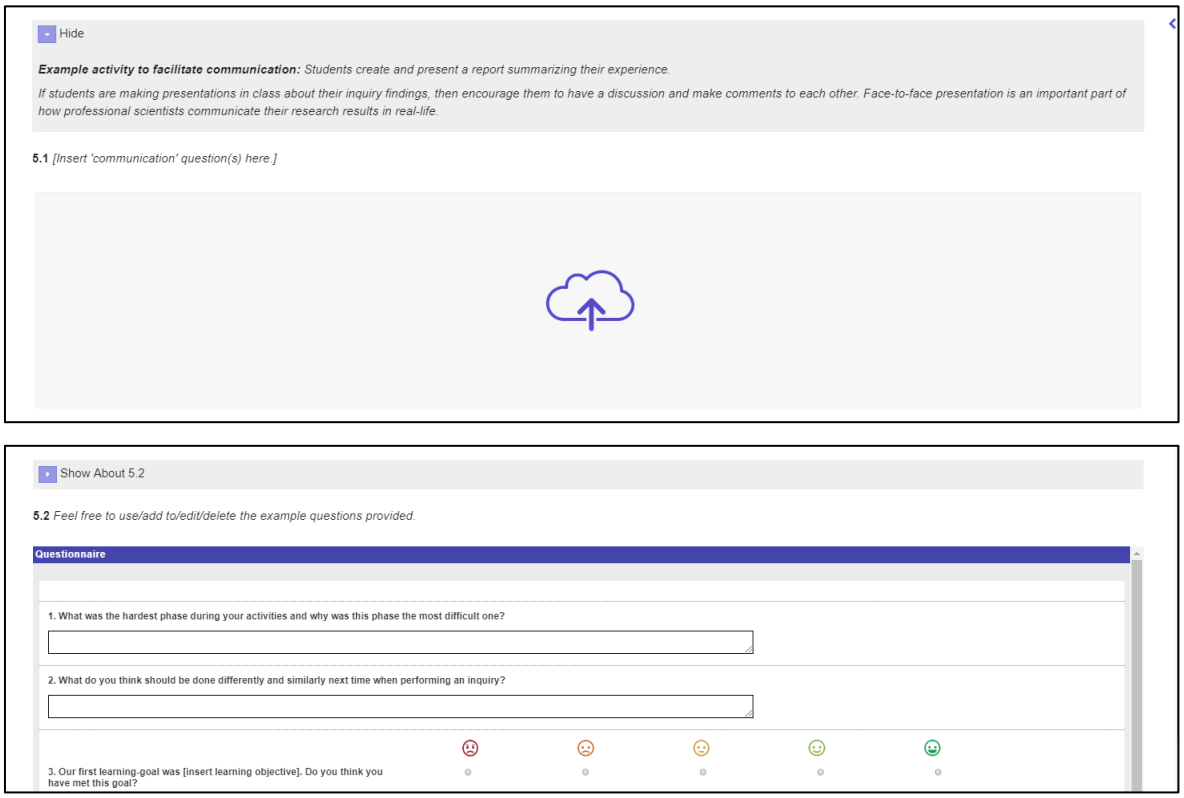


Figure 6: ILS Scenario template with scaffolding

The second kind of template is skeletal and is aimed at teachers who are comfortable implementing the scenarios but are looking for a little guidance. Such templates are not as fleshed out as the ones described above and simply contain brief instructions for each phase.

Teachers are encouraged to use the templates with scaffolding before they use the skeletal ones just as they are encouraged to use the Basic approach before trying the other scenarios. Doing so ensures that they build a solid foundation and eventually succeed at making effective ILSs independently.

In summary, this sequence (of a scenario-description, followed by an annotated example, then a scaffolded template and finally a skeletal template) gradually builds understanding and ILS-planning skills. This approach of gradually letting go will help teachers take baby-steps and gradually build the confidence they need to create their own ILS. The clear explanation of the scenarios will push experienced users to move beyond the basic

approach. Eventually, teachers should be able to independently tweak the inquiry cycle to fit their students' needs and construct varying, wholesome and engaging ILSs.

4.2 Support Area

The goal of the new support area remains to assist, guide and train Go-Lab users to use the full potential of the ecosystem, by providing them with the pedagogical and technical support they need to implement the Go-Lab ecosystem in the classroom. Furthermore, the support area connects the users to the Go-Lab community, national ambassadors and teacher training institutes and provides them with the project's news and updates.

The Support Area is even more important after the project ends as it continues to provide its service and information even with the NECs cannot use EU funds to offer personalised and face-to-face support and training. This is why we dedicated the tutoring / mentoring task (2.3) to update and enrich the support page in order to help teachers to become as autonomous as possible. Clearly, the effectiveness of real face-to-face training cannot be replaced, however more and more teachers are able to design and create ILS on their own with the help on the system. Also, the self-training modules aim to combine both aspects of introducing and showcasing all relevant functions, and to demonstrate how to make effective IBSE lessons for classroom implementation. In the following sections we present the current state and pending task until the end of the project.

4.2.1 Support Pages

The new concept of the Support Area for the Go-Lab ecosystem had been introduced in deliverable D2.5. The following section provides an update of the work that has been done on the Support Area, which includes the restructuring and amendment of the content on golabz.eu support pages https://support.golabz.eu/, and the re-conceptualization and creation of the Go-Lab Online Course, renamed as the Online Training Modules, available on graasp.eu. These will be promoted on the projects' social media channels and during the upcoming events. During the events, feedback from teachers and users will be collected and analysed to validate and further improve the Support Area.

The content of the Support Area has been reviewed and restructured to better meet the users' needs and present the Go-Lab ecosystem's technical and pedagogical affordances in supporting inquiry-based science education and the development of 21st century skills. Hence, content has been updated, some replaced while others added. The changes can be classified into four categories:

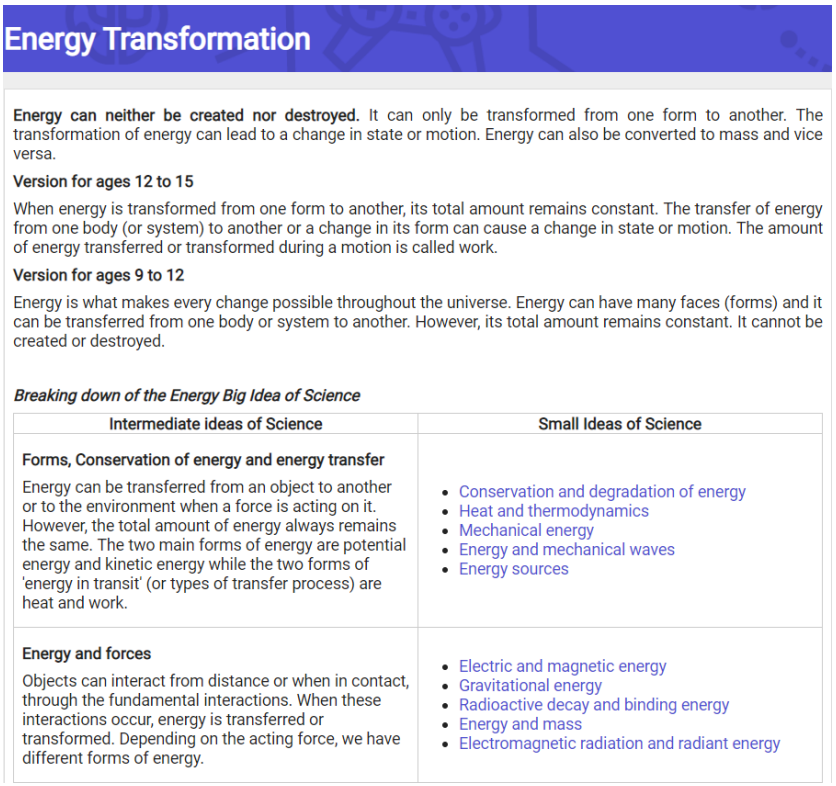
1. Updated Content

How to section: With new and updated Apps being developed during the project, and with the updates of the Authoring platform graasp.eu, the content of the "how to" videos and guides was updated as well. Hence, the *How to create an ILS* and *How to set up Apps* videos, as well as the *How to start with Graasp* guide have been amended to reflect the new changes.

Pedagogical Scenarios: Go-Lab pedagogical scenarios aim at providing teachers with a variety of learning and teaching approaches that promote inquiry learning and the acquisition of 21st century skills. Not only do these scenarios support the development of scientific and critical thinking skills, but also enable the acquisition of reflection, collaboration and cooperation skills. Consequently, encouraging teachers to make use of these scenarios would add value to their teaching practices and allow them to use the full benefits that the Go-Lab ecosystem has to offer. As a result, the description of the pedagogical scenarios

was updated, and the benefits of each scenario were highlighted. Additional support in the form of templates will be provided to the teachers to facilitate the implementation of these scenarios in the classroom (see section 4.2.2).

Big Ideas of Science: The Big Ideas of Science are essential for students to relate the different science domains to each other and to the real world around them, in a more tangible and holistic way. To help teachers better relate to the Big Ideas of Science and their content, a thorough and detailed representation of each of the 8 ideas, in contrast to the previous short definitions, is now available. Two variations on how to approach each idea depending on the age group of the students (9 to 12 and 12 to 15) are provided. Additionally, each big idea is broken down to its intermediate and small idea, making the integration possibilities of an idea in a lesson more concrete for the teachers (see Figure 7).



Energy Transformation

Energy can neither be created nor destroyed. It can only be transformed from one form to another. The transformation of energy can lead to a change in state or motion. Energy can also be converted to mass and vice versa.

Version for ages 12 to 15

When energy is transformed from one form to another, its total amount remains constant. The transfer of energy from one body (or system) to another or a change in its form can cause a change in state or motion. The amount of energy transferred or transformed during a motion is called work.

Version for ages 9 to 12

Energy is what makes every change possible throughout the universe. Energy can have many faces (forms) and it can be transferred from one body or system to another. However, its total amount remains constant. It cannot be created or destroyed.

Breaking down of the Energy Big Idea of Science

Intermediate ideas of Science	Small Ideas of Science
Forms, Conservation of energy and energy transfer Energy can be transferred from an object to another or to the environment when a force is acting on it. However, the total amount of energy always remains the same. The two main forms of energy are potential energy and kinetic energy while the two forms of 'energy in transit' (or types of transfer process) are heat and work.	• Conservation and degradation of energy • Heat and thermodynamics • Mechanical energy • Energy and mechanical waves • Energy sources
Energy and forces Objects can interact from distance or when in contact, through the fundamental interactions. When these interactions occur, energy is transferred or transformed. Depending on the acting force, we have different forms of energy.	• Electric and magnetic energy • Gravitational energy • Radioactive decay and binding energy • Energy and mass • Electromagnetic radiation and radiant energy

Figure 7: Big Ideas of Science – Energy Transformation page

2. New content

Go-Lab introduction videos*:* a video showcasing the Go-Lab ecosystem and presenting the different resources and functionalities it offers is already available on the support area. With the continuous growth of the ecosystem and its spread to different stakeholders, users and visitors might be interested in the different associated projects under the Go-Lab Initiative. Thus, a short video introducing the *Go-Lab Initiative*, its related projects and the various cooperation possibilities were added to the Support Area, with the purpose to inform and attract potential stakeholders. Another video *Why use Go-Lab* was also added. The video highlights the pedagogical and technical affordances of the Go-Lab ecosystem, by explaining how the resources available on the platform support inquiry-based science education and the development of 21st century skills. The video is meant to relay Go-Lab's pedagogical value to teachers and explain how it is reflected in the resources and features of the ecosystem.

Learning Analytics: Not only do the Learning Analytics (LA) Apps and features in Go-Lab enable teachers to better follow-up on their students' progress and performance but they also allow students to develop time management, reflection and assessment skills. With 12 out of the 41 available Apps on Go-Lab supporting LA, a new page was created. (see Figure 8).

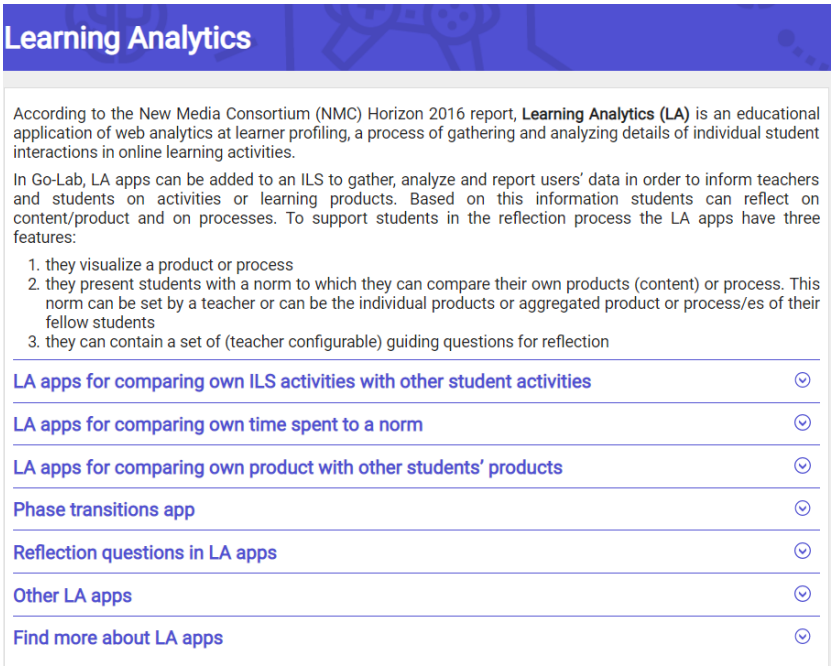


Figure 8: Learning Analytics page

The page provides a short introduction to LA and how it is supported in Go-Lab. The page then categorises the LA Apps by their functions and provides a short introduction to each. A dedicated Online Training Module is also available for teachers to learn how to make use of the LA Apps (see section 4.2.2).

Tips & Tricks: Tips & Tricks were previously included in the Pedagogical Scenarios Handbook and was migrated from Handbook to the Support Area to improve users experience with the platform. The content of the handbook is now reflected in the updated Scenarios pages, and a dedicated, more visible page for Tips & Tricks has been added to the Support Area. The content of this page was created to answer the main questions and challenges Go-Lab users face when working with the ecosystem. They address users' different level of expertise and provide concise step-by-step guides. Thus, the new page provides 5 Tips for Beginners, 5 for Advanced Users, and 5 Technical Tips (see Figure 9).

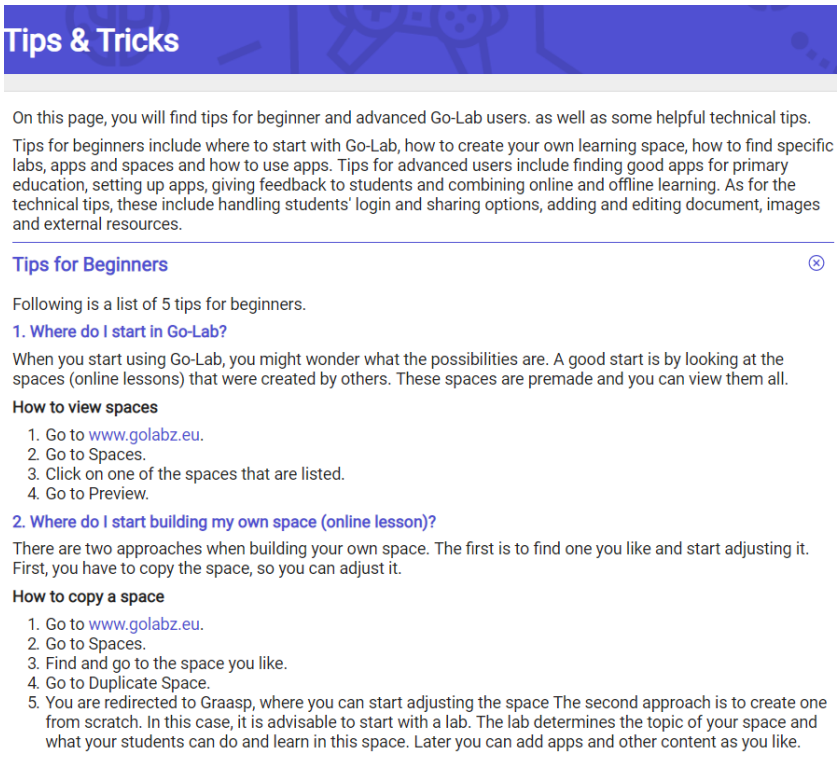


Figure 9: Tips & Tricks page – Example of Tips for Beginners

Learning Theories*:* The Go-Lab ecosystem is designed around the inquiry-based science education approach. Nevertheless, with Apps and Scenarios addressing collaborative learning, self-regulated learning and promoting the Flipped Classroom approach, introducing teachers to these learning theories and approaches and how they are supported by the ecosystem became essential. Hence, in addition to Inquiry-Based Learning, Collaborative Learning, Self-Regulated Learning, and The Flipped Classroom were added under the Learning Theories page, replacing the Inquiry Learning Cycle page. Each page provides a short introduction of the theory/ approach, with concrete examples and guidelines on how the Go-Lab ecosystem can be used to facilitate and enable their integration in the classroom (see Figure 10).

Collaborative Learning

Collaboration is one of the 21st Century Skills that encompasses most, if not all, of the 21st Century Skill set. Students who work together to reach a certain goal are collaborating or cooperating. Collaboration and cooperation share that in both approaches, students need to exchange information and must tune their own outcomes of subtasks with those of fellow students. They differ with respect to the division of labor.

In **collaborative learning** students, **all perform the same task together** and each student should reach the outcome of the task individually. In **cooperative learning**, different **tasks are divided** among group members and all individual outcomes should be brought together to reach one overarching goal. This means that in collaborative learning, basically, each student performs the same task, in cooperative learning there is a set of tasks that are divided over the students (Roschelle & Teasley, 1995).

Collaborative learning (CL) is, therefore, an educational approach to teaching and learning that involves groups of learners working together to solve a problem, complete a task, or create a product. In a CL setting, learners can be challenged by peers, present and defend ideas, exchange diverse beliefs, question other conceptual frameworks, and are actively engaged (Srinivas, 2011). CL represents a significant shift away from the typical teacher-centered in classrooms. Collaborative classrooms are based on students' discussion and active work. Teachers introducing such learning approaches consider themselves rather be coaches of students, than experts that transmit knowledge to their students.

Collaborative learning in Go-Lab

Go-Lab is providing several apps that help students to acquire collaboration skills. Collaboration among students can be supported by offering students apps to help them perform an inquiry task collaboratively (like the Go-Lab hypothesis scratchpad), awareness apps, and by offering collaboration rules to structure the collaboration.

Review studies and meta-analyses on collaborative and cooperative learning consistently show the virtues of these approaches, both for cognitive (Hattie & Donoghue, 2016; Lou, Abrami, & d'Apollonia, 2001; Lou et al., 1996) and social outcomes (Slavin, 2015). The mechanisms through which collaborative and cooperative learning work mainly concern the fact that students need to explain subject matter to their peers and receive explanations from their peers.

Collaboration and cooperation are important skills by themselves as well because these skills are needed in professional life too, and this is even of more importance now as it was before. In collaborative and cooperative learning students learn how to take the stance of other students, weight the differences between these stances and their own standpoint, need to explain these differences and find bridges.

Asymmetric collaboration in Go-Lab

The Go-Lab team has designed and created a set of new and revised apps to support the acquisition and application of 21st century skills by students, such as collaboration.

SpeakUp

SpeakUp enables communication between students, not only through a browser on their PC or laptop, but also using mobile devices. Using SpeakUp as communication channel, a new type of collaboration, **asymmetric collaboration**, has been introduced to the Go-Lab ecosystem. In this form of collaboration, students have different versions (variations) of the same lab and therefore need to exchange information to successfully solve the task at hand. For more information regarding SpeakUp look here: http://speakup.info/bib/speakup-tutorial.pdf

Seesaw Lab

The Seesaw Lab is a virtual laboratory that integrates with the SpeakUp app to provide a collaborative learning experience in Go-Lab. An innovative aspect of this lab is that there are actually two versions of it. In one version, a student can only interact with the left side of a seesaw. In the other version, a student can only interact with the right side of a seesaw. Furthermore, a student sees only objects that are placed on his or her side of the seesaw. If an object is placed on the other side, the seesaw may move out of balance, but the reason for this is not immediately apparent to the student who sees only his or her side. For more information about the Seesaw lab look here: https://www.golabz.eu/lab/seesaw-lab

References & Further reading

Roschelle, J., & Teasley, S. D. (1995). The construction of shared knowledge in collaborative problem-solving. In C. E. O'Malley (Ed.), Computer-Supported Collaborative Learning (pp.69-197).

Marjan Laal, Mozhgan Laal, Collaborative learning: what is it?, Procedia - Social and Behavioral Sciences, Volume 31, 2012, Pages 491-495,ISSN 1877-0428, https://doi.org/10.1016/j.

Slavin, Robert E. (2015), Cooperative Learning in Elementary Schools, Education 3-13, v43 n1 p5-14 2015.

Figure 10: Learning Theories – Collaborative Learning example page

How to design a good ILS: designing a good lesson that makes learning intriguing, captivates students' attention and challenges them without frustration requires experience and thorough planning from teachers. Throughout the project period, the Go-Lab partners worked closely with teachers, providing them feedback on how to create and improve their ILSs. This experience led to the creation of a "How to create a good ILS" checklist, which is usually provided to teachers during the training events. The checklist includes pedagogical and implementation guidelines on how to create a good ILS. Teachers find the checklist very helpful and useful, hence making these guidelines available to all users was essential. The "*How to design a good ILS*" page is listed under Pedagogical Support on the Support page. It includes seven main elements: captivate attention, maintain attention, make it meaningful, plan for success, watch out for memory, include reflection, include investigation. Each element is elaborated practically, in relation to how it can be implemented in an ILS. (see Figure 11).

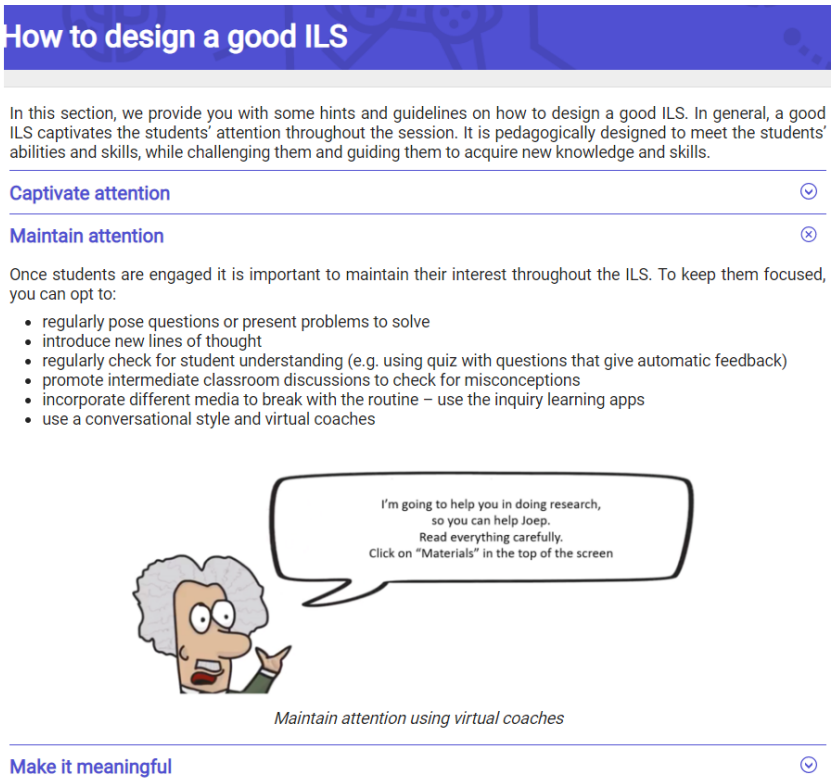


Figure 11: How to design a good ILS – Maintain attention example

Online Training Modules: the previously offered Go-Lab Online Course has been replaced by the Online Training Modules. Section X provides a detailed explanation of the modules. An overview page with access to the offered modules is provided on the Support page.

3. Content reorganization

With the new and updated content of the Support Area, a new representation of the content was needed. The main menu titles familiar to the users were mainly left unchanged, except the addition of Teacher Training as a separate section. The new pages were placed under their corresponding menu titles, and two pages *Go-Lab in your Country* and *Teacher Training Institutions* were moved from *Join the Go-Lab Community* to the added *Teacher Training* section (see Figure 12).

Figure 12: Support page navigation menu

4. Compile your manual function

The previous Teachers Support Manual was available for download in 16 languages. The manual content needed to be updated, and with the expansion of the Go-Lab ecosystem to additional countries, more languages were required. Instead of re-writing the manual and translating it to multiple languages, a “Compile your Manual” function with auto-translation was added to the Support Area. The function ensures sustainable and up-to-date support in the future with minimal effort, since it is compiled from the Support pages available on the platform. Once content is updated on the platform, it will directly be updated in the manual. Since the content is auto-translated, a pop-up notification window was added when opening the manual. The content of the how to and introductory videos is also included in the manual in the form of screenshots and step-by-step guide. Teachers can now choose among the 26 available languages and select the section(s) they would like to download, giving them a more personalized support experience (see Figure 13).

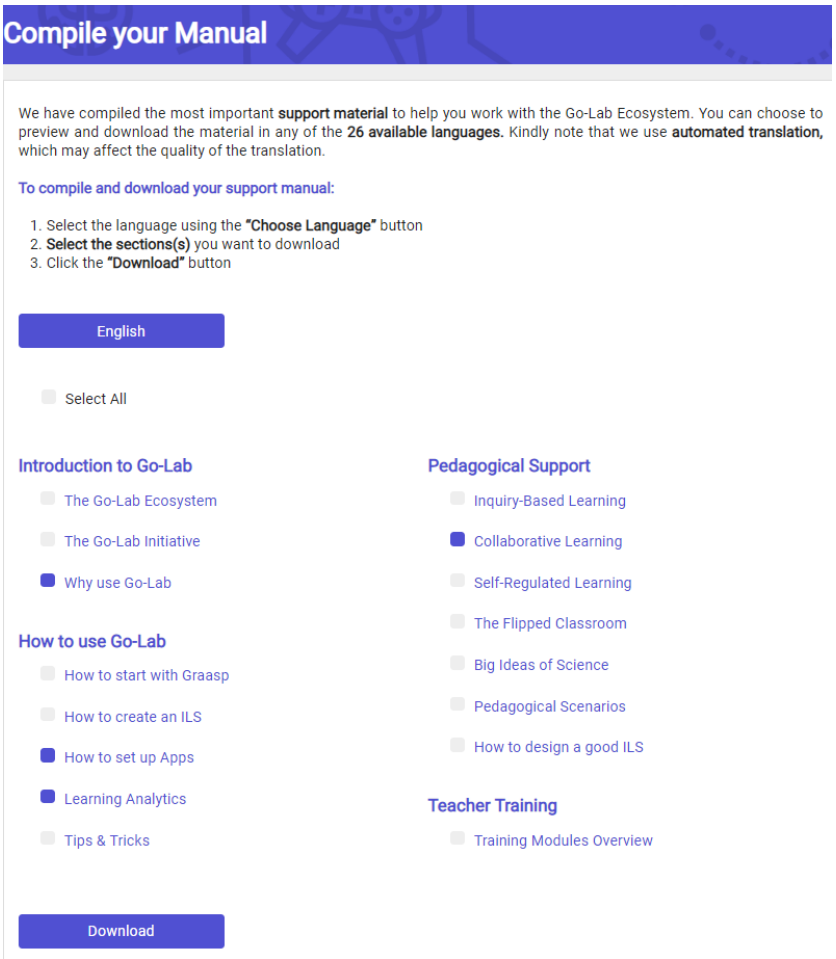


Figure 13: Compile your manual page

4.2.2 The Go-Lab Self-Learning Training Modules

The online modules purpose is to train teachers pedagogically and technically on how to best use the Go-Lab ecosystem taking full advantage of the capabilities it offers. The modules must enable the creation and implementation of ILSs following an inquiry-based cycle with Go-Lab tools, but they should also go deeper and provide expertise on applying specific pedagogical concepts and practices. The training modules are built as ILSs in the Graasp platform which already allows the teacher to get an insight to the students' perspective. Each module implements a different learning approach and is designed around a different learning scenario allowing users to experience with all the scenarios and learning approaches. Moreover, different sets of apps will be presented in each module so that in the end, the user has been exposed to a considerable number of apps. The modules will introduce work-examples in order to provide the pedagogical rationale and the technical support behind each phase of the ILSs.

There are two types of modules: informative and exemplary. Informative modules are designed to provide information about specific pedagogical or technical concepts, and exemplary modules are designed for teachers to have a real feel of how a student experiences an ILS and therefore are actual ILSs.

This set of modules helps beginners with the basics of the Go-Lab Ecosystem and creation of an inquiry-based ILSs, show details on what makes a good ILS and how to implement it in the classroom. And it also trains more advanced users, exploring the differences between

structured and guided inquiry, what is learning analytics and which apps can help, how different scenarios and apps can help cooperation and collaboration with Go-Lab.

The modules are basically independent, except for the first two that give the basic elements of the use of Go-Lab. After the first two introductory modules, the teacher can go through the remaining modules in the order they wish.

All modules have an opening tab called “About the module” which introduces the teacher to the objectives of the module, the topics to be covered, as well as apps and labs used in the modules. And any other information relevant for the module.

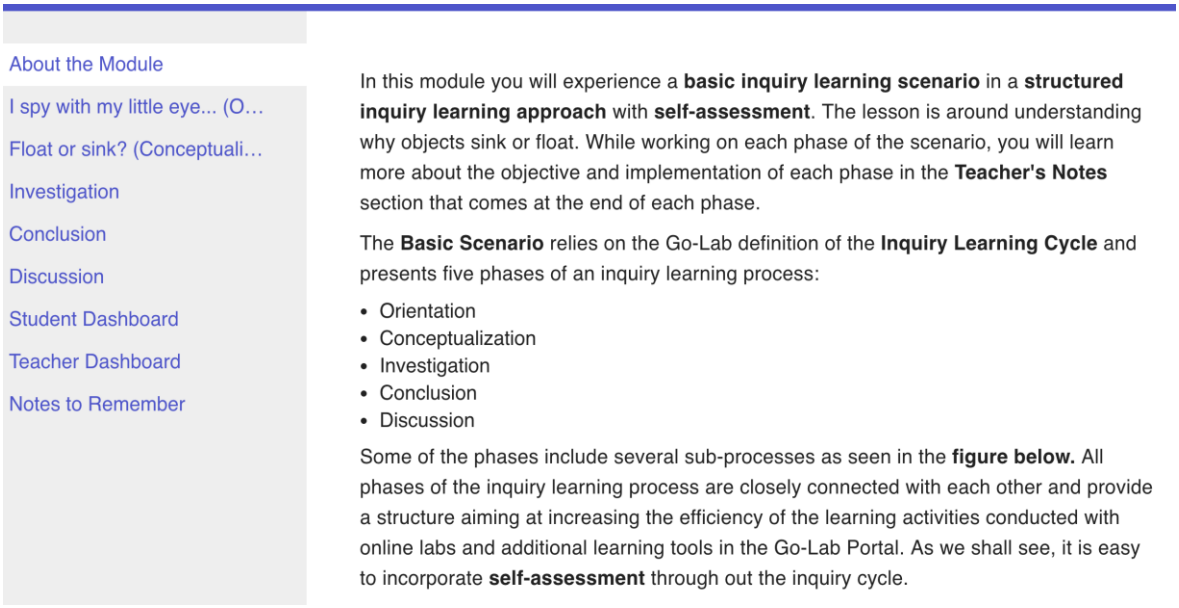


Figure 14: The “About the Module” tab

At the end of each module, a tab called “Notes to remember”, closes the module by enumerating the most important things to remember. See Figure 15.

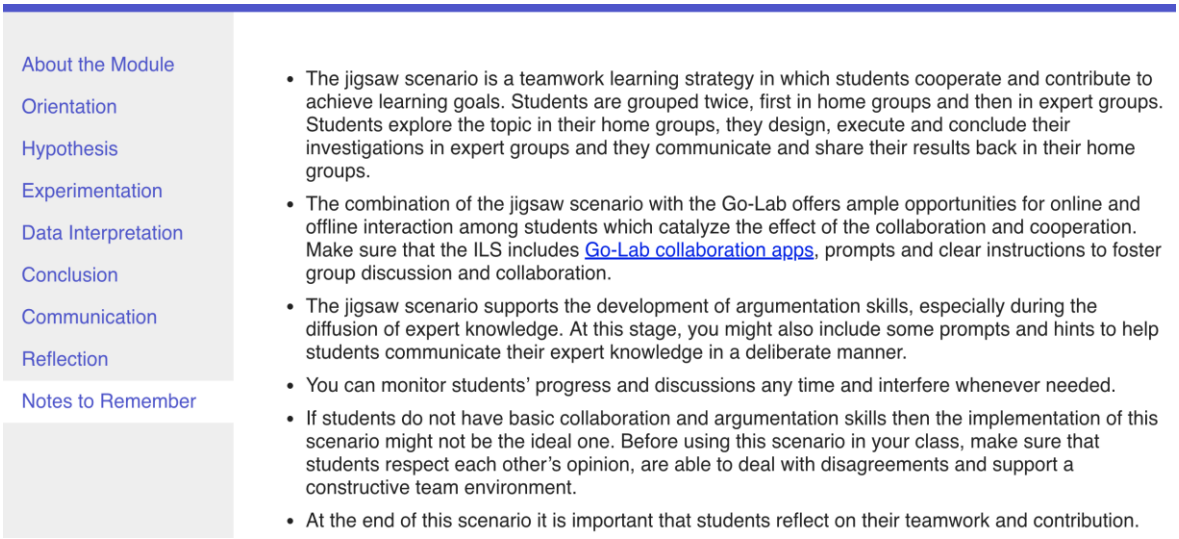


Figure 15: The “Notes to Remember” tab

While informative modules then develop their contents into different tabs, the exemplary modules are worked examples, and therefore, are real ILSs. As the teachers go through the

phases of the learning scenario of the exemplary module, they will first carry out the phase as a student would, with additional teacher's notes presented at the end of each phase providing the pedagogical insight to the phase's elements.

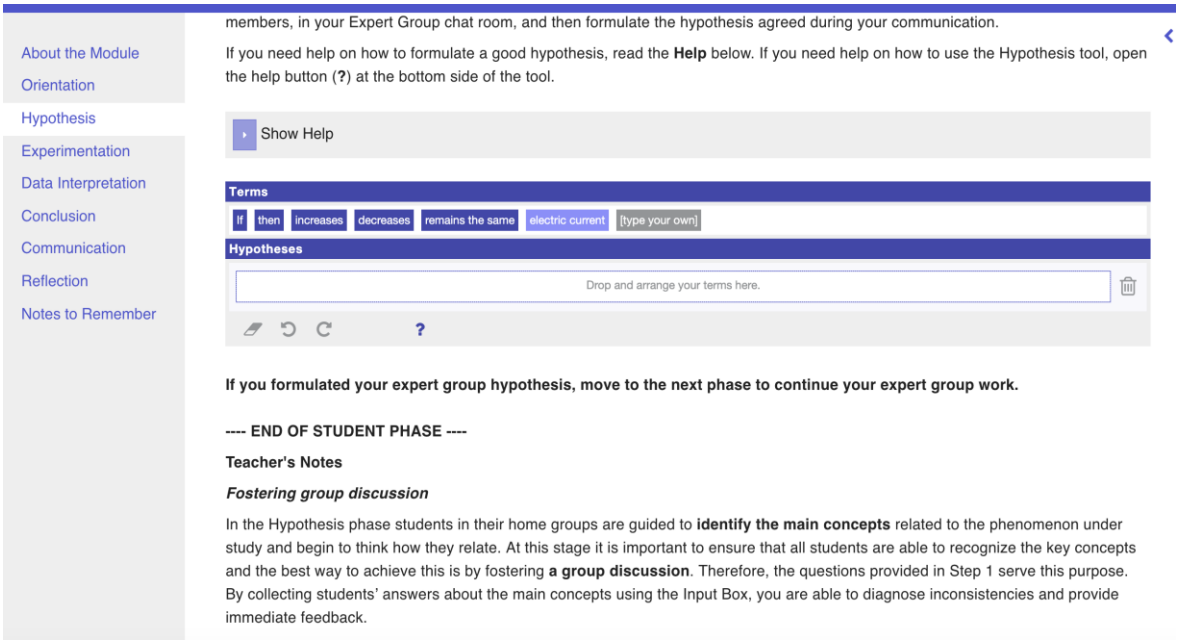


Figure 16: Testing and finalizing

The modules will be firstly reviewed between partners. We will take the opportunity of the Summer schools to have teachers evaluating the modules. We are planning to have the training modules ready to be published before the end of the project.

4.3 Exemplary ILSs

Most of the learning spaces in Go-Lab and the ones published on Golabz, have been developed by teachers themselves. Additionally, in Next-Lab we have designed a set of exemplary learning spaces co-created between teachers and experts from the Next-Lab consortium. These ILSs are meant as examples to inspire teachers to develop their own ILSs but also as off the shelf ILSs that can easily be implemented in class. The initial list of 60 ILS has been provided in D2.6. Since then more ILS have been created and published. Below you will find the titles and links to these spaces.

Figure 17: Example ILS

All of the exemplary ILS have been marked as shown in the figure above and can be filtered in www.golabz.eu/spaces. The new additions are:

Primary education

- Το Ταξίδι Της Τροφής – The journey of food - Link
- Вади Зору – Seeing sharp - Link
  Пригоди Крапельки – Adventures of droplets – Link

- Балансування – Balancing - Link
- Πώς παράγεται ο ήχος – How sound is produced – Link

Secondary education

- Prepare an insoluble salt – Link
- Υδατικά Διαλύματα Ηλεκτρολυτών - Water Solutions for Electrolytes – Link
- “Mas por que é que a alface enruga?” - “But why does the lettuce wrinkle?" – Link
- "Condicionantes Naturais Da Poluição Do Ar” - "Natural Air Pollution Conditioners" – Link
- Безопасность На Дороге - Safety On The Road - Link
- Конвекция – Convection - Link
- Двигун Внутрішнього Згорання - Internal Combustion Engine – Link
- Τσουνάμι – Tsunamis Link
- Μαθαίνοντας για τα ηφαίστεια – Learning about volcanoes - Link
  Η Μαγεία Πίσω Από Τον Νευρώνα – The magic behind the neuron - Link

5. Annexes

Case Study – Interview questions/guidelines

A) The teachers' perspective

Introduction to Go-Lab

- When did you first encounter Go-Lab? How did you first learn about Go-Lab?
- How long did it take you to feel comfortable working with Go-Lab? Did you help yourself by using the support page?
- How long before you used Go-Lab in your teaching in a classroom?
- How often do you use Go-Lab? Have you created ILSs? Have they been published? Have you implemented the ILSs in your classroom? How many ILSs have you created, duplicated, duplicated & modified?

Training / Support used / received

- Have you received any training on Go-Lab? How often, what type of training did you receive? Who trained you (project partners, colleagues, teacher, etc.)?
- What type of support have you experienced generally / from the project team / others?

Implementation of Go-Lab in the classroom / Usefulness

- How have you used Go-Lab? As part of curricular activities in the class, as homework, project work or within after-school activities (clubs, voluntary activities, etc.)? Have you thought of any other modes of delivery?
- Are you using experiments in your science teaching more often, thanks to Go-Lab?
- Are you working with colleagues from other subject domains in an interdisciplinary way while using Go-Lab?
- Do you think it takes students more or less time to learn using Go-Lab compared to using real labs?
- Do you think you spent more or less time in lesson planning when using Go-Lab compared to using real labs?

Introducing Go-Lab at the school level

- What were the biggest obstacles in using Go-Lab in your class / school (curriculum, attitude, infrastructure, technical, financial aspects, etc.)?
- Has the school administration been supportive to implement Go-Lab in your teaching?
- What needs to be done to allow for a broader implementation of Go-Lab in your teaching, in your school in generally?
- Are your colleagues supportive and interested in using Go-Lab?
- How did you communicate about Go-Lab in your school, to your headmaster, to your colleagues?
- What is the Go-Lab adoption process in your school?

- In which subject areas would you adopt it?
- What would you suggest in order to facilitate school implementation?

Impact on students' learning

- Do students generally enjoy working with Go-Lab / using ILSs?
- Did Go-Lab have a noticeable effect regarding your teaching / students' learning?
- Drawing from your experience, how effective are the learning outcomes with Go-Lab?
- When has it been most effective aspect of Go-Lab? And least effective?
- Has the use of Go-Lab been a challenge (in any way) in their learning?

General remarks about Go-Lab

- What are the most positive / negative aspects that come in your mind about Go-Lab?
- What do you think is missing / would help in order to introduce Go-Lab more broadly in your school / in your country?

B) School administration / school director's perspective

Introduction to Go-Lab

- When have you heard about Go-Lab for the first time?
- Who has introduced Go-Lab to your school? Did you propose it to your colleagues, or has a colleague proposed it?
- Please describe briefly the STEM profile of your school. Is your school encouraging inquiry-based learning (even before using Go-Lab)?
- What is the school's approach to using ICT tools as part of the classroom?
- Could you briefly summarize the school's ICT infrastructure (Is every classroom equipped with computers? Does every student have access to computers? Does the school have WiFi?
- What are/were the main challenges of introducing Go-Lab in your school?

Go-Lab impact at the school level

- Would you say that colleagues have been open to learning about and using Go-Lab in their STEM teaching? How many teachers are using it? In what subjects is Go-Lab being used?
- How did / can the school administration support the introduction of Go-Lab?
- What would you say is the most noticeable impact that Go-Lab has had on your school? Was it positive/negative? Useful/ineffective?
- Is your school planning on using Go-Lab in the future?

General

- How does the availability of the Go-Lab affect the schools' attitudes (awareness) and motivation towards inquiry learning and online labs?
- What professional development opportunities related to supporting science teachers in educational use of ICT would you like them to have?
- What do you think is missing / would help in order to introduce Go-Lab more broadly in your school / in your country?

G C School of Careers – Cyprus

A) The teachers' perspective

Introduction to Go-Lab

Mr. Andreas Shianios (Physics teacher) has attended a Go-Lab training event back in 2016, in the context of his master's degree in the Department of Education at the University of Cyprus. The undergraduate program was the "Learning in Natural Sciences" and the course in which the Go-Lab training was offered was the "The Role of Information and Communication Technology in Promoting Learning in Natural Sciences". As part of the course's obligations the teacher created some ILSs and later implemented one ILS in his classes, during the school year 2016-2017. Moreover, Andreas collaborated with two other teachers from his Department and together they implemented a co-teaching using one of his ILSs. The Go-Lab training was extensive enough to make the teacher feel comfortable with the Go-Lab Ecosystem and explore it later by himself without any serious difficulties. Besides that, the teacher is very motivated with any technological innovation. Until now, one of his ILSs has been published on the Go-Lab portal.

Training / Support used / received

As mentioned before, the teacher received his first training form partners of the NEC in Cyprus. The training was offered into two three-hour meetings in which the Go-Lab portal was demonstrated and an extensive training on how to use the Graasp environment and configure the main apps (i.e. inquiry apps, quiz and quest) was made. After this training no other support was offered instead of receiving feedback on the ILS that he created. The teacher also participated in an international training event in 2018, the Bilbao Go-Lab Spring School. During this event the teacher received more advanced training on how to create good ILSs and include the learning analytics apps.

Implementation of Go-Lab in the classroom / Usefulness

The Go-Lab implementations were part of curricular activities in the class, however the teacher is willing to use Go-Lab as homework and complementary learning material in the future. The experiment is already at the center of science teaching in the school but definitely using Go-Lab allows students to conduct multiple experiments in less time without any cost. Each student has his/her personal style of learning, so it is suggested to use both real materials and online labs for the same topic so that to offer the opportunity for all students to master the science content. Besides that, Go-Lab is valuable because it allows the personalization of the learning and the support of an experimental activity in many ways. The Go-Lab Ecosystem has been introduced to the Physics Department, the Chemistry Department and the General Science Department. STEM teachers agreed that Go-Lab must be included into their curriculum, however without being mandatory or time

consuming, mainly because the most important aim of the school is to prepare students for the exams. Currently, the use of Go-Lab in an interdisciplinary way has not been discussed among teachers, but Andreas admits that it will be a good idea to do so in the future. Finally, when someone becomes familiar with Go-Lab then the lesson planning will take less time, but at the beginning a considerable amount of time is needed to learn how to create and modify ILSs.

Introducing Go-Lab at the school level

A main problem with using Go-Lab is the need to access one of the computer labs of the school. Computer labs are used mainly for Computer Science teaching and therefore if any other teacher wants to use computers he/she must book the lab many days in advance. In addition, by moving a class in a computer lab the time of the actual lesson is reduced. For example, a single period lesson of 45 minutes might be reduced into 30 minutes until the students go to the lab, log in to the computers and open the ILS. A second problem is encountered when a teacher wants to use the Go-Lab with older students. Specifically, regarding the schools' curriculum, older students must prepare for external exams (IGCSEs and A Levels) and the time allocation for each lesson is very strict. Thus, using Go-Lab in regular basis is not ideal.

The school administration is in general very open to new teaching approaches and the use of Go-Lab has not been a case of disagreement. However, more empathy is need regarding the time that someone needs to prepare Go-Lab materials and thus other school duties of the teachers should be reduced. In order to implement Go-Lab in a systematic way the school curriculum may need to be redefined so that to incorporate more the IBSE approach. The STEM teachers of the school have shown interest in using Go-Lab, however they prefer to use ready-made ILSs that will be provided by their Department, instead of creating something on their own.

So far, the teacher delivered a brief presentation about the Go-Lab Ecosystem and demonstrated his ILSs with emphasis on how an ILS can be tailored to the normal school curriculum. His future planning is that he will lead the effort for the creation of ILSs for the General Science subject for lower grades. According to him, in order to facilitate the implementation of Go-Lab in the school level, a group of teachers which will be assigned the creation of ILSs based on the school's needs is needed and therefore the other teachers can later use these ILSs.

Impact on students' learning

Most of the students who used an ILS commented that is very interesting, mainly because it is something new and very different from what they are doing in their lessons. Many students expressed their willingness to use Go-Lab more often in their classes because it helps them to gain deeper understanding of the topic at hand. However, since Go-Lab has not been used extensively it is very early to claim that the use of Go-Lab is changing their way of thinking and their behavior towards science. Regarding the teaching practice, Go-Lab offers a well-structured approach for inquiry learning and definitely has a positive impact. The most challenging thing that was reveled from the Go-Lab implementations is that some students did not have the ability to manage properly their time when going through the activities of an ILS. In that way, they did not complete all the required activities. Therefore, more control and monitoring of their work is needed in future implementations.

General remarks about Go-Lab

The only negative aspect about Go-Lab is the time required to transfer traditional learning resources into ILSs. This of course can be done during a school year but is very difficult for newcomers and novice users of Go-Lab. The positive aspect though is that, as soon as everything is transformed and running with Go-Lab, the teachers can share and co-create ILSs. In this way, more than one teachers who teach the same grades but in different classes, they can use common ILSs and offer to the students an identical but at the same time an individualized learning experience, since students can follow their own pace.

For introducing Go-Lab more broadly, continuous training and support is needed. The teacher believes that a series of possibly quarterly seminars/webinars in which teachers can attend not only for training but in addition for exchanging good practices and ideas with other teachers, could have an impact in the number of teachers that are using it more systematically. Finally, the teacher stated the following remark:

"*An online community could be created were teachers with similar interests could join. For example, in the private sector most schools follow similar examination boards (e.g. Edexcel) and their students take the same examinations. As a Physics teacher who teaches IGCSE Physics for example, if I could find other Physics teachers, either from Cyprus or even abroad, who teach Edexcel IGCSE Physics and have created ILSs, I will know that those ILSs could be tailored to my needs. Using those ILSs it removes away a lot of effort to create new ones. This however may not work if teachers who spent the time and effort to create those ILSs are not willing to share them with anyone without anything in return.*"

B) School administration / school director's perspective

Introduction to Go-Lab

The school director heard about Go-Lab on summer 2018, when Mr. Andreas Shianios made an introduction to the school's science teachers. In his introduction he explained the idea behind the Go-Lab ecosystem as a technological tool to help teachers follow the inquiry learning cycle using the available online laboratories. Teachers of the science department were encouraged to use Go-Lab if they believed that it would be beneficial for their teaching and in accordance to the curriculum followed by the school. In general, since the school is private, there are no specific instructions as to how each teacher delivers his/her lessons. However, science teachers are encouraged to do practical experiments with students whenever this is appropriate. The main challenge of introducing and using Go-Lab in the school, is the school's ICT infrastructure, which at the moment is not suitable to do so in a daily basis. Specifically, every classroom has one desktop computer and an overhead projector. This equipment can be used only by the teachers. ICT labs are mainly used for ICT lessons but it is sometimes possible for STEM teachers to book a lab so that the students can have access to computers. There are also some computers available in the school library that can be used by the students. Finally, WiFi is available to specific areas in the school but strictly for staff use. Students do not have access to the WiFi network.

Go-Lab impact at the school level

The staff members of the Science Department, specifically the heads of Physics, Chemistry and Biology show some interest to learn more about the Go-Lab Ecosystem, however the need to keep up with the school curriculum prevent them from spending more time to learn and adapt Go-Lab in their teaching practice. The school administration is more than willing to help teachers use such an innovative tool in their classroom. One idea is to from a special group of teachers (one teacher from each discipline) that will be trained on how to create

learning activities with Go-Lab and then prepare learning materials to be used by all science teachers of the school. Currently, the school administration focused on an effort of introducing the use of tablets at the school. During this effort, all the teachers of the school will have some kind of professional development workshops and of course, a systematically training on how to use Go-Lab can be part of this. Since Go-Lab has only been used with younger students but not in a consistent way, it is not wisely to argue about the impact of Go-Lab. However, is assumed that when Go-Lab is used in a regular basis in science classes it could have a positive impact on students' attainment and motivation in STEM subjects.

General

The school's administrator acknowledge the inquiry learning as the mainstream approach in teaching and learning science and the Go-Lab as a useful means for inquiry learning. The Go-Lab Ecosystem is a rich source of online labs and inquiry activities and, of course, this impacts teachers' attitudes and motivation towards inquiry learning. Teachers can find and create their learning materials, tailored to their needs. Many teachers in the school are interested and are willing to learn new teaching approaches that involve ICT and Go-Lab does provide the necessary tools to move forward with that. In order to help teachers that are interested in learning more about Go-Lab, a good practice would have been if some experienced teachers demonstrate the use of Go-Lab in their classes, live or video-recorded. By watching and discussing on real implementations with Go-Lab, teachers will be more aware on how to use it.

As mentioned earlier, the school's ICT infrastructure is the main concern in order to introduce Go-Lab more broadly. In addition, senior teachers who have many years of teaching experience sometimes they are hesitant in changing their practices. In a national level, there is a need of a new kind of ICT qualification/certificate that teachers could obtain. This will verify that there ICT skills go beyond the outdated knowledge of Microsoft Office software (Word, Excel, PowerPoint etc). For example if the school is about to hire a new Science teacher who has such a certification, then he/she is immediately a better candidate. In a similar way, regarding the Go-Lab Ecosystem, if for example a teacher has enough publications in Go-Lab portal then it is evident that this person is an expert in using this platform and he/she can then trained other school's teachers on how to introduce innovative inquiry activities with Go-Lab in classroom.

Tartu Hansa Kool - Estonia

A) The teachers' perspective

Introduction to Go-Lab

The school teacher first encountered Go-Lab at a professional development in-service course offered by the University of Tartu. She heard about the course from a science teacher at her school who was already familiar with Go-Lab and recommended it to her. She continued her learning at an international Go-Lab summer school, working together with teachers from other countries in small groups to become more familiar with how to use Go-Lab.

At the beginning, she was not confident working with Go-Lab. But the Go-Lab summer school was sufficiently intense to compel her to learn how to work with it. Compared to the university professional development course, the summer school was not as research-oriented and watching other beginner teachers present their work gave her confidence that she was just as capable as others. The process of becoming confident happened over a

time period of about six months. She did not consult the support page but did look at an Estonian translated manual, provided to her by a colleague, to identify relevant terminology in Go-Lab and inquiry learning.

She actually tried using Go-Lab immediately after her university professional development course, because she felt that the "student view" offers a simple and easy-to-understand presentation of content. Also, the university course required that she test an ILS with her students.

Her use of Go-Lab depends on whether a topic is missing information from a traditional resource (e.g. a textbook) and requires supplemental material or whether a topic requires a more engaging approach. She has created around ten ILSs. However, because she is a primary school teacher for grades 1 to 4, her use of Go-Lab for science topics has been limited because there is a lack of suitable science labs suitable for younger students and especially a lack of Estonian language labs. The young children she teaches are not yet reading English at a level that would make it comfortable to use non-native language materials (aside from use in English language lessons). She uses Go-Lab more as a general-purpose digital learning environment that facilitates using interactive ICT learning materials with her students. Topics for which she has made ILSs include social sciences, language and history. She actively shares her ILSs and spaces with her colleagues and even organized a training on her own initiative to get more teachers involved with Go-Lab.

Training / Support used / received

The training the teacher received in Go-Lab was mentioned previously. When the teacher encountered technical difficulties with Go-Lab, she contacted project team members at the University of Tartu or the Go-Lab project in general for assistance via email. They replied to her promptly with answers and sometimes asked for screenshot images to see exactly what the problem was before offering a solution.

Implementation of Go-Lab in the classroom / Usefulness

For example, the teacher has used Go-Lab with 4th grade students during several regular school crafts lessons in which students worked in groups to design a future city. The Go-Lab space allowed her to integrate collaborative digital apps such as Padlet for collecting ideas and the Graasp Input Box app to collect answers to questions as students worked on this project. She even saw that the lesson could be continued in other subjects, and sent it to the Estonian language teacher, who extended the ILS to integrate teaching language skills.

Introducing Go-Lab at the school level

The teacher stated that the biggest obstacle to using Go-Lab are **teacher attitudes**. She said that if a teacher does not feel like making a class more interesting to students by using ICT technologies then it will not happen. Motivated teachers will seek out the necessary technical knowledge to get started with a learning environment like Go-Lab. She believes that **teachers comfortable with their routine teaching methods** and unconcerned whether students find their lessons boring **will not take the time to begin using Go-Lab.**

The **school administration has been supportive** for teachers to learn about Go-Lab at professional development courses by permitting flexible teaching schedules. Teachers have freedom to choose their own approach in the classroom and implementing Go-Lab has not faced any restrictions by the school administration.

Teachers would benefit from ready-made examples before they begin to adapt, revise or create their own Go-Lab learning experiences. Improving teacher ICT skills and

confidence with the Go-Lab learning environment could possibly help implement Go-Lab more broadly at the school.

The teacher remarked that **language related subjects could benefit from Go-Lab** because digital devices attract student attention to reading and can motivate them to write/type longer sentences or write more creatively.

Impact on students' learning

The teacher noticed that Go-Lab was effective in **motivating students** to study various topics. She was **less convinced** that it would be better **for learning factual knowledge** and stressed more the possibilities for using **Go-Lab to support interdisciplinary knowledge building**.

The **least effective** aspect of Go-Lab according to the teacher **is providing feedback** and **grades** to students. This process is currently very time-consuming for her in the Go-Lab environment.

General remarks about Go-Lab

Initially the teacher did not feel confident because her content creation in Go-Lab did not match the elaborate examples that had been presented to her and this caused some negative feelings. However, **with time and practice**, as well as moderating her expectations, she gained confidence in the learning environment and felt positively about her created learning materials.

From the perspective of a primary school teacher, the teacher noted that learning resources for children in grades 1 to 3 are underrepresented in Go-Lab. She would like more age-appropriate resources for primary school children. In addition, a tool for conveniently making corrections to all students' text simultaneously, without having to enter each individual student view, would offer added value over simply working with paper-based materials and making corrections with a red marker. This would help introduce Go-Lab more broadly in her school.

B) School administration / school director's perspective

Introduction to Go-Lab (replace the questions with the descriptive paragraphs)

The director heard about Go-Lab for the first time about 3 to 4 years ago from teachers at her school who participated in the Go-Lab Summer School and in-service professional development courses where this learning environment was introduced. Teachers at her school introduced Go-Lab. The director herself did not propose it to her colleagues.

The director describes the STEM profile of her school as offering several activities related to science and mathematics tracks and includes robotics extracurricular opportunities. In science classes, inquiry-based learning is being applied most frequently in grades 4 to 6. A teacher who participated in the Go-Lab Summer School is applying inquiry for younger children in grades 1 to 3.

The school encourages using ICT tools and the experience is positive. According to the director, the school has WiFi inside and outside near the school grounds, three computer labs consisting of PC desktop computers, and 4 classroom sets of iPad tablet computers (about 96 iPads in total). Also, the school has an open classroom where four classes learn together. This open classroom methodology encourages group work and is used for science classes in grades 4 to 6.

The director believes that the main challenge to introducing Go-Lab is the **workload** of teachers and a **lack of ICT skills**.

Go-Lab impact at the school level

The director says that science subject teachers and general-purpose teachers use Go-Lab. In total around 10 teachers may be using it. The school administration supports teachers in attending the professional in-service courses where Go-Lab is introduced. The director stated that Go-Lab is a **positive way to support the inquiry-based learning approach**, an approach that is specifically required in the Estonian national curriculum.

General

The director felt that it is difficult to give a conclusive answer to whether the availability of Go-Lab affects the schools' attitudes (awareness) and motivation towards inquiry learning and online labs. She would like science teachers to be more open to new ideas and the use of ICT in teaching. She feels teachers require time to learn about Go-Lab in order for it to be more broadly used. The director is very happy that teachers themselves have taken up efforts to educate their colleagues about Go-Lab. This is a better approach than having the director give top-down directives that such a learning environment must be used in their teaching.

A case study - Finland

A) *The teachers' perspective (interview with two teachers)*

Introduction to Go-Lab

We encountered Go-Lab at the beginning of 2019 when the project researcher introduced the portal for us. Go-Lab was interesting right from the beginning. When the project researcher came to our lessons and worked with our students using Go-Lab, the basic principles of the portal became visible. After the introductory lesson, we could repeat the same procedures that he used. However, it was only after the training sessions we felt more comfortable to work in the portal since we learnt how to modify the materials. At this point, we have used the ready-made Go-Lab-materials seven times (7 x 2 hrs) in our classrooms. We think that after these experiences and training sessions we are ready to create ILSs of our own.

Training / Support used / received

First, we have received personal instruction from the project researchers here in Turku. When we have had questions related to Go-Lab, they have instructed and helped us. They also gave a two-hour workshop for teachers of our school. Second, we attended the Go-Lab Spring School in Tallinn, Estonia. The spring school was really well organized. We were assigned to different groups based on our knowledge and skills in using Go-Lab. It was still a positive surprise that as two relatively novices we were assigned to a group with two more advanced colleagues. We learnt a lot from them. The structure was that first project partner gave us a lecture. After that, we experienced the possibilities of Go-Lab on our own. The overall support given by Go-Lab team has been extensive. Even during our classes, we've had the possibility to call and ask for technical support in using Go-Lab.

Implementation of Go-Lab in the classroom / Usefulness

Since the platform was new for the students, we started to use it together. Now the use is more routine, and the students use it individually. Go-Lab has been part of our curricular activities and we have used it on our lessons. We have not given homework that would

require the use of Go-Lab at home. Our next objective is to start creating our own ILSs and to differentiate the materials for different students. Furthermore, we are going to adopt collaborative working methods in Go-Lab. Compared to our science lessons before this spring, Go-Lab has now given us plenty of possibilities to do "extra experiments" in addition to real labs. For example, we have taught electrical circuits virtually and using physical equipment. In mechanics, it has been a lot easier to do experiments using the virtual skate ramp than to build a real one. Based on our experiences, when the students are familiar with the platform, it is easier for them to learn to use laboratories in Go-Lab compared to using real labs. Since we, as teachers, have used the ready-made ILSs, we have also spent less time to plan our lessons compared to using real labs. Naturally, if you modify the ILSs, it will first take more time but then you are able to use the materials again without a detailed planning of your lesson.

Introducing Go-Lab at the school level

The ninth graders of our school do not have individual laptops which causes obstacles to using Go-Lab frequently. They have to use our ICT class which is not an optimal collaborative learning environment for Go-Lab since it's built to function as a "language learning studio". At the start, the slow WiFi connection was a bit problematic, but now it has been improved and is no longer a problem. On the next school year, all our students will get individual laptops and we are waiting how the WiFi works then. We, as teachers, are free to choose the methods in our classroom to fulfil the objectives of the curriculum and the school administration supports us in our work. This has also been a situation when implementing Go-Lab. In order to implement Go-Lab broader in our school, more training and Finnish materials would be needed. However, there is definitely more interest to use Go-Lab in our school when we have informally discussed it with our colleagues. The adoption process is that the teachers browse the applicable resources and test the platform in their classroom. Based on our experience, Go-Lab has provided adoptable resources at least for Physics, Chemistry, Biology and Geography lessons.

Impact on students' learning

Generally, the students enjoy and are motivated to work with Go-Lab. When using the platform, they can do more experiments compared to learning with real labs. Since the ILSs are divided into phases, in addition to only experimenting, students can learn how to actually perform an inquiry: to do mistakes and then try again. One example of learning outcomes was an assignment to draw a circuit diagram: one student drew a visual electrical circuit following the same visual pattern than in the pHet simulation "Circuit Construction Kit". Meaning that the transfer of learning varies with different learning methods. For our students who have learning difficulties, Go-Lab has been easier and more effective learning method compared to the real labs. At the same time that it is still concrete and visual, it lacks the obstacles related to the real labs. For example, we don't have the same kind of large batteries in our schools that are available in virtual labs. Furthermore, virtual labs do not break down.

General remarks about Go-Lab

Generally, Go-Lab provides multiple opportunities for classroom usage. The platform is easy to adapt and it does not require students' registration which makes it easy to introduce. As a negative side, we do not find the data provided by the platform to be particularly useful. The learning analytics tools give information to assess students by comparing them side-by-side, but we would like also to get data from individual students' perspective (e.g. which topics have been challenging for an individual student). As a conclusion, more materials

and training would be needed to introduce Go-Lab more broadly in Finland. We believe that just adding the Go-Lab to the curriculum would be insufficient. There needs to be teachers who are familiar with the platform and then can help others to start using it.

B) *School administration / school director's perspective*

Introduction to Go-Lab

Go-Lab was introduced in our school by the two teachers who started using it during this school year. They are the experts of Go-Lab in our community and they have introduced it to other teachers. Pedagogically, some of our teachers are ready to implement inquiry-based learning in their teaching, some are not. Especially on higher grades, even the students expect that learning should be based on traditional, teacher-centered instruction. This makes it challenging to implement new methods widely. Technically, extensive ICT equipment is available for the students in our school, e.g. all the students on the grades 7 to 9 have personal devices. If more equipment is needed, it will be acquired. To summarize, ICT infrastructure is in a good condition and use of ICT is a part of everyday learning in our school.

Go-Lab impact at the school level

We have quite a large school, which means that we can develop and try out new approaches in various small groups, thus achieving good results. After seeing and hearing about the good experiences of our two Go-Lab teachers, I would now like to see Go-Lab implemented more widely in our school. We need to resign from passivating teaching, and in order to do that, we need more materials and methods that support active learning.

As the headmaster of the school, I cannot force the teachers to implement new things. We have a system of shared leadership where teams have responsibilities. For instance, if we have a project in our school, there can be a team that is responsible for that for the whole school year. Our plan is to form a Go-Lab team in our school. The team will have time allocated for developing materials and supporting other colleagues in the use of Go-Lab (about 1 hour per week). This team will begin their work next semester.

General

Generally, when we want to create something new, there should be some preparations made in advance, couple of teachers who are keen to develop new ideas and the headmaster who gives backup for the teachers if needed. We are anticipating the collaboration with the Go-Lab project team next fall and we think it will benefit the work of the whole school community. We can see that the results of Go-Lab on students' performance are successful, and now it would be important to introduce it more widely in our school.

2nd Primary School of Voutes - Greece

A) The teachers' perspective

Introduction to Go-Lab

Fotini first met Go-Lab at a seminar organized at Heraklion by the Educational Laboratory Center of Science in the autumn of 2015. She felt comfortable to use the environment relatively quickly but needed a little time to study about inquiry-based learning and how to integrate it into the classroom. She began to use Go-Lab in the classroom in the winter of 2016.

In the last 3 years she has been using the Go-Lab in the 5th and 6th grade. In collaboration with other teachers, they teach physics curriculum through specific STEM activities. These activities draw on the introduction of modern physics and cosmology (through the "Playing

with Protons" project), space and environmental awareness. She usually creates her own ILSs depending on the topic they are working on or duplicate and modify an ILS that exists. She had created 14 ILSs, published 5 and has duplicated & modified 5 ILSs.

Training / Support used / received (replace the questions with a descriptive paragraph)

She was trained by the project partners in the **Go-Lab summer schools** of 2016 and 2017. These lessons were very informative, and she did not need extra help.

Implementation of Go-Lab in the classroom / Usefulness

She has only used Go-Lab in the class, as curricular activities and project work. In most cases she cooperates with the class teacher to build and implement the lesson. She believes that using Go-Lab, the **learning process is more structured and more student-centred.** In addition, students can make experiments that are difficult to do, either because of a lack of equipment, lack of time or because it is difficult to make them in real-time. The teachers have noticed that using Go-Lab, **difficult concepts of physics are more easily understood by children**, and generally the use of computer **increases their motivation** for learning.

She often uses Go-Lab and **online labs in combination with hands on activities** using physical computing. It is a field that she is very interested in, as it offers a wide range of applications, the equipment is affordable, and it increases students' computational thinking.

Introducing Go-Lab at the school level

Fotini uses Go-Lab in the school's computer lab, which in the last two years has been transformed into a STEAM Lab. Unfortunately, from the curriculum there is only one hour for computer science per class, so anything they do with their pupils is done in extra hours in collaboration with class teachers.

The **school's administration has been very supportive** during implementation of Go-Lab. Class teachers who are using web 2.0 tools were interested in using Go-Lab, so many informal presentations were held in the school. In order to be used more in our school, **teachers should be trained more**.

Go-Lab is mainly used in 5th and 6th grade in computer science and physics courses and in STEM projects. It is mainly used in the computer lab, but it is usually occupied as it is also used by all school classes. **There is the intension to create a portable lab using Raspberry pi** so that all the students can use it in their classrooms.

Impact on students' learning

Students became familiar relatively quick with the Go-Lab. According to Fotini, Go-Lab itself is very helpful in this. The fact that they were exploring what they were going to learn was **very effective in learning**. Also, the fact that they could go back to any stage, check and modify was also very important for the learning process.

Moreover, it is a very useful tool for teachers as an intermediate stage in PBL or design thinking processes. Many difficult concepts and misconceptions have been understood through the Go-Lab. Go-Lab was **less effective when we used it in large groups**. The pupils had difficulties working together. So, they ended up working in groups of two when using Go-Lab.

General remarks about Go-Lab

Fotini thinks it is a very powerful tool and a well-structured platform. What is missing though is the training of teachers on both philosophy and the platform. Perhaps to introduce it more broadly online training could be done.

2nd Minority Primary School of Komotini – Greece

A) The teachers' perspective

(teachers interviewed: Marina Molla, Katerina Chatzopoulou and Pigmalion Milonas - teachers of the Greek language program and Ali Molla Amet Ali - teacher of the Turkish language program*)*

Introduction to Go-Lab

Marina Molla was the first teacher of the school to be introduced to Go-Lab. She learned about Go-Lab during a workshop of the PLATON project (a spin-off Erasmus+ project of Go-Lab which also makes use of the Go-Lab tools to introduce online experimentation) during the "Open Schools for Open Societies Conference 2017" in Athens. She published her first ILS called 'Astronaut Academy' the following summer. Marina introduced her ILS to the three other teachers, and they implemented it collaboratively with 4th grade students. Katerina, Pigmalion and Ali all found Go-Lab easy to use and navigate and expressed an interest in collaborating again in the future, create and implement new interdisciplinary ILSs.

Training / Support used / received

Marina was originally trained by the PLATON team (all PLATON partners were members of the Go-Lab consortium) in the use of Go-Lab. She then organized a face-to-face training workshop for her colleagues, the headmaster and the deputy headmaster. All teachers expressed the wish to learn more about Go-Lab. They contacted the Go-Lab team when they needed help and found it to be very supportive.

Implementation of Go-Lab in the classroom / Usefulness

The four teachers collaborated and introduced the ILS to 4th grade students each of them working on a different part of the ILS in their class. The ILS was implemented in both languages (Greek and Turkish) and different subjects were introduced (language teaching, Geography, Science). Ali mentions that he uses experiments in his science teaching and now thanks to Go-Lab it is easier, and he will do it more often since it takes less time in lesson planning when using Go-Lab compared to using real labs. Additionally, he found that his students were very engaged in the learning procedure. Pygmalion hadn't used online labs before; now he is exploring them as well as the apps in the Go-Lab platform.

Introducing Go-Lab at the school level

According to all the interviewed teachers, the biggest obstacle they faced in using Go-Lab was the lack of a computer lab with a permanent setting of laptops/PCs. Teachers share classrooms in their school because of the bilingual program. A good internet connection in all the classrooms (two of their classrooms are not in the main building and many times don't have internet) is also essential but not always available. The school administration has been supportive and helped the teachers to implement Go-Lab in their teaching. They are now trying to create a classroom that will allow a broader implementation of Go-Lab in their school as well as managing the internet connection problems.

Impact on students' learning

All four teachers agreed that their students were fascinated by Go-Lab and loved working with it. It triggered their curiosity and imagination, it raised their degree of engagement and motivated them. They had fun and enjoyed themselves while learning. The teachers also enjoyed collaborating and using innovative teaching methods that motivate and engage students.

General remarks about Go-Lab

The teachers of the school believe that Go-Lab effects students, teachers and their school altogether positively. For them it is an innovative way of teaching that affects both students and teachers and the entire school can benefit from it. They wish to explore it more and receive additional training.

B) School administration / school director's perspective

(interview by the school's principal Ismail H. Aptoulah and deputy principal Vasilis Theodoridis)

Introduction to Go-Lab

Before Go-Lab Ismail and Vasilis hadn't heard about (or used) online laboratories. The main building of their school has a good internet connection. There are also two classrooms that are outside the main building that don't have wi-fi access many times. That can make the use of Go-Lab somewhat problematic. They are trying to solve this problem so their school's students can have easier access to the web and be able to engage in online educational activities.

Go-Lab impact at the school level (replace the questions with the descriptive paragraphs)

Before using Go-Lab they both weren't familiar with the concepts and the practices of IBSE and online experimentation. Marina Molla, the teacher who introduced Go-Lab to the school had been using the IBSE approach for 2 years and introduced it to the them this year with a workshop and face to face training. According to both Ismail and Vasilis, the implementation of Go-Lab in their school had a positive effect on students. They were engaged and motivated during the implementation. Following Marina, three additional teachers of their school have used it and implemented interdisciplinary ILSs. They plan to continue to use Go-Lab in the future and set up an ICT classroom in the main building in order to have a good internet connection.

General

The availability of the Go-Lab tools and ILSs in a school affects the schools' attitudes and motivation towards inquiry learning and online labs positively. Training and workshops are needed.

Canisius R.K Scholengemeenschap - Netherlands

A) The teachers' perspective

Introduction to Go-Lab

My first encounter with Go-Lab was about three or four years ago when a colleague of mine showed me his first made ILS. He showed me the possibilities of using online laboratories and I most liked the idea of using Go-Lab as a database for online laboratories. It took quite some time before I made my first own ILS and to be honest I did not make that many ILSs myself. Most of the time I just used the Labs in addition to the real classroom experiments we did during class. From the first encounter with Go-Lab until today I find it really handy to

have this website where all possible experiments are brought together in my web browsers favorites list.

As mentioned before, the first ILS I have created took some time. The main reason for that was that I first wanted to be familiar with the system and the usage of online labs in my classroom. I was not feeling comfortable yet using digital learning materials and in addition to that, I also found it quite hard and time-consuming to create nice- and good-looking ILSs.

Training / Support used / received

One of my colleagues is handy with the making of digital learning materials, and he trained me and some other colleagues a couple of times in how to use Go-Lab. This colleague came in contact with Go-Lab because he participated in a course at the University of Twente. He also participated in a summer school in Greece in 2015 in which he learned more about Go-Lab.

During these training moments we build a couple of ILSs together which we could use in a project for students called “research skills”. Because the colleague who trained us was also part of two workgroups I’m involved in, I knew more than enough about the Go-Lab project, further training was not needed. He was there to answer questions and give support when needed.

Implementation of Go-Lab in the classroom / Usefulness

Most times I use Go-Lab as a database for all the provided labs. But the past year I also started to create some simple ILSs. An example of such an ILS is one that I build around the Electricity lab. My colleagues and I have used this ILS multiple times to make students familiar with the use of electric symbols.

When I think about the amount of experiments we perform I just thought we are not performing experiments more often. But when I think about this question a little longer, I will change that to a yes, we are conducting more experiments. Most of the experiments we conduct with Go-Lab are in addition to the real classroom experiments.

In general, I think that the use of these online laboratories is not that difficult. The biggest challenge for the students is understanding all the apps and keeping an overview of what happened during the ILS. Besides these two points there is also the part off having a different learning approach that makes the use of Go-Lab/ ILSs challenging. Dutch students are mostly used to being motivated by extrinsic motivation, grades, punishment and non-grade related rewards, Go-lab is more about the intrinsic motivation and will require a different approach of them. Mostly because performing an online experiment in an ILS is about learning without getting a pass or fail.

Introducing Go-Lab at the school level

In our school the digital infrastructure is almost perfect. We have a complete WIFI-network though the entire school fast enough to let every student stream an online YouTube-video. Also the amount of available laptops is more than fine, because all students bring their own devices which need to match certain technical demands that exceed the minimum Go-Lab system requirements by far.

To make the Go-lab product to be used more frequently and by more teachers, the building tool Graasp should be more intuitive. I still find it a real struggle to create a good working ILS. Less options and a clearer ILS composer would make it a way better product.

My fellow science teachers are also enthusiastic about the use of Go-Lab, although they also find it quite hard to make an ILS.

The communication about Go-Lab went mostly by the colleague who went to the summer school and who is in regular contact with the University of Twente. And I don't think we have a school vision about the use of Go-Lab in the future.

Impact on students' learning

My students don't favor Go-Lab lessons above a normal lesson. Although they seem to like the use of online labs after real experiments. Because we work with many digital books and learning platforms, they are kind of used to digital lessons.

We see that our students are getting better in doing research. But I don't really believe that this is an outcome of the use of Go-Lab. I think this is most likely an outcome of our school's policy to spend more time and energy on learning research skills to our students.

General remarks about Go-Lab

The best experience I had with Go-lab was when I had a class that was working with energy charts. They did not understand what the difference between parallel and serial connections were. We tested it with the electric boards, but they still found it quite hard to understand. After drawing the charts on the white board, a couple of them started to understand but still not as much as I hoped for. At that moment we went for the use of an online setting and students started to experiment and after half an hour almost all students understood what the difference between both settings was.

B) School administration / school director's perspective

Introduction to Go-Lab

We heard about Go-Lab for the first time Four years ago. It was mentioned by a colleague of ours. This colleague showed it during an ICT management team meeting.

At the moment we are in the process of bringing more engaged learning methods to our school. We chose for engaged learning because our science teachers came to the conclusion that students were more motivated and gained higher scores. Besides this process we are also seeking for more formative ways of working.

We are very positive about ICT, and for the last seven years ICT is an integrated part of the curriculum and the way of working in this school. We make use of the Bring Your Own Device (BYOD) principle, students bring their own laptop and they are the ones responsible for their (state of the) device. The students are free to choose a laptop as long as this fits with the specifications that are set by the school. Parents are also free to choose a device selected by the school and acquire this device by a commercial party.

When introducing ICT in the school we started with the "4 in balans model" from Kennisnet. Which is about the conditions for optimal ICT usage. This meant that learning programs and hardware were integrated. The students and learning materials were not the biggest obstacles we needed to take, the hardest part were the teachers. We could force them to use a laptop but not to use any engaging learning materials. That last point took time. The choice we made for laptops instead of I-pads was one choice we are now really happy about.

Go-Lab impact at the school level

The school administration can support the introduction of Go-Lab by giving time for development, by encouraging teachers and by making it part of the curriculum of the school. We should worry not to make it an isolated part of what we do but an integrated part of what we do. I have no good picture of the use of Go-Lab in our lessons at this moment. We are planning on using Go-Lab more in the future but the creation of an ILS should be way easier.

General

Go-Lab gave us insights in the availability of online labs, and I think that because of that we are currently using online labs on a more regular basis. In order to introduce Go-Lab more broadly in our school Graasp should be easier to use and teachers should see the added value, for themselves as well as for students. Furthermore, training about how and why to use engaged learning could really help us.

Escola Dr. Horácio Bento Gouveia - Portugal

A) The teachers' perspective

Introduction to Go-Lab

Ana Lúcia Vasconcelos teaches Physics & Chemistry to 12-15-year-old. She heard about Go-Lab from a friend, a fellow teacher from another school in Madeira, who attended a certified teacher training course offered by NUCLIO (February 2014). That course covered, among other subjects, an introduction to Inquiry-Based Science Education and dissemination of the Go-Lab project. These two subjects, IBSE and Go-Lab, grabbed their attention so they applied and received a grant to attend a 5-day Comenius Training Event "Astronomy: Online Labs for Inquiry Minds", organized by NUCLIO and the University of Twente, (University of Twente, April 2014). This was their beginning with Go-Lab.

Training / Support used / received

Albeit finding the Go-Lab ecosystem a very interesting concept and being inclined to use it, Ana Lúcia found it hard to learn at the beginning. But she stresses that partly it was because Go-Lab was still being developed and many things weren't working properly yet, and there weren't many exemplary ILSs – a different reality from nowadays. She used the online support offered by Go-Lab and also volunteered to be a Go-Lab tester, which she says helped her to get more familiar with certain features.

After the first training in U. Twenty, April 2014, Ana Lúcia attended the Go-Lab Summer School in Greece in July 2014. She also asked NUCLIO to provide a teacher training course at her school which occurred in February 2016.

Looking back, Ana Lúcia estimates that it took her two years to become really confident working with Go-Lab, but since the Summer School she was already using ILSs in the classroom, especially the ones she produced as part of that training.

Implementation of Go-Lab in the classroom / Usefulness

Ana Lúcia uses her own ILS every 3 months – one per trimester. Two of these ILSs are used as activities in the classroom but the other one is a more extended assignment with a duration of one month and partly done as homework - the students have to submit a complete report and their grade in this ILS has a heavy weight on their final grade.

Besides using her own ILSs, as described above, Ana Lúcia also uses the on-line labs and ILSs from the Go-Lab repertory frequently, either as a demonstration in the class, or to introduce a new topic, or for students to explore at home.

Without denying the importance of working with real labs, the use of the Go-Lab ecosystem has provided more experiments in her science teaching for two reasons: first, there are topics she cannot cover experimentally at the real lab; and secondly, the time spent with a Go-Lab activity is much shorter than going to the real lab.

At her actual stage of proficiency with the ecosystem, Ana Lúcia doesn't take much time planning lessons with Go-Lab. Usually, she just refines or adapts the resources from the last time she used them and once in a while tries something new. It hasn't been always like this, but it is the reward for the time invested previously.

Introducing Go-Lab at the school level

Ana Lúcia has been at this school for more than a decade and has been involved in many successful projects. The headmaster of the school trusts her and is very supportive when there are new projects, giving her 2 hours/week for project development.

Although there hasn't been an official policy to make Go-Lab mandatory for Physics & Chemistry, it is recommended during teacher's meetings and more than half of the group is using it. It helps that Go-Lab serves the Physics & Chemistry curriculum very well. Most teachers had the training provided by NUCLIO in 2016 at this school and Ana Lúcia is always willing to help them when they need. Some colleagues go to her classes when she uses Go-Lab to be more acquainted with the implementation in the classroom. They also share their ILSs between themselves and their findings in the Go-Lab repertory.

The only technical obstacle is the internet, although it has not been a serious issue when using the computer rooms. Teachers must plan carefully to make sure there are computer rooms available when they want to use Go-Lab.

It has been difficult to spread Go-Lab to other groups, namely the Natural Sciences group, because Physics & Chemistry work separately from them and there hasn't been much interaction between the two groups. It is Ana Lúcia's opinion that, without administrative actions, such as establishing a schedule for teachers to work together in interdisciplinary projects, it will be difficult to spread Go-Lab to other groups. Fortunately, this will probably happen very soon since education, in Portugal, is at a turning point, with interdisciplinarity as one of the pillars of the education policy from the Ministry of Education.

Impact on students' learning

Go-Lab activities in the classroom or at home are generally received very enthusiastically by the students. They particularly enjoy working with some of the online labs. As already said above, students have access to more experimental classes because of the online labs and that has a significant effect in teaching Physics & Chemistry. So does the fact, says Ana Lúcia, that it is quicker for them to understand many phenomena using the online labs.

As for the ILSs per se, the first one that the students experience is the more challenging one. They offer some resistance in proposing the hypothesis, interpreting the data and making conclusions by themselves; they also need more support on how to use the apps, the tools, the labs, etc. But the ILSs that follow go smoothly and the students gain confidence in their work as well as autonomy. For each new class, Ana Lúcia demonstrates an ILS to the whole classroom some time before actually having them experience an ILS on their own.

General remarks about Go-Lab

According to Ana Lúcia, the positive impact on students' learning has been the most positive aspect of using Go-Lab in her teaching. And the most negative aspect is the initial time a teacher needs to invest to become comfortable to use Go-Lab in the classroom, and when something technical doesn't work, eg: if the internet is slow during the lesson with the ILS (fortunately, it is not very frequently); there have been labs that have stopped working.

To have Go-Lab implemented more broadly in her school, especially in other groups other than Physics & Chemistry, there has to be changes inside the school that brings together teachers from different areas – they need time to get to know better what is taught in other areas and time to plan joint activities/projects.

B) School administration / school director's perspective

Introduction to Go-Lab

Fátima Teles has been in the Executive Council of this school for 33 years and is the headmaster of the school for the last 15 years. She heard about Go-Lab for the first time from Ana Lúcia. She immediately recognized the importance of such a project and gave Ana Lúcia the support she asked for (authorization to attend the teacher trainings in Twente and the Summer School, help to organize the Go-Lab teacher training in their school). Fátima has great respect and trust in Ana Lúcia's work so it was easy to decide to allocate her time in her schedule (2hr/week) to work on the Go-Lab project.

Fátima has always been a big supporter of teachers bringing projects to her school and is proud of the diversity of projects that have been and are being conducted. There are projects involving Sciences, Environment, Journalism, Arts, European citizenship, Sports, Literature, Robotics, Responsible Citizenship, and still more areas.

The school encourages innovation and student-centered methodologies, although there is no formal school policy. It is more on an individual basis, like with Ana Lúcia, who ask for specific support. And fortunately, there are several very dynamic teachers.

The school is well equipped with computers and the internet (including Wi-Fi) when compared to other schools from the region or from the rest of the country. There are computer rooms that can be requested, computers at the library for students, and each classroom has one computer with a projector for the teacher.

In general, teachers have been able to use computer rooms when they want to implement ILSs with the students and the internet has been reasonable for the purpose.

Go-Lab impact at the school level

Introducing Go-Lab to colleagues has been done essentially by Ana Lúcia. Her enthusiasm with the project has led other teachers to also adopt the Go-Lab ecosystem. But it is still retained in the Physics & Chemistry group.

The administration cannot impose teaching with tools such as Go-Lab because education is still conservative in many ways, including the importance of exams in the final grading to enter the university. But now that the directives from the Ministry of Education are tending towards a big change in education, with student-centered learning, interdisciplinarity and flexibility in the curriculum, this should soon change. And Fátima believes that Go-Lab may be a big help to promote all these changes.

She has witnessed the enthusiasm of the students when using Go-Lab and has had very positive feedback from the teachers that use Go-Lab. She also finds it very beneficial that teachers work together because of Go-Lab.

General

The biggest challenge to have Go-Lab more broadly adopted in the school is to overcome certain teachers' resistance in trying something different from the way they have always taught. But with the expected changes coming from the Ministry of Education's policy, as mentioned above, even the most traditional teachers will have to change. And Fátima feels

that Go-Lab will be a tool that may help to go through this change. She will support all initiatives for a more broadly use of Go-Lab

Gallego Gorria Primary School – Spain

A) The teachers' perspective

Introduction to Go-Lab

On recommendation his colleague Almudena De La Peña, in 2017/2018 school year Mikel had been participated in training sessions organized by University of Deusto. Mikel suggested his colleagues Enrike and Amaia to join these sessions as well. Therefore, all of them were trained by Javier Garcia-Zubía through the workshops organized by UDEUSOT in frame of the Next-Lab project. The main objective was to learn how to co-/ create ILS using Go-Lab ecosystem labs, apps and graasp.eu authoring tool and to implement developed ILS in the classroom. The training offered five sessions of work during four months. Javier also supported them over the email and Skype communication tool. After the completing, the study teachers were able to apply it in their class (5 and 6 grades of the primary school) without any difficulty. Later Mikel and Enrike had modified by improving the content and presentation of created ILSs. In addition, Mikel duplicated and modified four ILSs created by other teachers and available at Go-Lab repository.

In 2018/2019 school year Mikel and Enrike created new ILSs and used these ones and last year built ILSs in their class instruction.

Training / Support used / received

Apart from the training abovementioned both Mikel Amezaga and Enrike Arribas had participated in Marathon Go-Lab Summer School where they took a deep and extensive knowledge about the new features of Go-Lab platform, employed different pedagogical scenarios in their existing ILSs, and obtained a hands-on activity and guide how to make a good/professional ILS.

Implementation of Go-Lab in the classroom / Usefulness

Mikel Amezaga uses ILSs as a part of curricular activities merging Science and English subjects at the same time. As an English teacher, he supports and helps a Science teacher to select and introduce science content in English for teaching in the classroom. The employment of online experiments inspire to create new knowledge in both subjects, to work on curriculum contents and, therefore, to increase the use and interest towards English. He does not use real laboratories.

Enrike Arribas uses ILS in formal education setting - Science and Nature of 6th grade of primary education. She believe that students of 4th grade can benefit from learning with Go-Lab ILS. Usually, she introduces an online experiment in a classroom in front of a usage of ILS. Students appreciate such presentation of learning materials and they like exercise with ILSs. She has not used remote or real labs, but she does not refuse them, since according her opinion she would need specific training for application these kind laboratory in elementary school curriculum.

Introducing Go-Lab at the school level

Mikel and Enrike do not have any crucial obstacles in the school. The school administration let them a freedom to use ISBE incorporated in Go-Lab ecosystem as teaching methodology.

According Mikel the main challenge is to design or to find fit to the national curricula a good ILS. In order to implement more ILS and to involve more teachers, the training lessons should be proposed. Starting from 2017/2018 they are organizing Go-Lab activity in the school, but in an adaption process is going slow. The colleagues knowing about the Go-Lab ecosystem are not in a hurry of implementation it in their classes. The reason could be in that that the school and the teachers are involved in other programs of innovation in education supported by Berritzegune. In order to succeed a Go-Lab deployment in the school, the Go-Lab initiative would/could be the part of the training program of innovation in education that is granted by Education Department of the Basque Government. The training program - the contents, levels and subjects - should be negotiated and agreed with the school administration.

Impact on students' learning

Generally, students enjoy working with Go-Lab using ILS. Although it is a challenge for them, since they have to learn in own way what the scientific method is, how to create hypothesis and to perform an experiment, they master using an attractive, active and encourage computer-based approach. In fact, new methodology with enjoying labs make them to work more motivated. Inquiry gives students opportunity to study meaningfully with own responsibility on the learning process.

General remarks about Go-Lab

In order to facilitate the communication between the Next-Lab team and the school, the introduction of the GoLab in a more general way, e.g. explaining the positive aspects to the head masters of the schools, is advised to do. Since the teachers study to work with in the Go-Lab ecosystem outside working time, it would be valuable to utilize the Wednesday – the school training session day. The Berritzegune department is the key of this action.

B) School administration / school director's perspective

Introduction to Go-Lab

Mikel Amezaga had introduced to Amaja Tejedor the Go-Lab ecosystem as an innovative approach of teaching STEM in the school. In those time scientific methods and use of digital instrument in the curricular were a weak aspects in the STEM pedagogical strategy. The school is still making great efforts in digitalizing the classrooms to developing the digital competences the teachers and the students.

In 2016/2017 school year Mikel had implemented the ILS by the first time in the Juan Ramón Jiménez. In 2017-2018 the ILSs were implemented in 4th, 5th and 6th grades of this elementary school.

For today, two main challenges are foreseen. The first one is the lack of the general strategy of the school to train the teachers; the second one is the insufficient collection of contents and labs for primary education.

Go-Lab impact at the school level

The teachers in Juan Ramón Jiménez School are motivated. The teachers' collaboration on the ILSs is crucial for them because they appreciate the use of Go-Lab ecosystem.

The administration of the school offers to these teachers technical and human support ,e.g. Amaia was involved as a personal assistant during the ILS implementation in the 4th-6th grades science and English curricula.

For the school, Go-Lab initiative has had a *positive impact* in the students' learning process since they were inspired by attractiveness of the ILSs and totally new activity in the class. Since teachers can arrange the same ILS with different levels complexity, the students with different learning styles can work with this ILS in the classroom simultaneously. This is important for the school where students are presented in large variety of socioeconomic status.

From the negative side, there are two drawbacks:

(1) before designing/creating and implementing ILS the teachers need at least basic training for beginners;
(2) in most cases, the level of the laboratories available on the golabz.eu are not adequate and suitable for primary education. As an example, Amaia created the ILS about the photosynthesis. Her students had a huge difficulty to understand the mechanism of the lab: bubbles, oxygen, etc.

In their school they will continue to use the created ILSs and Go-Lab ecosystem overall in teaching and learning process, especially when they teach science.

General

From teaching and learning point of view, the use of online labs is perfect. They oriented to scientific method and, at the same time, they are attractive for the students. She has again remarked that implementation of ILSs with the same topic and different complexity level of content is very relevant for the school with large number of students with different learning styles.

She has advised to promote the GoLab ecosystem over the Berritzegune and its consultants that work on this Innovation in Education Department.

Uppingham School – United Kingdom

A) The teachers' perspective

Introduction to Go-Lab

This teacher encountered Go-Lab in about October 2018, when he learned about it from a colleague at the University of Leicester. In his training process since then he did not use the support-pages provided, because he was trained in person by the ULEIC project partner (one intensive two-hour one-on-one workshop and several presentations and shorter sessions). The teacher has neither used Go-Lab in his teaching in a classroom yet nor created an ILS (outside of example ILSs during his training). However, he assumes that it won't be very long now until he uses Go-Lab in his teaching, he thinks in the next week or two. He imagines that he will be using Go-Lab with any given class once a fortnight, but with multiple classes, so it would be once or twice a week in total.

Training / Support used / received

This teacher has received training from the ULEIC project partner in the form of presentations, hands-on activities, and an intensive, one-off, two-hour individual workshop. Besides this training in person he also received support via email.

Implementation of Go-Lab in the classroom / Usefulness

The teacher has not yet used Go-Lab, but he imagines using it in a demo capacity, with him modelling how the students would use the software, showing the results on the board. In

addition to this in the class activities, he would use Go-Lab for the students' prep (= homework) to introduce the teaching as preparation of the class. Using labs for homework would be new, as the teachers currently use worksheets, no discovery. However, in the classroom they are doing experiments in every lesson anyway.

So far this teacher does not work with colleagues from other subject domains in an interdisciplinary way yet, as they only just started. But as a faculty they would discuss their experience with the system and how to collaborate.

Regarding the question if it takes students more or less time to learn using Go-Lab compared to using real labs the teacher thinks that there is a five minute understanding curve, what Go-Lab is. But once the students have gone through it once, they would know it. With Go-Lab the project is already set up, so it saves time on setting up and putting the equipment away. With Go-Lab students are getting a more structured lesson, with a much clearer plan as to how to reach the lessons objectives. On the other hand, teachers would probably have to spend more time, although with familiarity with the system the efficiency of using it would increase. Additionally, setting it up for one class means that it can be used for another class or a class next year as well.

Introducing Go-Lab at the school level

The three main obstacles in using Go-Lab identified by this teacher are: IT infrastructure, time and workload, and the curriculum. With the IT infrastructure teachers encounter the obstacle that it is currently changing. At the moment the school is switching from laptops provided to the students to a "bring your own device" approach. So the biggest challenge is to know how to implement it and what to do with the students that don't have laptops. Rolling Go-Lab out in the whole department faces the question "Will this cause me more work?", so the case to save time needs to be strong to convince colleagues. Regarding the curriculum, the teachers at this school would have to be confident that the platform is not changing, until it is well established it would need to be optional. To overcome the first obstacles and allow for a broader implementation of Go-Lab in the teachers' teaching and in the school in general, the school needs to come to a conclusion, if students have to own a laptop. Older students usually do, but for younger students it is unclear what to expect. To address the second obstacle, such a case could be made for Go-Lab, e.g. the plan is to set very regular homework using Go-Lab. The system could help teachers to get an overview about what students have done quickly and thus support other platforms, like SAM learning. To address the third obstacle, the existing activities/ILSs could be linked on existing exam board websites or the resources could be on the golabz.eu platform, in the same order than the exam board.

Go-Lab was initially discussed in meetings and minutes where taken during meetings. The minutes then went up to the headmaster, to whom Go-Lab was additionally mentioned in briefings. The school administration has been supportive towards implementing in the teaching. There have been no administrative issues and the technicians have also been supportive in regards to the IT requirements. Local support from colleagues has been really strong. They want to be an outwards reaching and forwards facing faculty and society and as Go-Lab feels progressive, there has been a lot of support. The adoption process will most probably be one person adapting it (the teacher interviewed), using department time to show usefulness and training time to train other members of staff, starting with the physics subject area to across science and mathematics. The key people to facilitate school implementation in general and other schools as well are people who have responsibilities, like deputy head in academics or heads of IT. Go-Lab should be pitched to those to let them filter it down into the school.

Impact on students' learning

Students generally enjoy working with Go-Lab and using ILSs. The feedback from the evaluation sessions with ILSs (which the University of Leicester organized at the school) was really clear that students found it enjoyable to use the interface. As the results of the evaluation sessions regarding student's learning are not available yet, the effect of Go-Lab on teaching and learning and the learning outcomes are not known yet. The most effective aspect of Go-Lab is that it speaks to the students' way of learning (they want to learn with devices, it is not a new language for them, they are used to computers).

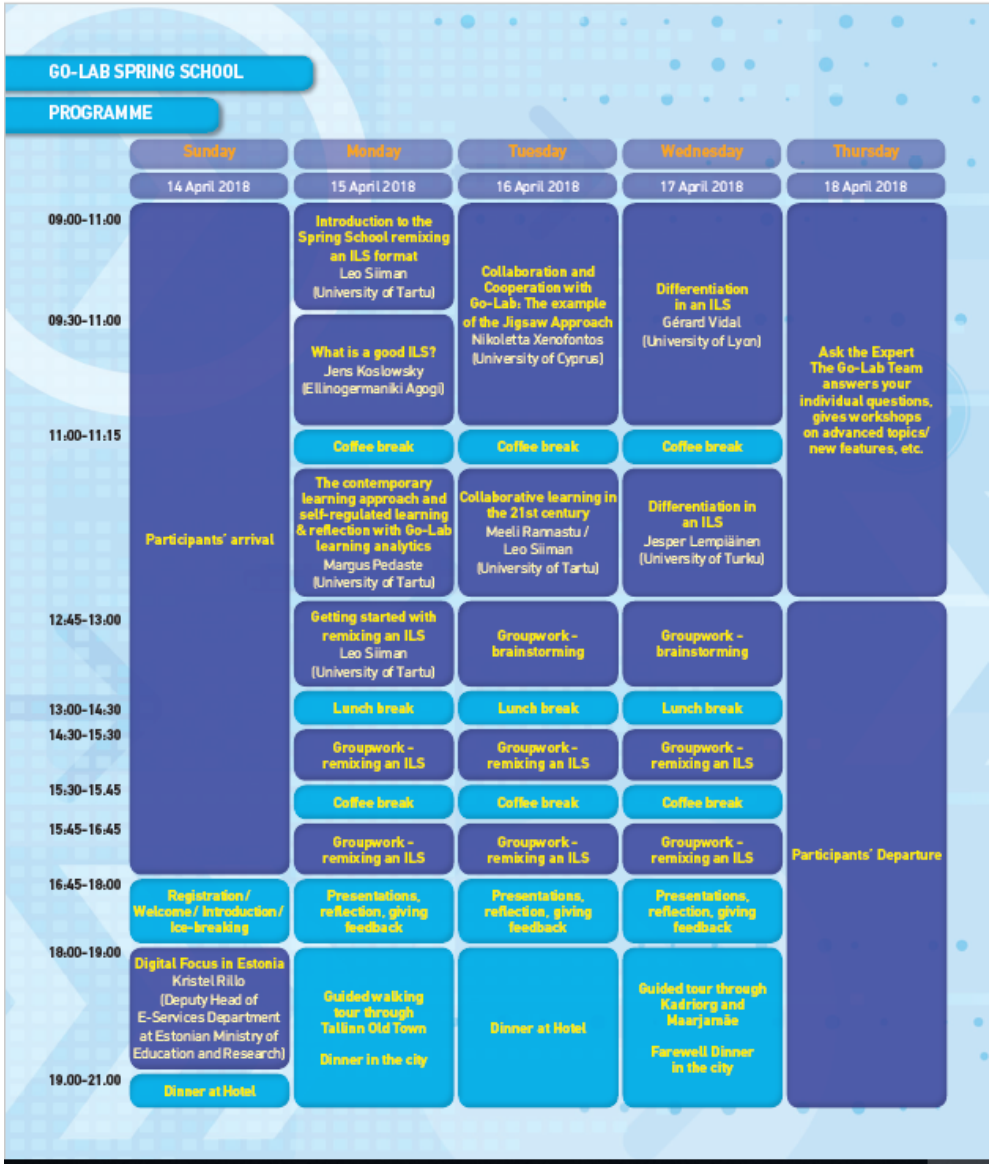
General remarks about Go-Lab

The most positive aspect that comes to mind about Go-Lab is that it is different, it is a nice looking interface, and thus the students like how it looks.

To introduce Go-Lab more broadly in the UK it could have a larger profile in the teaching body. Teacher twitter or meetings of various different groups (like the ASE conferente [NB: Go-Lab has been presented at the ASE Annual Conference 2019 in January and was promoted in several ASE mailings]).

Go-Lab Spring School 2019 – Tallinn, Estonia

Go-Lab Community Space



Go-Lab Winter School 2019 – Cascais, Portugal

[Go-Lab Community Space]

nextlab

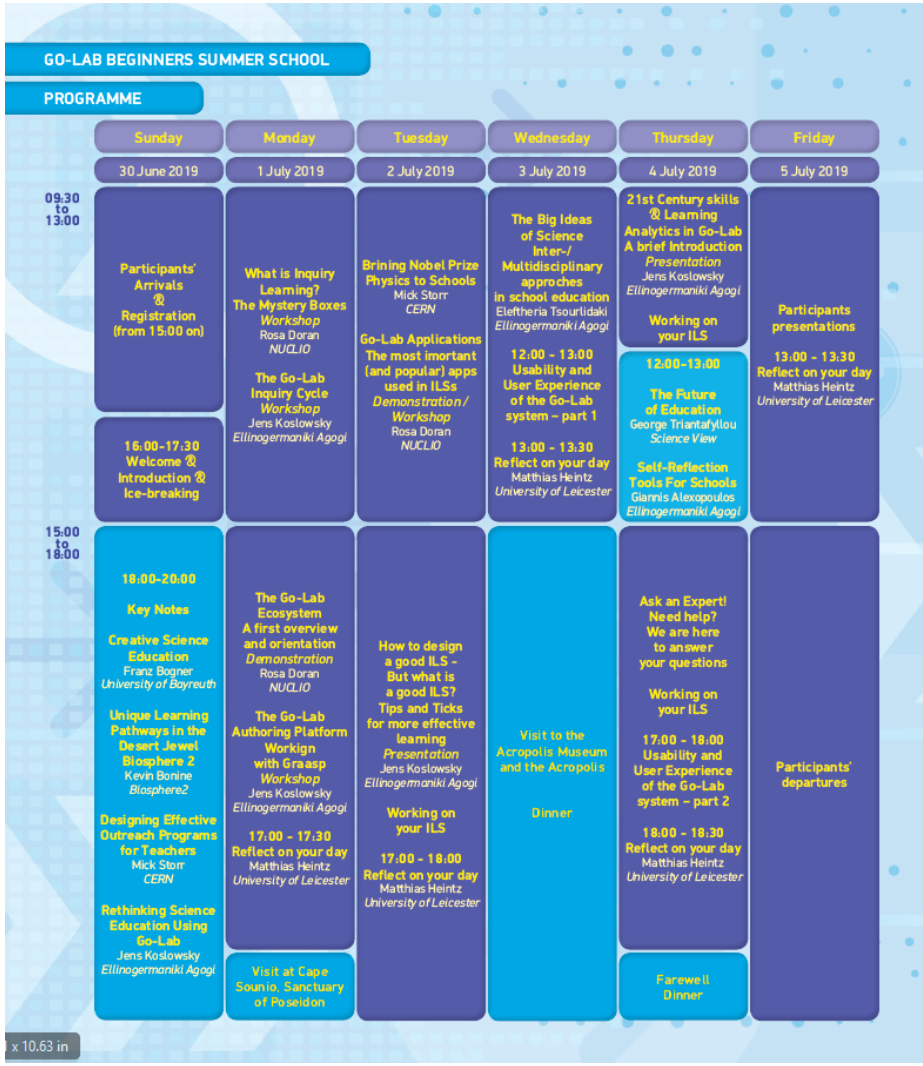
Go-Lab Winter School
Cascais, 5-9 March 2019

NUCLIO

Time	Tuesday 05-03-2019	Wednesday 06-03-2019	Thursday 07-03-2019	Friday 08-03-2019	Saturday 09-03-2019
09:30-10:00	Arrival	Warm-up Crime Scene	Warm-up Tangram	Warm-up Web of Life	Departure
10:00-10:30		Go-Lab introduction Why take Go-Lab to the university? (EUN)	Integration of Go-Lab into the university curriculum: TTIs presentations and discussion	Integration of Go-Lab into the university curriculum: TTIs presentations and discussion	
10:30-11:00					
11:15-12:00		Integration of Go-Lab into the university curriculum: TTIs presentations and discussion	Inter/Multidisciplinary approaches in school education Go-Lab as a facilitator + Hands-on workshop (NUCLIO/EA)	Differentiation in an ILS (ENS Lyon)	
12:00-12:30		Hands-on workshop: Graasp Challenge (NUCLIO)			
12:30-13:00					
13:00-14:30		Lunch	Lunch	Lunch	
14:30-15:00		Energizer: The shadow	Energizer - Mars, Moon & Earth	Energizer: Visual Thinking Strategy	
15:00-15:30		Integration of Go-Lab into the university curriculum: TTIs presentations and discussion	What makes a good ILS (U. Twente)	Group process for establishing priorities: a KJ session (NUCLIO/EUN) + Work on plans for each TTI	
15:30-16:00					
16:15-17:00		Effective examples on how to introduce inquiry to teachers + Hands-on workshop Test hypothesis/Compare conclusions (NUCLIO/EA)	Learning Analytics in Go-Lab Why, when and how to use them? (U Twente) + Hands-on workshop (U Twente)		
17:00-17:30				All TTIs presentations with discussion Evaluation of the winter school (NUCLIO/EUN)	
17:30-18:00					
18:00-20:00	18:00 - 20:00h Registration / Welcome / Introduction / Ice-breaking		Visit Belém		
20:00-22:00	Dinner	Dinner	Dinner in Lisbon	Dinner	

GO-LAB

Go-Lab Summer School 2019 – Marathon, Greece – Beginners' course



Go-Lab Summer School 2019 – Marathon, Greece – Advanced course