EFFECTIVE CREATION AND USAGE OF SIMPLIFIED VIRTUAL CURATION LAB USING GOOGLE SITES: IMPLEMENTATION FOR PRINCIPLES OF BIOCHEMISTRY LABORATORY COURSE

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ABSTRACT

The COVID-19 pandemic crisis has modified teaching and learning throughout the world. The developments in Information Communication Technology tools have played a critical role in the education community. During the pandemic, the organization and conduction of theory classes in Universities across India were managed reasonably on one side, but the problem existed in laboratory courses. A single-point portal is needed to organize and conduct a laboratory course in a virtual mode. While creating a virtual lab (based on the syllabus) would solve the need, creating such would be a tedious task for the teachers, requiring special skills and resources. Google Sites is a free website application tool that allows users to create and edit files online while collaborating with others in real-time. The application includes other Google applications such as Google Docs, Google Spreadsheets, Google Slides, Google Forms, Google Drawings, and Google Keep. Google Sites also accepts any online links or files, which is handy for creating a simplified virtual curation lab for free using common online resources.

Keywords: *Virtual lab, Principles of Biochemistry, Virtual simulation, Online class.*

INTRODUCTION

The COVID-19 crisis shocked the world, changing lifestyles and work cultures. The impact also affected the education industry, which witnessed a massive changeover in its system. Most educational institutions worldwide shifted to an online mode of the teaching-learning process to keep ongoing academic activities (Rapanta, 2020). Teachers and learners had to adapt to the change. The online modality presented significant challenges, such as the design and effectiveness of the teaching-learning process (Muthuprasad, 2021). These attributes were achieved to a certain extent in higher education theory courses, but the issue is still ongoing for laboratory courses. Many teachers still struggle to organize and design an online laboratory course (Gamage et al., 2020).

The biotechnology discipline with courses such as biochemistry, microbiology, cell biology, genetics, immunology, bioinformatics, bioprocess technology, etc., requires students to attend numerous labs and participate in hands-on sessions to gain skills. However, during the COVID-19 crisis, switching to an online teaching mode for laboratory courses became challenging.

India's government-based Virtual Laboratory project provides web-based digital learning with individualized learning and a higher degree of flexibility, providing practical science skills for analyzing scientific data (Nedungadi et al., 2011).

Information Communication Technology enabled virtual laboratory platforms offer animated experimental protocols, simulated replicas of real-life experimentations, and remote-controlled laboratory simulations to easily execute experimental practice at home (Radhamani et al., 2014).

NEED FOR VIRTUAL CURATION LAB

Various virtual labs and simulations were available online even before the COVID-19 pandemic, but the knowledge of the existing tools was limited among teachers and learners (Diwakar et al., 2019). The collection of links and other resources specific to a laboratory course is essential before the start of the class (MacBride & Lynn Luehmann, 2008). The syllabus is likely to vary from one institution to another, requiring every institution to have its own virtual curation lab portals to continue the education online.

Sharing the laboratory manual and simulation links, animation videos, assignments, and quizzes related to each experiment corresponding to the syllabus poses a challenge for tutors handling a laboratory course (Petkova, 2021). Thus, a virtual curation laboratory with all the necessary content in a single portal makes it more feasible for the tutor and learner in a laboratory course.

VIRTUAL CURATION LAB DESIGN AND DEVELOPMENT

The Indian university's Principles of Biochemistry laboratory course was offered to second-year B. Tech., Biotechnology students. Thirty-five students undertook the course, which was offered in an online modality by the author in the academic year 2020-2021. The course consisted of 14 experiment modules with a total of 45 hours for teaching all experiment modules. (The 14 experiments for this laboratory course are listed in Table 1). The learning objectives for this course are described below:

1. Students understand the operating guidelines for a biochemistry lab and [be] able to operate all required instruments and handling glassware with caution.
2. Students will be able to perform laboratory calculations and prepare various solutions.
3. Students will be able to perform qualitative analysis of biomolecules (carbohydrates, amino acids, and lipids).
4. Students will be able to perform quantitative estimation of biomolecules (carbohydrates, amino acids, and lipids) using various methods.
5. Students will be able to determine the saponification value of oils.

Table 1. List of experiments

Experiment No.	Experiment topic
1	General guidelines for working in Biochemistry lab
2	Laboratory Calculations and Solution Preparation
3	pH probe calibration
4	Preparation of buffers at desired pH using Hendersen – Hasselbalch equation
5	Qualitative analysis of Carbohydrates
6	Qualitative analysis of Amino acids
7	Qualitative analysis of Lipids
8	Quantitative Estimation of Glucose by Anthrone method
9	Quantitative Estimation of Glucose by DNS method
10	Quantitative Estimation of Amino Acids by Ninhydrin
11	Quantitative Estimation of Protein by Biuret Method
12	Quantitative Estimation of Protein by Lowry's Method
13	Determination of Saponification value of oils
14	Estimation of cholesterol by ZAK's method

A. Virtual simulation links

The virtual activities/simulation links with their corresponding experiment are provided in Table 2.

B. Google site – Creating the environment

Google Sites provides a platform to easily create a blog or website (Lemley & Martin, 2015). Google Sites also offers cloud-based facilities where users can embed media from other Google services, including Forms, YouTube videos, Docs, YouTube, and Slides (Lai & Jen, 2015). In the education field, Google Sites can be used for various purposes, such as creating virtual classrooms, assignments, collaborations of projects, course contents, etc.

These researchers used Google Sites to create and implement a virtual curation lab for a Principles of Biochemistry course. Google Sites has default

Table 2 Virtual Activities and simulations

Experiment No.	Title of Activity / simulation from the Module	Online link used for Activity/Simulation
1	Beer Lambert's Law	https://phet.colorado.edu/sims/html/beers-law-lab/latest/beers-law-lab_en.html
1	Spectrophotometer simulation	http://biomodel.uah.es/en/lab/abs/espectro.htm http://mas-iiith.vlabs.ac.in/exp1/expt1/mas_expt1.html
2	Making stock solutions from solid	http://chemcollective.org/activities/vlab/67
2	Solution stochiometry	http://chemcollective.org/activities/tutorials/stoich/solution_stoi
3	Creating a buffer solution	http://chemcollective.org/vlab/104
3	Determining pH of a buffer solution	http://chemcollective.org/activities/tutorials/buffers/buffers4act1
3	pH Buffer simulation	https://pages.uoregon.edu/tgreenbo/pHbuffer20.html
4	Titration curve of amino acids	https://vlab.amrita.edu/?sub=3&brch=63&sim=1336&cnt=2841
5	Qualitative analysis of Carbohydrates	https://vlab.amrita.edu/?sub=3&brch=63&sim=631&cnt=1411 http://amrita.olabs.edu.in/?sub=73&brch=8&sim=209&cnt=4
6	Qualitative analysis of Amino acids	https://vlab.amrita.edu/?sub=3&brch=63&sim=1094&cnt=4v
7	Qualitative analysis of Lipids	http://amrita.olabs.edu.in/?sub=73&brch=8&sim=210&cnt=4
8	Quantitative Estimation of Glucose by Anthrone method	https://vlab.amrita.edu/?sub=2&brch=191&sim=692&cnt=4
9	Quantitative Estimation of Glucose by DNS method	https://vlab.amrita.edu/?sub=3&brch=64&sim=163&cnt=2110
10	Quantitative Estimation of Amino Acids by Ninhydrin	https://vlab.amrita.edu/?sub=3&brch=63&sim=156&cnt=2113
12	Quantitative Estimation of Protein by Lowry's Method	https://vlab.amrita.edu/?sub=3&brch=64&sim=1087&cnt=2112
13	Determination of Saponification value of oils	https://vlab.amrita.edu/?sub=3&brch=63&sim=688&cnt=4

templates available, which can be used to create a customized form of webpages (Parmar et al., 2020). Users can also customize the backgrounds, themes, fonts, etc., based on individual requirements. Some sample images from Google Sites developed for this specific course are given in Figures 1–2.

CURATION OF DIGITAL RESOURCES

Digital curation is the process of using various digital tools to select, preserve, collect, sort, categorize, and share digital resources. Today, the use of digital curation is increasing in the field of education (Tsybulsky, 2020). Educators use this process to curate content of online resources for educational purposes, such as teaching, learning, and developing the learner's environment (da Rocha and Gouveia, 2020).

Digital curation is not just the collection and storage of knowledge but also the selection and shifting of the resource for a specific purpose toward a target audience (Ungerer, 2016). This gives the existing digital content a new significance through a new platform. Personalization of the information in a unique way is what distinguishes digital curation (Deschaine & Sharma, 2015).

Figure 1 Sample Image of Home Page With The Navigation for each Experiment Present on the Left

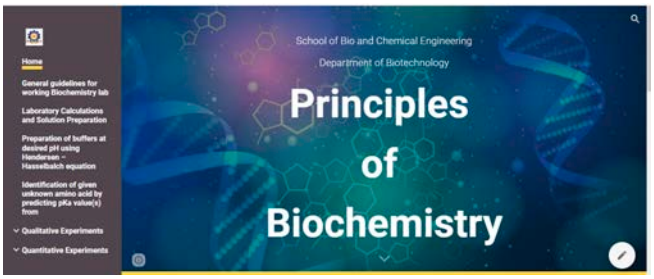
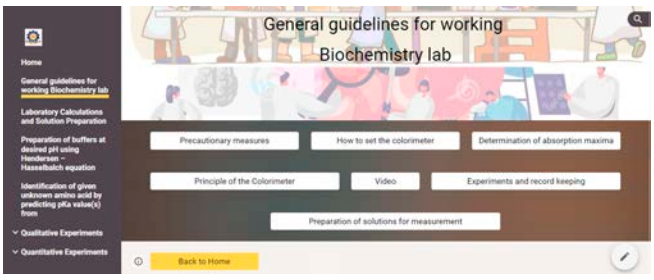


Figure 2 Sample Image of an Experiment From This Course With Buttons Leading to Various Sections



For the Principles of Biochemistry course, the curation process started with the identification of YouTube videos, virtual labs, virtual simulations, virtual games, and virtual activities matching the course topics. Then, the identified digital resources were validated for their relevance with the course topics and their usability. Finally, the resources were sorted and categorized to include in the curation lab. Some sample images of the curated digital resources used for this course are given in Figures 3–6.

IMPLEMENTATION OF VIRTUAL CURATION LAB

The development of the virtual curation lab is to be done well before the course starts. The teacher(s) handling the course should first become comfortable with all the curated digital resources by performing all the simulations and virtual labs without students. Teachers should ensure the feasibility and ease of use of the resources available. Once the course starts, the teachers can share the link of the published Google Site with the students either directly or via an LMS portal.

Teachers should check the availability and usability of the virtual curated resources as some may get modified or removed in time. The teachers can give a walkthrough of the virtual curation lab to the student participants, which will help the students understand the site and later practice with it.

Figure 3 Sample Virtual Resource Curated for This Course—Virtual UV—VIS Spectrophotometer (http://biomodel.uah.es/en/lab/abs/espectro.htm)

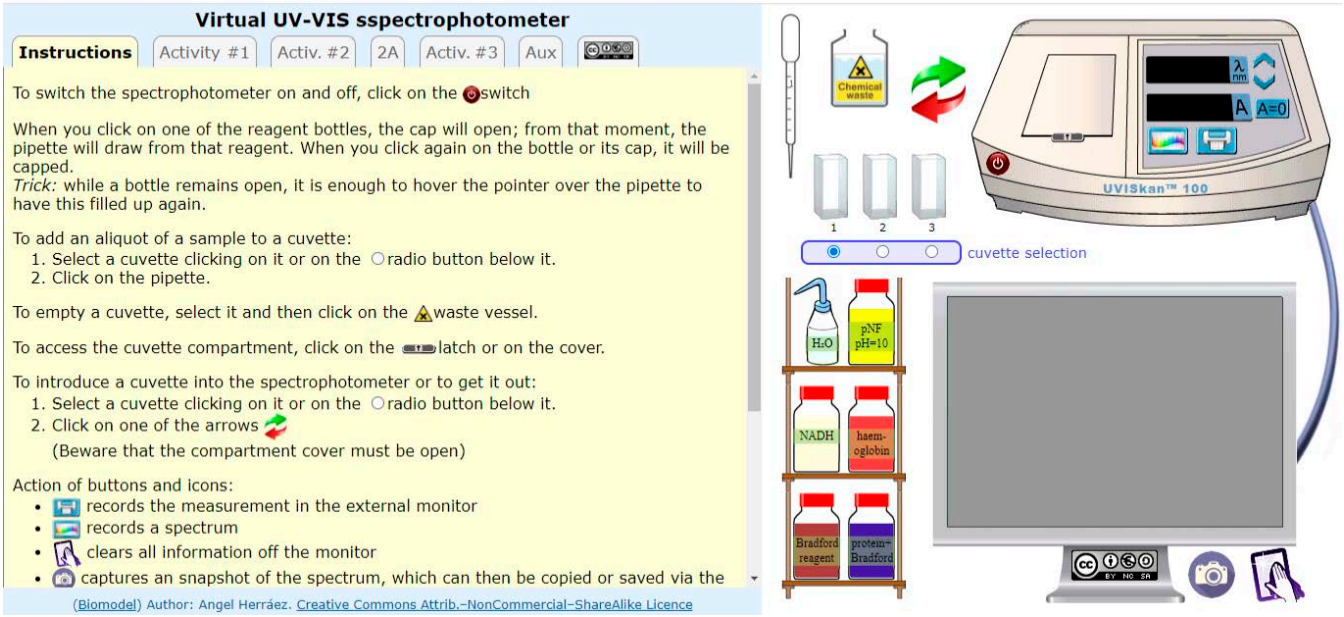


Figure 4 Sample Virtual Resource Curated for This Course—Virtual Lab for Learning Beer's Law (https://phet.colorado.edu/sims/html/beers-lawlab/latest/beers-law-lab_en.html)

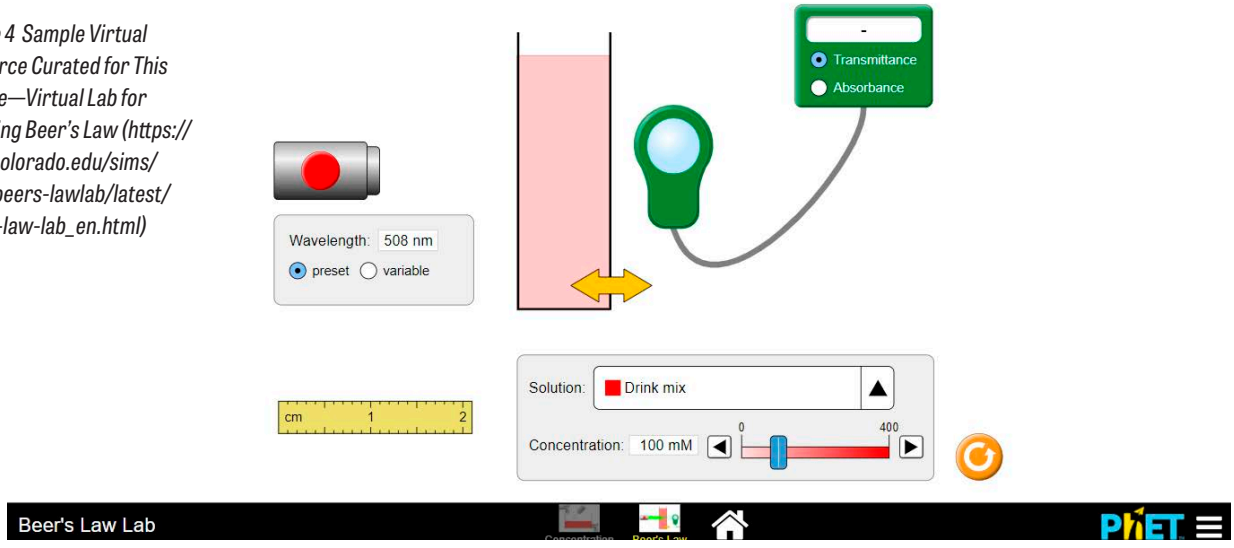
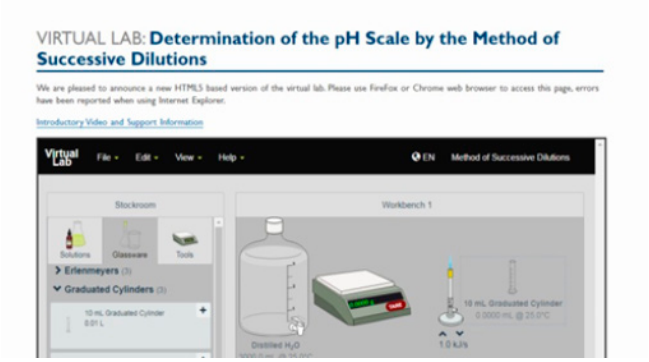


Figure 5 Sample Virtual Resource Curated for This Course—Virtual Lab for Titration Curves of Amino Acids (https://vlab.amrita.edu/repo/BIOTECH/BIC/Titration_curves_of_%20amino_acids/index.swf)

Figure 6 Sample Virtual Resource Curated for This Course—Virtual Lab for Determination of the pH Scale by the Method of Successive Dilutions (http://chemcollective.org/vlab/100)



C. Teaching Methodology

When teachers plan to implement the virtual curation lab for a course, the teaching and learning methodology must also be changed accordingly. The online class should be well pre-planned based on the activity/simulation discussed the day.

To conduct or perform the activities/simulations, the course teacher should keep the required digital resource open before initiating the session to avoid any issues. Narration should be planned for handling the activities. The most important thing is to make the students understand the objectives behind the activities/simulations.

STUDENTS' REFLECTION ON THIS VIRTUAL CURATION LAB

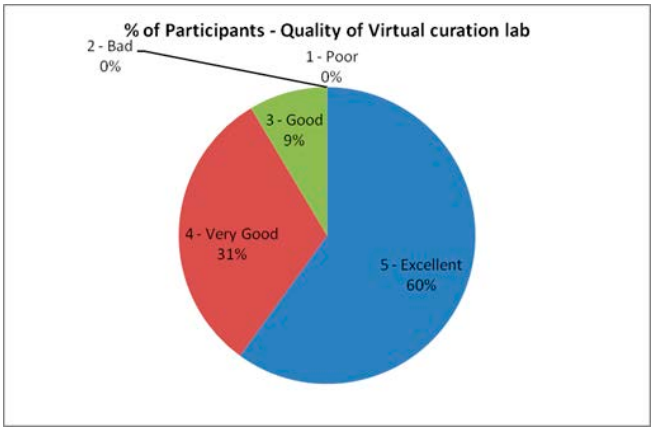
A survey was conducted and data collected on the impact and usability of this virtual curation lab from all 35 student course participants. The survey questionnaire consisted of a total of five questions. The questions and their corresponding responses are given as follows:

Q1. Rate the quality of the curated digital resources on the scale of 1-5 (Poor – Excellent) based on its relevance with the course topics?

The responses from the participants for survey question Q1 are depicted in a pie chart, as shown in Figure 7.

Figure 7 shows that about 60% of students

Figure 7 Response of Participants for Survey Question #Q1 on Quality of Curated Digital Resources



expressed that the curated virtual resources were "excellent," and around 31% of students evaluated them as "very good" based on their relevance to the course topics. This totals 91% of students happy/satisfied with the quality of curated resources for this course.

Q2. The activities and simulations available in the virtual curation lab were useful and effective in learning the particular experiment. The response from the participants for survey question Q2 is depicted in Figure 8.

Figure 8 shows that around 57% of the students strongly agree, and 37% agree that the activity and simulations available in the virtual curation lab for this course were useful and effective in learning the particular experiment.

Q3. The digital resources available in the virtual curation lab for this course were able to be accessed from all types of devices (Laptop/PC/Mobile).

Figure 8 Response of Participants for Survey Question #Q2 on Usefulness and Effectiveness of the Activity/Simulation

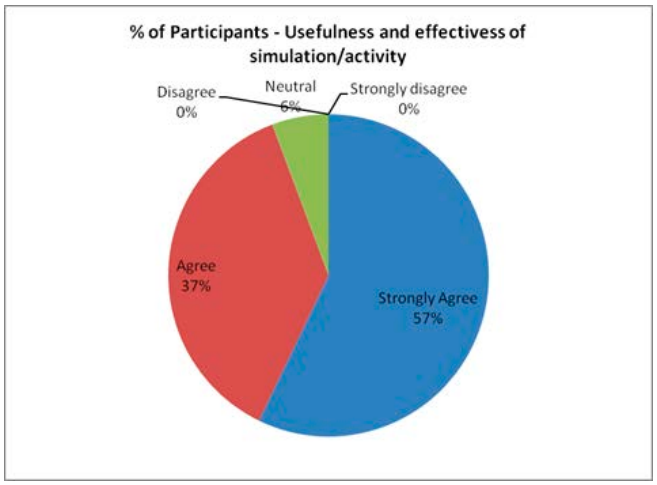
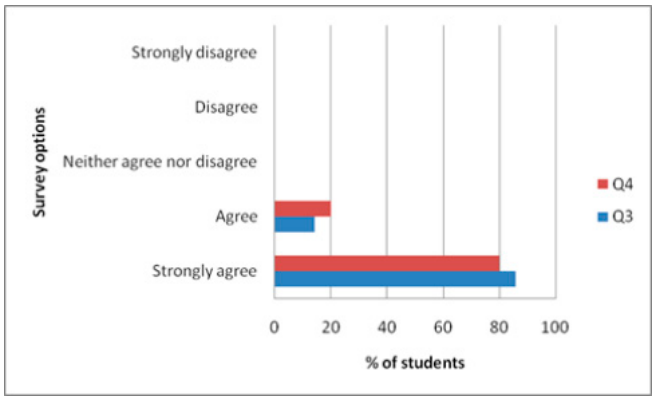


Figure 9 Response of Participants for Survey Questions Q#3 and #Q4 on Resource Availability and Induce Interest in the Course



Q4. The use of the virtual curation lab created an interest towards this course.

The responses from the participants for survey questions Q3 and Q4 are depicted in Figure 9.

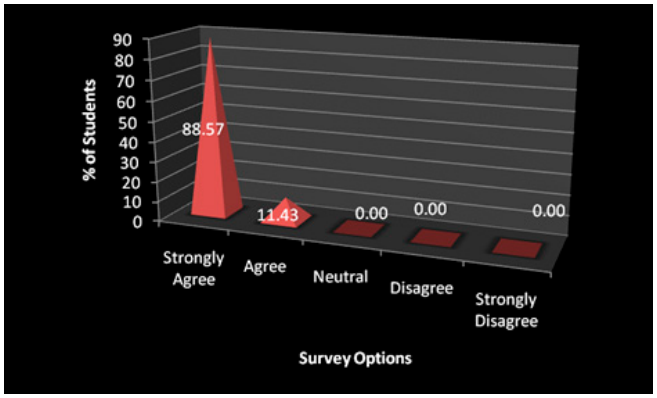
Figure 9 shows that around 85% of the students strongly agree, and the remaining 15% agree that the digital resources available in the virtual curation lab for this course could be accessed from all types of devices (Laptop/PC/Mobile).

These results also show that about 80% of the students strongly agree, and the remaining 20% agree that using the virtual curation lab created an interest in this course.

Q5. Recommends the course 'Principles of Biochemistry' with the support of this virtual curation lab made using Google Sites for future learners.

The responses from the participants for survey question Q5 are depicted in Figure 10.

Figure 10 Response of Participants for Survey Question #Q5 on the Recommendation of the Course for Future Learners



About 89% of the participants strongly agree, and 11% agree, which implies that all the students recommend this course with the support of the virtual curation lab created using Google Sites for future learners.

CONCLUSION

Participants of the course, Principles of Biochemistry, mentioned they support this Google Sites virtual curation lab. It increased their interest and learning and helped lead to effective virtual laboratory sessions. Much preparation is required when a teacher wants to create and implement virtual curation labs, but this study shows Google Suites can be a strong tool for teachers creating such virtual labs for their laboratory courses. Google Suites makes it easy to create, use, share, and collaborate on, plus it provides excellent visual appeal. This curated virtual lab can also be used to demonstrate during synchronous online classes.

The faculties and institutions offering similar courses could try such approaches to enhance their teaching-learning process, especially for virtual classes. This was a small-scale study with only 35 students from one sample site. It is best not to claim that the findings can be generalized to other courses/countries due to the size of the samples. The teaching methodology incorporated in this study was planned for a virtual environment only.

CONSENT FOR PUBLICATION

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise

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