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The Effectiveness of Content and Language Integrated Learning (CLIL) Online Assisted by Virtual Laboratory on Students' Science Process Skills in Acid-Base Materials

R Firmayanto*, L Heliawati and B Rubini

Department of Science Education, Graduate School of Pakuan University, Bogor, Indonesia

*Corresponding author: rudifirma@gmail.com

Abstract. This study aims to examine the effectiveness of Integrated Content and Language Learning (CLIL) online assisted by virtual laboratory on students' science process skills. The science process skills studied include the process of observing, classifying, communicating, measuring, predicting and inferring. This experimental research was conducted on students at Cahaya Rancamaya High School who used English as the medium of instruction in science learning. Student selection is done by purposive sampling. Data is collected through tests of science process skills. The results of the N-gain percentage analysis are 62% and in the medium category. The results show that CLIL online assisted by virtual laboratory is effective in improving students' science process skills in acid-base material.

1. Introduction

Teaching and learning process during the COVID-19 pandemic underwent a very significant change. Face-to-face learning in the classroom is now transformed into distance learning through an online system. This drastic change has occurred in all parts of the world, including in Indonesia. This was done to prevent the spread of the COVID-19 virus. Actually, online learning is not new. This learning has become a rapidly developing trend in educational technology since the beginning of the Internet era [1-2] and has been the focus of research in the world of education for more than two decades [3]. At present, the number of institutions offering online systems and the number of students enrolled in online courses is increasing [4]. This increase certainly changes the educational paradigm from conventional to digital era.

Online learning has also been applied at Cahaya Rancamaya Junior High School. This school supports learning policies from home by implementing online learning using the Zoom application for face-to-face (synchronous), Google classroom to provide material and assignments (Asynchronous), and other supporting applications. Learning with the Synchronous model allows direct interaction or communication between the teacher and students through the video conference application at the same time. Meanwhile, Asynchronous teachers and students are at different times, students work on assignments under the direction of the teacher through applications such as email, google classroom, etc. [5-6]. Through synchronous and Asynchronous learning, Cahaya Rancamaya Junior High School continues to facilitate students in learning even though their activities are limited due to the COVID-19 pandemic.



Teaching and learning using the online system has its own challenges. Technology literacy is not enough just to have a computer and software; it needs expertise in using various learning platforms and applications [7]. This challenge is also faced by Cahaya Rancamaya Junior High School during this online learning process. Many students and teachers are not yet familiar with this system, thus affecting readiness to use online platforms, even though readiness is crucial to success in online learning [8]. For some students, mastery of technology is still low, but teachers and students are working hard to adjust to this online learning system. Therefore, evaluation for the sake of evaluation needs to be continuously carried out in order to have a positive impact on the learning process.

Online learning is done by Cahaya Rancamaya Junior High School using the Content and Language Integrated Learning (CLIL) method. CLIL is widely used in schools that use languages besides the mother tongue as the medium of instruction [9], such as in Cahaya Rancamaya Junior High School which uses English as the medium of instruction in science learning. The CLIL method seeks to integrate content and language in learning [10-11]. The current science learning has not yet given maximum results. Findings in the field show that students' science process skills are still low, even though these skills are important skills that students must possess and have become one of the focuses in science education [12]. Therefore, CLIL learning is expected to be able to improve the quality of science learning especially science process skills in acid-base material. This study will also use a virtual lab to support the success of learning.

The virtual laboratory that has been integrated in this study includes phet simulation, chemistry simulation, and other simulations that support the acid-base learning process. Virtual laboratory has been considered as interactive media where simulation experiments can be conducted [13]. With this simulation, it can be easier for students and educators to conduct experiments without having to be in a laboratory. In addition, Virtual Laboratory can help to improve the understanding of scientific concepts, such as chemistry which contain many abstracts content in microscopic or particle areas [14-15]. It is expected that the use of virtual labs in science learning could help students to understand scientific concepts, so that they can improve students' science process skills.

The science process skills to be investigated refer to AAAS which consists of observing, classifying, communicating, measuring, predicting and inferring [16]. These skills aim to develop students' ability to use various tools and procedures to understand and engage in learning about natural phenomena better in the same way as scientists do [17]. Science process skills are the basic skills students must have in order to comprehend science concepts thoroughly. However, Duda and Susilo's research [18] and Wariato [29] found that education in Indonesia has not yet fully focused on developing scientific process skills. Therefore, this research is very important to do in order to provide an overview of the implementation of CLIL online learning assisted by virtual Labs on students' science process skills. These results can later be a reference for other similar schools in the middle of this pandemic.

2. Methods

The research method used in this study is the experimental method referring to Sugiyono [19]. The experiment was conducted on the 7th grade students of Cahaya Rancamaya Junior High School. The experiment aimed to find out the impact of using the virtual lab-assisted CLIL method on students' science process skills (SPS). Student selection was done by purposive sampling referring to Arikunto [20]. Data was collected through tests to measure students' science process skills on acid-base material.

The test of students' science process skills is in the form of 20 multiple choice tests consisting of 4 choices in each question. The measured process skills included the process of observing, classifying, communicating, measuring, predicting, and inferring. Data analysis of the test results used point system, where the correct answer of one question is given 5 points and wrong answer does not get points. Thus, the maximum value for this literacy result is 100 points. This test problem was tested with a one-group pretest-posttest design technique that refers to Fraenkel et al. [21]. The scheme is shown in Table 1.

Table 1. The Scheme of the One Group Pretest-Posttest Design

<i>Pretest</i>	<i>Treatment</i>	<i>Posttest</i>
T ₁	X	T ₂

T₁ as pretest is done before treatment is given to students, X as treatment is given through CLIL-assisted virtual lab learning, and T₂ as posttest is done after treatment is given to students. Through these pretest and posttest, students' science process skills are measured before and after treatment. The significant difference tested through paired sample t-test using SPSS.

3. Results and Discussion

Research data for the pretest-posttest analysis of students' science process skills on acid-base material is presented in Table 2.

Table 2. The Results of the Pretest and Posttest Analysis per SPS Indicators

SPS Indicator	% N-Gain	Criteria
Observing	72	High
Classifying	75	High
Communicating	65	Medium
Measuring	80	High
Predicting	60	Medium
Inferring	65	Medium

From the table above, we can see that from the six SPS indicators, indicators number 1,2 and 4 are in the high category. While indicators number 3, 5 and 6 are in the medium indicator. This means that the learning that has taken place gives an increase in student SPS on each indicator as seen from the pretest and posttest scores.

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Table 3. Analysis Results of SPS Pretest and Posttest

Implementation data	<i>Pretest</i>	<i>Posttest</i>
Number of students	20	20
Lowest score	30	40
Highest score	75	100
Average score	51	81,5
% N-Gain	62% (medium)	

From the table above, we can observe the difference between the pretest and posttest seen from the lowest, highest, average value and percentage of N-gain obtained in general. The above data tells us there is an increase in numbers at the lowest, highest and average values seen from the pretest and posttest values. The N-gain presentation is 62%. This number is in the medium category [22]. Comparison of the average value of pretest, posttest and N-Gain is presented in Figure 1.

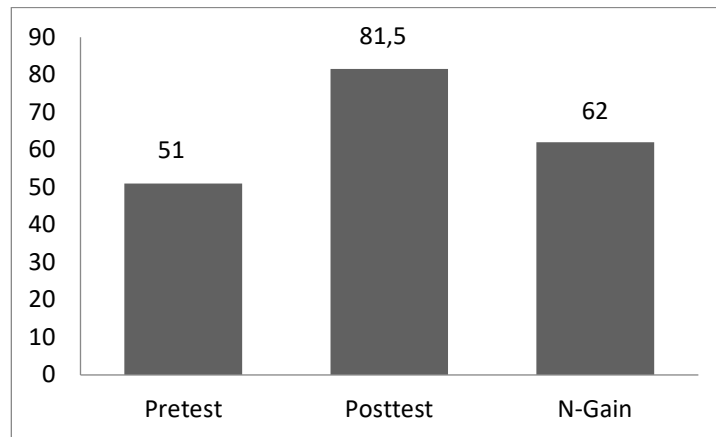


Figure 1. Comparison of Pre-test, Post-test, and N-Gain

The data of normality and homogeneity tests results on students’ science process skills (SPS) using SPSS version 23 is presented in Table 4.

Table 4. Normality and Homogeneity Test Results

Data	Sig. Value	Information
<i>Pretest</i> - <i>Posttest</i>	Normality test = 0,499	Data is normally distributed
	Homogeneity test =0,931	Data is homogenous
	Paired sample T-test=0,00	Very significant

From the table above, the prerequisite tests for normality are normally distributed and homogeneity shows homogeneous data. Then the data is tested to determine differences in values before and after learning with the Paired sample T-test. In the table the value of Sig. (2-tailed) = 0.00 means <0.05, so it can be concluded that there is a significant difference between the pre-test and post-test scores of students’ SPS after CLIL online learning assisted by virtual lab.

The process skills in the research are focused on six things, namely the process of observing, classifying, communicating, measuring, predicting, and inferring. In the process of observing, students use their senses to gather information about an object of learning. This process is the basic process of all science process skills and is the main avenue through which students get information [23]. In the topic of acid-base, observing activities that have been carried out by students are observing the physical properties of objects that are classified as acid-base. The process of observing through a virtual lab is done by looking at the change in color of a substance on litmus paper. This activity can be seen in Figure 2.

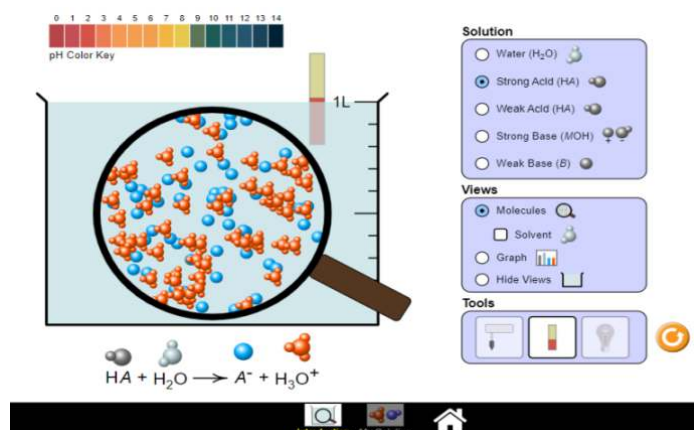


Figure 2. The process of observing the change in acid base colors (source : https://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_en.html)

The figure above, observing activities using phet simulation, students are also trained to observe microscopic images of acid and base molecules. Microscopic understanding of science, especially in chemistry is very important to the overall understanding of science [24]. The application of phet simulation used can help students in observing aspects of microscopic aspects of acid-base material. The findings of Correia et al. [25] confirm this. They stated that phet simulation can improve students' cognitive abilities at the microscopic level.

The process of classifying is a process skill for sorting various event objects based on their specific characteristics, so that a similar group of the event [26] is obtained. Classifying activities using virtual lab is shown in Figure 3.

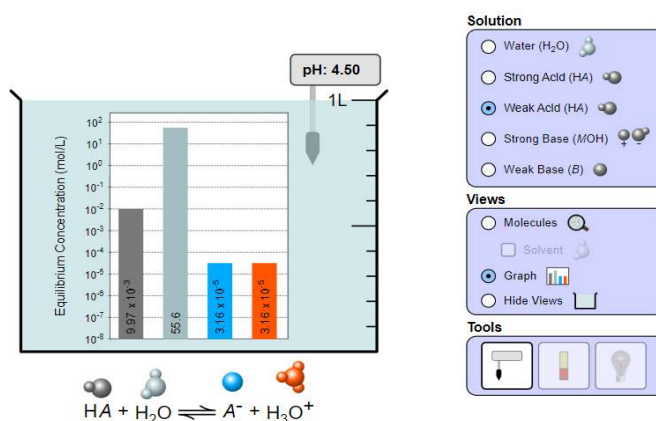


Figure 3. The process of classifying acid-base (source : https://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_en.html)

Through this activity, students classify a substance into acid, base or neutral as seen from its pH. Through this virtual lab, students can also learn and classify types of acid-base. In this process, students are trained to look for similarities and differences in the properties of acids and bases, comparing the strength of acids and bases. This is in line with Emda [27] which explains that the classification process includes several activities such as finding similarities, looking for differences, contrasting features, comparing, and looking for the classification base obtained by observing the object being studied.

The measuring process is carried out on acid-base pH. Measurement activities are scientific processes in which students describe the dimensions of an object or event. This process adds to the accuracy of

students' observations, classifications and communication [23]. Measuring activities using a virtual lab can be seen in Figure 4.

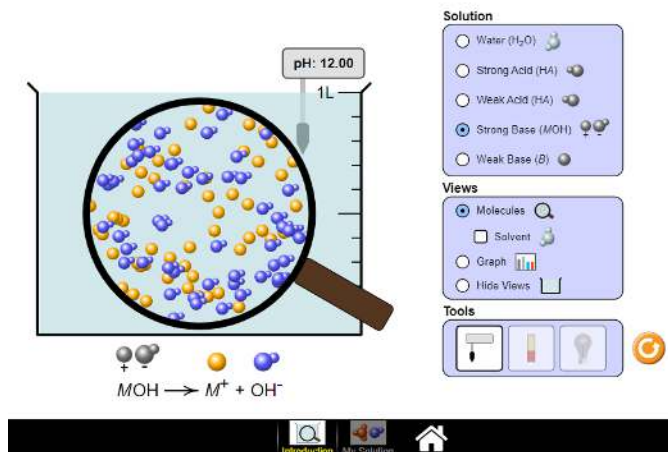


Figure 4. The process of pH measurement of acid-base (source : https://phet.colorado.edu/sims/html/acid-base- solutions/latest/acid-base-solutions_en.html)

In the process of measuring pH above, students are trained to understand both the pH range in acids and bases. Furthermore, students can understand the difference in pH between strong acids, weak acids, strong bases, weak bases, and neutral substances such as water. The process of measuring is part of the process of researching in science. Bortnik et al. [28] state that the use of virtual labs can improve research skills and practice of science.

The process of predicting requires students to predict the results of an experiment using observations and prior discoveries [23]. Activities of the predicting process are shown in Figure 5.

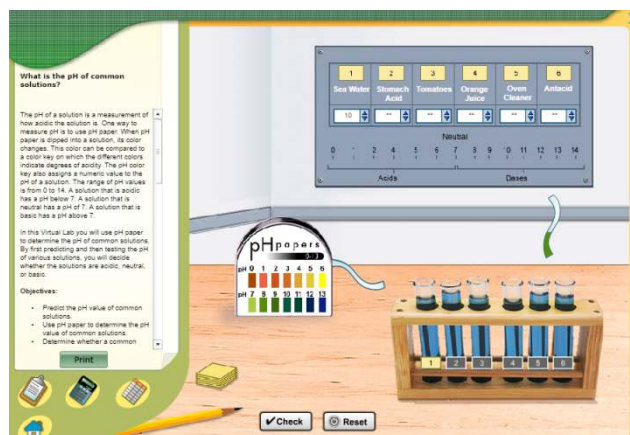


Figure 5. The process of predicting the pH of a base acid (source http://www.glencoe.com/sites/commonassets/science/virtual_labs/E22/E22.html)

In the process of predicting above, students are asked to estimate the pH for each given solution. The solution consists of sea water, acid in the stomach (HCl), tomatoes, orange juice, oven cleaners, and antacids. Learning through this virtual lab invites students to observe and predict the pH of substances that are around their environment.

The inferring activity was strengthened by answering acid-base questions in a fun way using interactive board works presentation in Figure 6. Through this activity students can finally infer concepts related to acid-base.

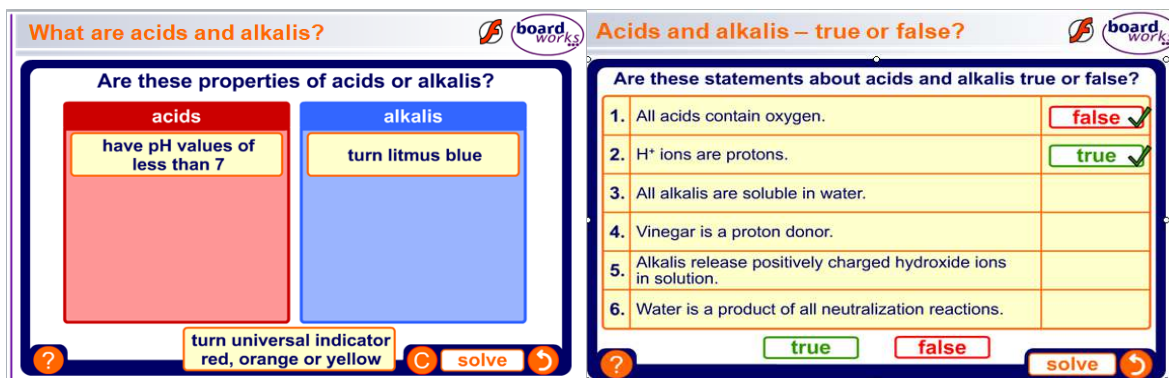


Figure 6. The inferring process is preceded by answering a question

The process of communicating is done by reading and writing observations with graphs/tables/diagrams, compiling and explaining experimental reports, discussing the results of activities [29]. In this study, students are asked to submit their observations about acid and base through the zoom activity as shown in Figure 7.

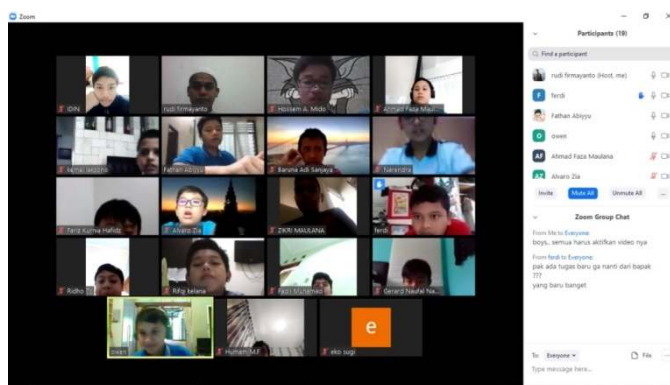


Figure 7. Online Learning process

From the explanation above, it is clear that the use of virtual labs can improve students' science process skills, especially in acid-base material. This is reinforced by the findings of Geban et al. [30] and Saat [31] who confirmed the use of virtual lab and web-based learning helps in the achievement of science process skills. Understanding of virtual usage is certainly supported by the use of the CLIL method applied to the learning. Through CLIL learning, students' ability to understand content and language of science can be improved. Thus, a good understanding of the content and language of science has helped students in using the virtual lab applications used.

4. Conclusion

Content and Language Integrated Learning (CLIL) online learning assisted by virtual laboratories effectively improve students' science process skills. The overall N-Gain pretest-posttest achievement is 62% and it is in the medium category, so it can be considered capable of increasing the SPS score significantly. The significance level is strengthened by Sig. (2-tailed) = 0.00 less than 0.05 which means very significant.

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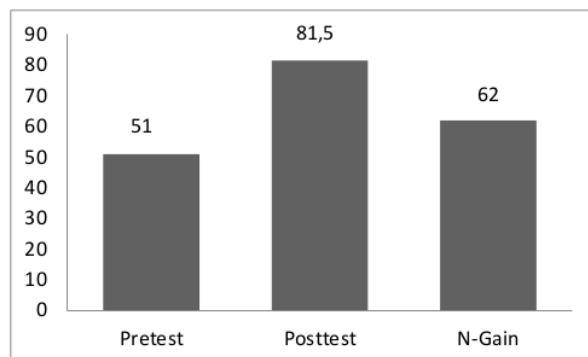


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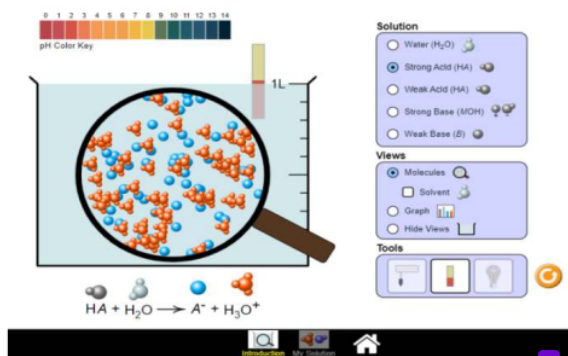


Figure 2. The process of observing the change in acid base colors (source : https://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_en.html)

The figure above, observing activities using phet simulation, students are also trained to observe microscopic images of acid and base molecules. Microscopic understanding of science, especially in chemistry is very important to the overall understanding of science [24]. The application of phet simulation used can help students in observing aspects of microscopic aspects of acid-base material. The findings of Correia et al. [25] confirm this. They stated that phet simulation can improve students' cognitive abilities at the microscopic level.

The process of classifying is a process skill for sorting various event objects based on their specific characteristics, so that a similar group of the event [26] is obtained. Classifying activities using virtual lab is shown in Figure 3.

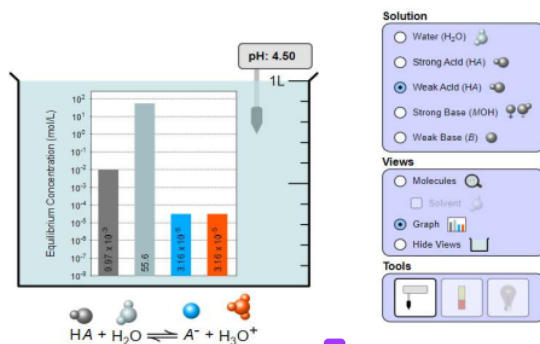


Figure 3. The process of classifying acid-base (source : https://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_en.html)

Through this activity, students classify a substance into acid, base or neutral as seen from its pH. Through this virtual lab, students can also learn and classify types of acid-base. In this process, students are trained to look for similarities and differences in the properties of acids and bases, comparing the strength of acids and bases. This is in line with Emda [27] which explains that the classification process includes several activities such as finding similarities, looking for differences, contrasting features, comparing, and looking for the classification base obtained by observing the object being studied.

The measuring process is carried out on acid-base pH. Measurement activities are scientific processes in which students describe the dimensions of an object or event. This process adds to the accuracy of

students' observations, classifications and communication [23]. Measuring activities using a virtual lab can be seen in Figure 4.

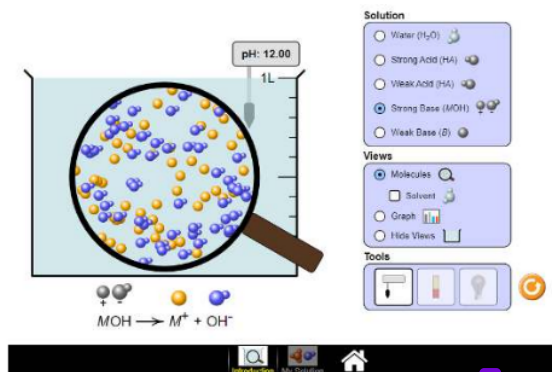


Figure 4. The process of pH measurement of acid-base (source : https://phet.colorado.edu/sims/html/acid-base-solutions/latest/acid-base-solutions_en.html)

In the process of measuring pH above, students are trained to understand both the pH range in acids and bases. Furthermore, students can understand the difference in pH between strong acids, weak acids, strong bases, weak bases, and neutral substances such as water. The process of measuring is part of the process of researching in science. Bortnik et al. [28] state that the use of virtual labs can improve research skills and practice of science.

The process of predicting requires students to predict the results of an experiment using observations and prior discoveries [23]. Activities of the predicting process are shown in Figure 5.

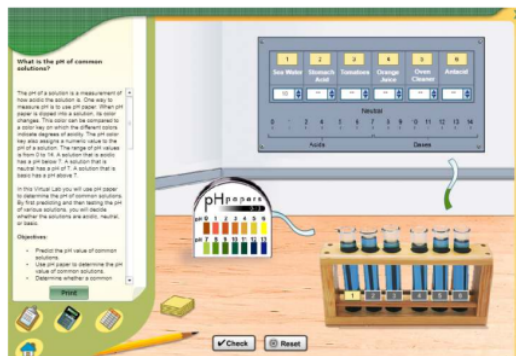


Figure 5. The process of predicting the pH of a base acid (source http://www.glencoe.com/sites/commonassets/science/virtual_labs/E22/E22.html)

In the process of predicting above, students are asked to estimate the pH for each given solution. The solution consists of sea water, acid in the stomach (HCl), tomatoes, orange juice, oven cleaners, and antacids. Learning through this virtual lab invites students to observe and predict the pH of substances that are around their environment.

The inferring activity was strengthened by answering acid-base questions in a fun way using interactive board works presentation in Figure 6. Through this activity students can finally infer concepts related to acid-base.

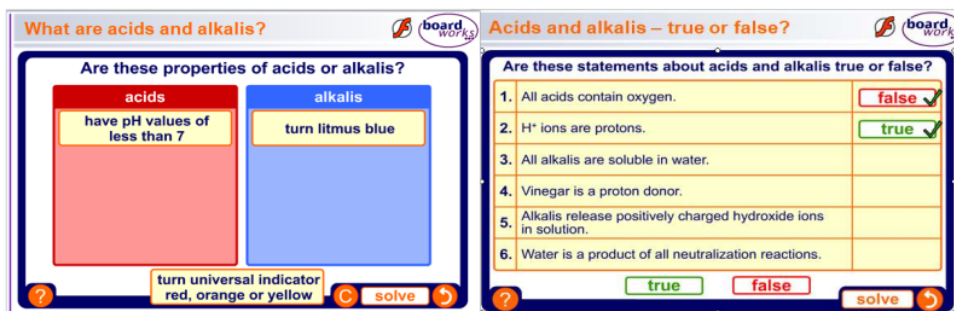


Figure 6. The inferring process is preceded by answering a question

The process of communicating is done by reading and writing observations with graphs/tables/diagrams, compiling and explaining experimental reports, discussing the results of activities [29]. In this study, students are asked to submit their observations about acid and base through the zoom activity as shown in Figure 7.

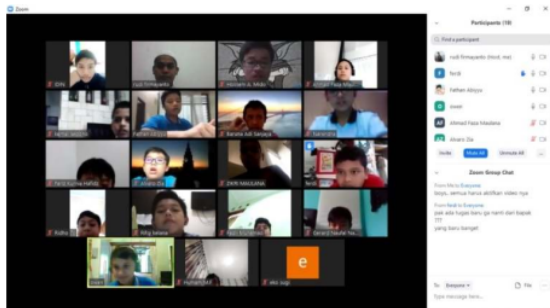


Figure 7. Online Learning process

From the explanation above, it is clear that the use of virtual labs can improve students' science process skills, especially in acid-base material. This is reinforced by the findings of Geban et al. [30] and Saat [31] who confirmed the use of virtual lab and web-based learning helps in the achievement of science process skills. Understanding of virtual usage is certainly supported by the use of the CLIL method applied to the learning. Through CLIL learning, students' ability to understand content and language of science can be improved. Thus, a good understanding of the content and language of science has helped students in using the virtual lab applications used.

4. Conclusion

Content and Language Integrated Learning (CLIL) online learning assisted by virtual laboratories effectively improve students' science process skills. The overall N-Gain pretest-posttest achievement is 62% and it is in the medium category, so it can be considered capable of increasing the SPS score significantly. The significance level is strengthened by Sig. (2-tailed) = 0.00 less than 0.05 which means very significant.

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The Effectiveness of Content and Language Integrated Learning (CLIL) Online Assisted by Virtual Laboratory on Students' Science Process Skills in Acid-Base Materials

R Firmayanto¹, L Heliawati¹ and B Rubini¹

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rudifirma@gmail.com¹ Department of Science Education, Graduate School of Pakuan University, Bogor, Indonesia<https://doi.org/10.1088/1742-6596/1918/5/052061>

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Abstract

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This study aims to examine the effectiveness of Integrated Content and Language Learning (CLIL) online assisted by virtual laboratory on students' science process skills. The science process skills studied include the process of observing, classifying, communicating, measuring, predicting and inferring. This experimental research was conducted on students at Cahaya Rancamaya High School who used English as the medium of instruction in science learning. Student selection is done by purposive sampling. Data is collected through tests of science process skills. The results of the N-gain percentage analysis are 62% and in the medium category. The results show that CLIL online assisted by virtual laboratory is effective in improving students' science process skills in acid-base material.

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