The Go-Lab ecosystem: A practical solution for school teachers to create, organize and share digital lessons

Leo A. Siiman, Meeli Rannastu-Avalos, Mario Mäeots, and Margus Pedaste

Abstract—The Go-Lab ecosystem is an integrated set of digital tools and services aimed at increasing the meaningful use of technology in teaching and learning. Go-Lab offers a free authoring platform to create digital lessons that has been translated into over 30 languages. It also offers a sharing platform to share content or to find ready-made digital lessons and support. This article gives an overview of the diverse possibilities afforded by Go-Lab. We show how one can get started creating and using Go-Lab digital spaces. We then give an example of a complete digital lesson that was made using the pedagogically grounded Go-Lab inquiry cycle. Finally, we show a new and innovative approach to supporting the development of students’ collaboration skills based on the use of asymmetric simulations. As the recent coronavirus outbreak has made clear, online teaching can suddenly become mandatory. Go-Lab offers school teachers a practical and useful solution for delivering online digital lessons.

Index Terms—Collaboration, Computer aided instruction, Distance learning, Educational technology, Mobile learning, STEM

I. INTRODUCTION

Imagine that you are a teacher preparing for a lesson about how the earth, sun and moon move with respect to each other in outer space. You want your students to learn how that movement relates to phenomena like the seasons of the year, phases of the moon and solar eclipses. An online search for relevant material provides you with useful pictures and an informative five-minute video. You even find a website with an animated 3D model of the earth-sun-moon system that enables students to actively explore the situation by pausing or slowing down the animation and then navigating around the 3D simulation to look at it from different viewpoints. You are now satisfied with the content you found and begin designing the lesson.

At the start of the lesson you plan to collect ideas students may already have related to this new topic. Instead of just asking a few students to volunteer ideas, you use an online survey to collect responses from everyone (via their personal smartphones or school provided tablets). Then you display the results to everyone and think aloud while organizing them in a way that ties into the new topic. You highlight important questions that remain unanswered. Next you show the introductory video, but before playing it, give the students a list of questions that will direct their attention while they watch it. After the video ends you check their understanding with an online quiz. The quiz gives students immediate feedback and explanations and you see on a digital dashboard how well the class performed overall. Finally, you begin the main activity involving the 3D simulation. You decide to have students work collaboratively in groups and develop tasks accordingly. You share cloud-based documents with groups so that they can record their observations, complete the taskwork and reflect on their experience. The lesson concludes with you discussing the work done by groups and reviewing again the new concepts and skills practiced during the lesson.

The imagined scenario above highlights that teaching in today’s digital age can easily involve organizing a number of digital tools and resources for just a single lesson. Clearly teachers can benefit from an efficient way to organize their digital lessons. The Go-Lab ecosystem arose from a European project originally aimed at promoting the widespread use of innovative digital technologies in the teaching of science and math subjects [1]. Before Go-Lab, science teachers who happened to find an interesting computer simulation would usually create and print worksheets with instructions and questions to guide learning with the simulation. Typically the lesson occurred in a computer classroom and the limited time allotted to use this room meant that the teacher would try to maximize the time students had on the computer at the expense of interacting with them in discussions. Thus, students mainly relied on the worksheets for guidance and support, with occasional individualized attention by the teacher. But in a class with a large number of students, and the not so uncommon situation of the teacher having to deal with unforeseen technical problems, receiving adequate support from the teacher was likely to be sporadic at best.

Learning science with computer simulations is particularly advantageous when an inquiry-based approach is used [2, 3]. Interactive simulations offer students control over some of the variables in a model of a physical system and make it particularly convenient to observe what happens when those variables are changed. Simulations can speed up processes that are too slow to observe on natural time scales, visualize objects that are too large or too small to observe with the naked eye, and simulations allow one to study phenomena too dangerous to handle in a school laboratory. By manipulating variables to discover cause-and-effect relationships,
students engage in an authentic scientific practice. Furthermore, simulations are often intentionally designed with visually appealing cartoonlike and game-like elements to capture the interest of young people. The PhET project repository (https://phet.colorado.edu) provides free math and science simulations and purposefully designs simulations to encourage exploration, show familiar everyday objects, and utilize visual clues to emphasize pedagogically important concepts [4]. For example, the Balancing Act simulation (https://phet.colorado.edu/en/simulation/balancing-act) allows one to place cartoonlike objects representing different masses on either side of a seesaw at varying distances away from the pivot points. A simple press of a button removes a virtual support underneath the seesaw and reveals whether the seesaw will tilt or balance. A gaming mode option for this simulation offers students the opportunity to test whether they can successfully balance various configurations of a seesaw given only one attempt. The game keeps tracks of successful attempts with a score and progressively increases in difficulty.

Although advantageous in many ways, one challenge with inquiry learning is that students often struggle with certain tasks during an investigation. Woolley et al. [5] describe several common mistakes students can make during scientific reasoning tasks. For example, when designing an experiment, students may confuse independent and dependent variables or fail to control all variables. When predicting results, students may simply rely on prior knowledge rather than drawing conclusions strictly from the data they collected. That is, students often persist in holding pre-existing ideas or beliefs even when confronted with evidence to the contrary. The authors de Jong and van Joolingen [6] classified problems learners encounter during inquiry learning according to the main cognitive and metacognitive processes usually occurring during an inquiry activity: hypothesis generation, design of experiments, interpretation of data, and regulation of learning. The authors emphasized that for learning to be effective these problems must be alleviated. Support, guidance, or scaffolding are the general terms used in education research to describe assistance given to learners that simplifies or prescribes the processes required for learning to be successful. A meta-analysis on the effects of guidance in inquiry-based learning concluded that adequate guidance should always be given to assist learners in accomplishing tasks [7]. When adequate guidance is provided, research has consistently shown that inquiry learning is more effective than teaching methods based on more expository forms of instruction [8, 9].

The Go-Lab (Global Online Science Labs for Inquiry Learning at School) learning environment was developed as a free online educational resource to provide teachers with not only a platform to create digital lessons, but also provide pedagogically designed support tools to assist students in the learning process. Support tools in Go-Lab are called apps. The Hypothesis Scratchpad app (https://www.golabz.eu/app/hypothesis-scratchpad) is an example of a Go-Lab app designed to assist students in formulating a hypothesis during an inquiry investigation. Figure 1 shows an example Hypothesis Scratchpad app configured to assist students in forming a hypothesis related to studying the time it takes for sugar to dissolve in water. The app displays a set of words or phrases that the student can drag-and-drop into place to form a complete hypothesis. Although not directly prescribing a hypothesis, the app constrains the selection of terms and suggests possible relationships that one should consider. For a novice learner, the support provided by this app can significantly help to overcome difficulties in generating a useful hypothesis that can be tested later empirically.

More generally, we note that an app which allows a teacher to create a set of words or phrases and have students arrange them into a meaningful order has potential beyond just supporting scientific inquiry learning. The Hypothesis Scratchpad app, if applied appropriately, has potential as a support tool for language teachers.

The aim of the present article is to broadly consider the usefulness of Go-Lab as an all-purpose digital teaching and learning resource. Educators in many nations are increasingly expected to exhibit digital competence [10]. The sudden and abrupt move to a temporary period of online teaching due to the coronavirus outbreak highlights the need for educators to be prepared to delivery digital lessons. The Go-Lab ecosystem offers a practical solution to meet these expectations. Figure 2 shows a screenshot of the main webpage from which a beginner can find information about getting started using Go-Lab.

Although the original motivation for developing Go-Lab was for online STEM (science, technology, engineering, and mathematics) teaching, we will see that Go-Lab actually offers teachers of any subject a practical way to create, organize and share digital lessons. This article is organized as follows. In Section II we describe the basic technical aspects of the Go-Lab learning environment and show how one can quickly get started using it. An important distinction is made between the authoring platform where a teacher puts together different components of a digital lesson and the standalone or student view where a user interacts with the lesson. Section III introduces the Go-Lab inquiry cycle as a pedagogically grounded approach to structuring a complete digital lesson. An example related to the biology topic of natural and sexual selection is used to illustrate this inquiry cycle. Section IV discusses the potential of Go-Lab to support...
the important 21st century skill of collaboration. We present a new type of interactive simulation for developing students’ collaboration skills. Finally, we conclude the article with some thoughts on where Go-Lab may be headed in the future.

II. A Basic Go-Lab Digital Space

A. The Student and Teacher Views

It is instructive to look at a simplified example of a Go-Lab digital space before considering an example of a complete Go-Lab digital lesson. A Go-Lab digital space behaves like an interactive webpage when accessed by students. It is formally called an ILS. The acronym ILS stands for Inquiry Learning Space, but for our purposes it is better to think of it as an online digital space, since from our general considerations an ILS need not be directly related to inquiry learning.

Figure 3 shows the student view of an ILS with four phases labeled ‘Introduction’, ‘Guppy Simulation’, ‘Seesaw version A’ and ‘Seesaw version B’. Here the term ‘phase’ refers to the links appearing in the left-hand navigation bar. Clicking on different phases causes the content in the main area of the student view to change. In Fig. 3 the ‘Introduction’ phase is currently active and displays two elements: (i) a text document that begins with the words ‘Hello world!’ and (ii) an embedded video from the online video-sharing platform YouTube. A student or online user can access this ILS by opening the web address https://graasp.eu/s/kehtdb on any internet-enabled device. When the ILS first opens, there is a prompt to enter a login name. Afterwards the login name appears in the upper right-hand corner of the student view. Identification via login names is how the author of an ILS can monitor the activities or progress of users who access their digital space. The view presented in Fig. 3 is called the student or standalone view because it represents what a user sees when they open the ILS. This view is different from what the author sees in the Go-Lab authoring platform.

Figure 4 shows the teacher view for the aforementioned ILS. It displays what an ILS author or coauthors see in the Go-Lab authoring platform, which is called Graasp. We will shortly introduce the Graasp platform in more detail, but for now we just want to highlight how the various elements we previously saw in the student view appear in the teacher view. In the teacher view the four phases are represented as purple colored folders. The title of the ILS is ‘My first ILS’ and is prominently displayed at the top. A green button labeled ‘Show standalone view’ is displayed at the bottom in a panel called ‘Sharing’. Clicking this button opens the student view shown previously in Fig. 3.

So just to repeat, a Go-Lab digital space (or more formally ILS) is created by a teacher or author using the Graasp platform. In this platform a teacher creates and arranges various components together. For example, a science teacher might begin by adding a simulation. Then he or she creates a text document to write instructions explaining how to use the simulation. The teacher also might also want to include questions that can be interactively answered in the ILS. This can be done using the Input Box app. We will soon see an example describing how to use the Input Box app.

After a Go-Lab digital space has been prepared in the authoring platform and is ready for use by students, a link to the student view must be retrieved. This can be done by clicking on the ‘Show standalone view’ button at the bottom of Fig. 4 and copying the url of the web page that is opened. A short link can be obtained using the ‘Get short link’ option underneath the button. Alternatively, to the right of the show standalone view button is an icon that generates a QR code. When students are using smart devices, then distributing links as visual barcodes avoids students having to type in long links and allows them to quickly open a Go-Lab digital space by simply scanning a QR code.

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Fig. 3. A screenshot of the student or standalone view of a Go-Lab ILS with four phases labeled ‘Introduction’, ‘Guppy Simulation’, ‘Seesaw version A’, and ‘Seesaw version B’. Links to these phases are displayed in the left-hand navigation bar. The first phase is currently active and displays text followed by an embedded YouTube video. See https://graasp.eu/s/kehtdb.

Fig. 4. A screenshot of the teacher view for the example ILS presented above in student view. The four phases appear here as purple colored folders. Not shown are two components inside the ‘Introduction’ phase: a text document starting with ‘Hello world!’ and a YouTube video element.
B. The Input Box App for Collecting Student-Generated Data

One of the most useful Go-Lab apps is the Input Box app (https://www.golabz.eu/app/input-box). It enables a teacher to collect text-based data from students. Let us see how this is done.

Figure 5 shows, in student view, the second phase of the example ILS we have been looking at. In this phase the Input Box app has been used to prompt a user for information. The app appears as a rectangular area with the text ‘Type here’ inside it. The app automatically saves the text typed inside it and associates this data with a user’s login name. A teacher retrieves this data in the teacher view of the Input Box app. Figure 6 shows the teacher view after the Input Box app has been opened in Graasp. We see the login names of students, their input data, and a date/timestamp displayed in a table. The Input Box app is a particularly convenient way to collect text-based data from students in Go-Lab.

C. Basic Components in the Go-Lab Authoring Platform

The Go-Lab authoring platform Graasp (https://graasp.eu) resembles a typical graphical user interface in which folders can be hierarchically organized. What one usually considers to be a folder is called a ‘space’ in Graasp. At its most basic level Graasp is simply an online web service in which one can store digital data in the cloud. But Graasp is also a powerful tool to create digital lessons for students, and this is its unique and defining feature. We previously mentioned that an ILS is a particular kind of space in Graasp that is viewable to students as an interactive website. An ILS is distinguished from a regular space by an icon that looks like an ancient Greek temple (see Table 1).

It is important to be aware that only an ILS can be viewed in student view. Within an ILS are usually a number of phases. Phases look like spaces in Graasp but are referred to differently because they function in the student view as navigation bar links. Within phases are the core components of a Go-Lab digital lesson (i.e., text, images, files, apps, embedded web content, simulations, etc.).

A teacher has the ability to ‘hide’ phases in Graasp using a menu option (see ‘Menu for a space or ILS’ in Table 1). This is a convenient feature when a teacher does not want to display to students all of the content at once. The lesson can then be paced according to a tempo set by the teacher. When the teacher is ready to reveal a phase, he or she unhides it and tells students to refresh their web browsers, thereby revealing it in student view.

More information and even video tutorials for getting started in the Go-Lab authoring platform are available online, and we next discuss how one can access such support material.

D. The Go-Lab Sharing Platform

The Go-Lab sharing platform (https://www.golabz.eu) is a website where one can find resources and support related to creating and using Go-Lab digital spaces. It was originally aimed at helping science teachers find online labs and inquiry learning applications appropriate for their class. Golabz currently lists more than 600 online labs and 45 inquiry apps. In addition, there are more than 1200 digital lessons (i.e., ILSs) listed on Golabz. A teacher can search through and read descriptions of the labs, apps or spaces to see if they can be useful in creating their own digital lesson.

Golabz also offers a support page (https://support.golabz.eu) for beginners to learn how to get started with Go-Lab. There is a glossary explaining the terms and definitions used in Go-Lab, a step-by-step guide, online training modules, and video tutorials. The videos include a detailed look at how to create an ILS and the specific actions one must make in Graasp to add multimedia elements. There is also information on Golabz about ‘Developing an Inquiry Lab digital lesson (i.e., ILS) and the Premium Membership. This is one possibility for schools to have their teachers receive training with the Go-Lab ecosystem and learn best practices for using it.
III. THE GO-LAB INQUIRY CYCLE

Inquiry learning is often discussed in terms of a cycle. Learners start with question, seek and find an answer, and at the end of this process generate a new question which restarts the cycle. The Go-Lab inquiry cycle was developed from a systematic literature review of inquiry processes described in psychology and education research [11]. It consists of five general phases labeled as Orientation, Conceptualization Investigation, Conclusion, and Discussion. In addition, there are various subphases in some general phases and it is possible to move between phases in different ways.

<table>
<thead>
<tr>
<th>Graphic</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Home" /></td>
<td>Home tab</td>
<td>The “root” or top-most container for viewing all of your Go-Lab spaces.</td>
</tr>
<tr>
<td><img src="image" alt="Joined spaces" /></td>
<td>Used for viewing the content in your Home directory or within a particular Go-Lab space.</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Settings icon" /></td>
<td>Used to change settings in the platform such as your login password or email.</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Members icon" /></td>
<td>Used to view the users who have logged in to your space and retrieve their data.</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Sharing icon" /></td>
<td>Used to retrieve the student or standalone view link of an ILS.</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Grid view" /></td>
<td>Visually organizes content into a grid view so that components can be ordered by dragging-and-dropping.</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Create item" /></td>
<td>Enables the creation of new spaces and ILSs. Also enables you to add text, images, links or other multimedia components to an ILS.</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Example space" /></td>
<td>Space</td>
<td>A space is like a folder. It enables you to organize your content hierarchically.</td>
</tr>
<tr>
<td><img src="image" alt="Example ILS" /></td>
<td>ILS</td>
<td>An ILS is a space that can be viewed in the student or standalone view as an interactive website.</td>
</tr>
<tr>
<td><img src="image" alt="Orientation" /></td>
<td>Phase</td>
<td>A phase corresponds to a separate webpage in the student view.</td>
</tr>
<tr>
<td><img src="image" alt="Hidden phase" /></td>
<td>A phase can be hidden or unhidden. In the student view a hidden phase does not appear in the navigation bar and therefore is not accessible by a student.</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Content name" /></td>
<td>The name of a space or phase can be changed by directly clicking on it.</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Menu for a space or ILS" /></td>
<td>Spaces have a menu of options (e.g., hide, delete) that are accessible by clicking in the upper right-hand corner.</td>
<td></td>
</tr>
<tr>
<td><img src="image" alt="Standalone view button" /></td>
<td>An ILS (i.e., a Go-Lab digital space) can be accessed in student view by clicking on this button.</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7 illustrates the Go-Lab inquiry cycle and its various pathways. The Orientation phase is described as a stage for stimulating curiosity about a topic and leads to a problem statement. Conceptualization involves understanding the concepts belonging to a stated problem and also generating scientific questions and/or hypotheses. The Investigation phase is where students perform a study in a systematic way and gather evidence for testing their hypothesis or answering their question. The Conclusion phase is where learners address their initial questions and/or hypotheses based on their interpretation of the evidence. The Discussion phase involves communicating to others about one’s inquiry process or its outcomes, as well as reflecting on one’s learning processes. The Discussion phase elicits both transformative and regulative learning processes.

Figure 8 gives an example of a complete self-contained Go-Lab digital lesson that follows the five-phase inquiry cycle structure. This example is based around the simulation Sexual Selection in Guppies (https://www.golabz.eu/lab/sexual-selection-in-guppies-html5), which is an online interactive simulation that allows users to recreate the classic experiments performed by the biologist John Endler when he first investigated the balance of natural and sexual selection in guppy fish in the 1970s. Traits which increase an animal’s success in obtaining mates can sometimes decrease their chances at survival. The simulation deals with this evolutionary trade-off. In guppy fish, females prefer to mate with males that have lots of colorful spots. But those males are more easily noticed by predators.
Fig. 8. Layout and screenshots of the Go-Lab digital lesson ‘Is it good to be beautiful?’ ([https://www.golabz.eu/ils/is-it-good-to-be-beautiful](https://www.golabz.eu/ils/is-it-good-to-be-beautiful)) designed according to the five phases of the Go-Lab inquiry cycle. Notable design components in this lesson include: 1 – Text document, 2 – Padlet wall, 3 – YouTube video, 4 – Concept Mapper app, 5 – Image file, 6 – Table, 7 – Question Scratchpad app, 8 – Hypothesis Scratchpad app, 9 – Virtual laboratory Sexual Selection in Guppies ([https://www.golabz.eu/lab/sexual-selection-in-guppies-html5](https://www.golabz.eu/lab/sexual-selection-in-guppies-html5)), 10 – Observation Tool app, 11 – Conclusion Tool app, 12 – Input Box app, and 13 – Input Box app. Four important design components used in this digital lesson have been magnified. Adapted from Fig. 2 of Ref. [12].

The guppy fish simulation allows students to manipulate the strength of female preference for spotted male guppies and the number of predators in the environment to observe what happens to the average number of spots per male guppy over time. We do not have space in this article to go through all of the details of this example Go-Lab digital lesson. It can be previewed at [https://www.golabz.eu/ils/is-it-good-to-be-beautiful](https://www.golabz.eu/ils/is-it-good-to-be-beautiful). We refer to Ref. [12] for additional information. But we would like to point out a few
notable design components used in this ILS. The Concept Mapper app (component 4 in Fig. 8) is a Go-Lab app that enables a student to graphically create concepts and connect them relationally. In this ILS the app was preconfigured with some concepts and relations. The purpose of the concept map activity was to help make the learning topic personally relevant to students. A number of other Go-Lab apps were also used in this ILS (components 2, 7, 8, 10, 11, 12). Detailed information about these apps can be obtained at https://www.golabz.eu/apps.

Overall, the five-phase inquiry cycle is one way to structure the learning experience in Go-Lab. Based on this inquiry cycle, certain phases may benefit from different types of guidance [13]. Such considerations are useful in ensuring students receive adequate guidance during an inquiry lesson.

IV. SUPPORTING COLLABORATION SKILLS WITH ASYMMETRIC SIMULATIONS IN GO-LAB

Collaboration is an important characteristic in today’s workplace as well as in knowledge production. Wuchty, Jones, and Uzzi [14] found that in the past half-century there has been a dramatic increase of publications by teams of two or more authors across all academic fields. The ability to successfully collaborate is regarded as essential in solving the increasingly complex problems society faces.

In order to prepare young people with useful collaboration skills, it is necessary to understand how such skills can be taught and assessed. The assessment of collaborative problem-solving skills was studied by the ACT21S project [15] as well as part of the PISA 2015 study [16]. Both assessments identified that collaborative problem solving involves an interaction between a cognitive dimension (problem-solving) and a social dimension (collaboration). The challenge for the developers of these assessments was to create tasks that reliably and accurately measure these dimensions. Both ACT21S and PISA 2015 arrived at the conclusion that collaborative problem solving involves a condition where a person relies on and learns from another person or persons during the course of solving a problem. The ATC21S project developed what are called asymmetric tasks. These tasks involved computer simulations and are based on the presumption that getting students to collaborate requires that they initially have different information. Researchers studying preliminary ATC21S tasks had observed that “Our students tended not to collaborate on tasks where they and their partners were presented with the same information” [17]. Solving an asymmetric task requires students to collaboratively pool together different information. The term asymmetric derives from the asymmetric distribution of information among collaborators.

Tasks involving asymmetric collaborative simulations are similar to the hidden profile task [18]. The hidden profile task describes a situation in which a decision-making group has been provided with two types of information: shared information that is common to all members of the group and unique information that is initially only available to particular individuals. When the group gets together to begin discussing what decision to make, then if they rely mainly on shared information, a less than optimal decision will be made. In contrast, if the group considers all of the information equally, that is, unique information is shared by individuals to the rest of the group and it is duly considered, then an optimal decision can be reached. Research on the hidden profile task finds that groups rarely choose the optimal decision because they tend to concentrate on mostly shared information at the expense of considering unique information [18-20]. Research also shows that performance on the hidden profile task improves when people are encouraged to communicate any relevant information they have, even if it contradicts the consensus view.

An example task developed by the ATC21S project to assess collaborative problem solving involved two students working remotely on computers. They could communicate using a text messaging application and they shared a virtual beam balance. However, each student could see and place masses on only one side of the balance. The other side was hidden from view and under the control of the other person. Thus, this task established a condition of interdependence, meaning that the only way the students could balance the beam was by sharing information and coordinating their actions. Johnson and Johnson [21] introduced the term ‘positive interdependence’ to describe a condition where people rely on one another for success. They defined positive interdependence as “the perception that we are linked with others in a way so that we cannot succeed unless they do.”

Similar to the simulations used in tasks developed by the ATC21S project, Go-Lab offers asymmetric collaborative simulations [22]. This type of simulation comes in two variations so that different functionalities are offered to students working in the different variants. Figure 9 shows an example of an asymmetric collaborative simulation called the ‘Collaborative Seesaw Lab’ (https://www.golabz.eu/lab/seesaw-lab). A student in one variation (version) of this simulation is able to place masses on only the left side of the seesaw. But this student cannot balance the seesaw by him- or herself because he or she lacks the functionality to place masses on the right side of the seesaw. A second student working with the second version of the simulation place masses on the right side, but not on the left side. In this way the two students are dependent upon one another to solve the task of balancing the seesaw. Students can exchange masses using a “sharing” box located in the lower right-hand corner of the simulation.

When a Go-Lab asymmetric simulation first opens a student sees an input field labeled “Enter a chat room number” and a “Join”
button. A pair of students who enter the same number in their respective versions of the lab are then able to control variables and see the effects in the same simulation. Assigning different chat room numbers to pairs of students is done by the teacher.

A study by Rannastu et al. [23] revealed that students’ collaboration skills for successfully completing tasks with a Go-Lab asymmetric simulation are weak and require further support and development. Moreover, the sudden move to online teaching due to the coronavirus outbreak revealed that supporting collaboration online is particularly difficult for teachers [24]. New and innovative approaches to digital collaboration may be one way to foster the development of students’ collaboration skills.

V. CONCLUSION

Go-Lab is a powerful online platform for teachers to create, organize and share digital lessons. Teaching in today’s digital age requires a well-designed organization of digital content and Go-Lab is ideally suited for this task. Although originally aimed at science teachers, Go-Lab enables teachers of all subjects to enhance their teaching with digital content, tools and learning support applications. For this article, the constraints of space limited us to describing the essentials of creating and using digital spaces in Go-Lab, as well as one innovative application for supporting students’ collaboration skills. More advanced uses of Go-Lab, such as teacher co-creation of digital spaces, were not discussed. In a time when online teaching may suddenly become mandatory, it is important that school teachers are able to find a pedagogically grounded digital environment. Go-Lab was developed as part of a European funded education research project and its unique affordances for educators are based on a clear and comprehensive understanding of pedagogy. As more and more teachers begin to realize the benefits of using Go-Lab, we hope that a community of collaboration will develop. As an open educational resource, Go-Lab encourages the sharing of digital resources. The Go-Lab sharing platform (https://www.golabz.eu) currently offers over a 1000 contributor-made digital lessons in a range of different languages for free use by anyone. This growing source of open digital lessons is a valuable place where educators can easily find inspiration and ideas, freely remix or adapt digital lessons as they please, and use them to enhance their own teaching.

REFERENCES

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