

Integration of Technology in the Teaching and Learning Process in Chemistry

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Abstract – *The integration of technology in the teaching and learning process in chemistry was investigated in order to determine if the extent of using technology is related to the performance of the students in Chemistry. It also determined the positive and negative impact of technology to the teaching of the five chemistry teachers and to the learning of the 193 B.S. Medical Laboratory Science and 120 B.S. Nursing students of the Lyceum of the Philippines University-Batangas during the first semester of the school year 2019-2020. Data were collected using the Likert scale instrument on the extent of using technology, achievement test on the performance of the students, and checklist on the impact of technology to the teaching and learning process in chemistry. To analyse the collected data, statistical tests like weighted mean, frequency, percentage, chi-square and t-test were used. It was found that there was a significant relationship between the extent of using technology and the performance of the students in chemistry. It was also found that although technology was used only sometimes in chemistry instruction, and there were some negative impacts of technology, still the students had a very good performance in chemistry.*

Keywords – *impacts of technology, technology integration, transfer of knowledge*

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INTRODUCTION

Technology has played a major role in today's dynamic world as it has revolutionized this fast-changing world. It has greatly affected the different aspects of one's life and it is undeniable to say that life without technology is meaningless. With the onset of modern teaching-learning styles and modes of education, it is imperative to consider the use of technology to make the educational system more responsive to the demands of the 21st century. The advancement in technology had improved the way the teachers transfer the knowledge to the students. It is evidenced using computers and internet in the presentation of information, thus making the teaching process easier but more effective, and learning on the other hand is more interesting. Learning new concepts has been more accessible from educational CDs (compact disc), uploaded lectures on websites in PDFs (portable document format) or in videos and can be shared among teachers and learners. Distance learning is made possible as in online degrees and training courses. According to Seery, and McDonnell [1], technology will make students engage in active learning, facilitate group collaboration, and support self-regulated learning.

Chemistry is a modern science where the concepts should be delivered effectively to the students with technology. Information and communication technology is a very useful tool in designing new learning environments, integrating virtual models and creating e-learning communities. It is a reliable source of scientific data and theoretical information that support authentic learning in chemistry [2]. The traditional mode of teaching chemistry lecture is a face-to-face discussion inside a classroom which is provided with whiteboard, projector, laptop, or television. The teacher usually prepares a PowerPoint presentation which is displayed in a white screen. Assignments are given to be submitted by the students in a piece of paper and quizzes are administered during class hours. Chemistry laboratory classes are conducted inside a laboratory room where students can develop manipulative skills in using different laboratory apparatuses while performing experiments. In the same manner, different laboratory skills like the ability to predict, observe and explain experimental results are cultivated during laboratory sessions.

In the light of the foregoing concepts and based on the continuous evolution and advancement of the art of teaching,

there is a need for educators to re-evaluate not only the teaching pedagogies but also the technological methods to apply in their instruction. The outbreak of COVID-19 pandemic causes a great shift in how chemistry teaching is conducted in all learning institutions globally. The current situation of teaching chemistry is through online remote learning where teachers utilized various technology platforms unlike the usual face to face instruction. It is very challenging not only on the part of the teacher but most especially on the students.

With the current situation when education is facing a lot of challenges in the midst of this pandemic, it is but necessary for teachers to find ways in making the teaching and the learning process more meaningful by using various technologies in the instruction. The researcher who had been teaching chemistry for several decades faced a lot of challenges in deciding how to deliver the assigned curriculum using appropriate technology that will advance the teaching-learning process in a particular course. In this study, the researcher considered some of the various technologies applicable in the teaching of chemistry which include flipped learning, podcasting, screen casting, Wikis, videos, mobile phones, laptops, PowerPoint presentation, projector, local area network, video conferencing, messenger, electronic mail, Dropbox, electronic books, internet, web seminars and distance learning.

OBJECTIVES OF THE STUDY

This study aimed to determine the effect of integrating technology in the teaching and learning process in chemistry. Specifically, it determined the extent by which technology was used in the teaching and learning process in chemistry, determined the performance of the students in chemistry and investigated the positive and negative impact of technology in the teaching and learning process in chemistry. This study tested the relationship between the extent of using technology in Chemistry instruction and performance in Chemistry. The study also tested the comparison of responses of the two groups of respondents on the extent of using technology in Chemistry. Towards the end, an action plan was proposed to enhance the teaching and the learning process in chemistry.

MATERIALS AND METHODS

Research Design

This study made use of the descriptive design particularly the quantitative method which according to Shuttlesworth [3] is a scientific method that involves observing and describing the behavior of a subject without influencing it in any way. This method was employed because quantitative collection of data described the situation for the purpose of casting light on current issues or problems.

Participants

This study involved the entire population of the first year BS Medical Laboratory Science students and the first year

BS Nursing students of Lyceum of the Philippines University – Batangas who were enrolled in College Chemistry during the first semester of the school year 2019-2020 together with their chemistry teachers. The total population of 193 first year BS Medical Laboratory Science students, 120 first year BS Nursing students and five chemistry faculty were included in this study.

Instrument

To determine the extent by which the teachers use technology in teaching chemistry, a Likert Scale Instrument was self-developed by the researcher. This instrument includes fifteen items that described different types of technological practices which can be integrated in teaching chemistry. This consists of five scale options that described whether the teacher always, often, sometimes, seldom or never use such technology in teaching chemistry. This Likert Scale Instrument consists of two sets, one for the students and the other for the faculty. The items in each set were parallel to each other. The instrument was presented to some chemistry teachers for comments and suggestions and then to experts for face and content validity.

An Achievement Test was used to determine the level by which knowledge was transferred to students by integrating technology. This include basic knowledge in chemistry that can be acquired not only in the lecture but also in the laboratory. This Test was a validated instrument that was adapted from Reyes et al. [4]. This consist of 59 multiple type questions with 4 options to choose from.

In investigating the impact of technology to the teaching and learning in chemistry, two sets of checklists were developed by the researcher. One set was intended for the faculty and the other for the students. Both of them consist of 10 items that identified the advantages or positive impact of technology and another ten items that identified the disadvantages or negative impact of technology not only to the teaching but also to the learning of chemistry. The respondents were asked to check the item which based on their experience was a positive or a negative impact to the teaching and learning of chemistry. Similar to the previous instrument, the questionnaire was presented to chemistry teachers for comments and suggestions and to experts for face and content validity.

Procedure

The researchers secured permission from the Deans of the College of Allied and Medical Profession, and College of Nursing in order to utilize their students as respondents in this study. As soon as the consent to conduct the study was granted, the Likert Scale instrument and the checklist were distributed to the faculty respondents and were retrieved a week after the distribution. In order to validate the responses of the faculty in their use of technology the Likert Scale Instrument and the checklist intended for students were posted in the group chat of the class. The students were required to submit a printed copy of the instruments with

their responses. The achievement test was administered to the respondent students before the end of the semester. The achievement test was collected from the students right after its administration.

Data Analysis

The results about the extent of using technology in teaching chemistry using the Likert Scale instrument was analyzed using weighted mean. The scores of the students in the Achievement Test which show the level by which knowledge is transferred to students using technology was treated statistically using Frequency and Percentage. Responses in the Checklist Instrument about the impact of technology to the teaching and learning chemistry was analyzed using frequency. The relationship between the extent of using technology in chemistry instruction and the performance of students in chemistry was analyzed using chi square test while t-test was used to determine the difference

between the responses of the students and the teachers in the extent of using technology.

Ethical Consideration

The researchers established trust with the participants of the study through ensuring anonymity and confidentiality. The names of the student and faculty respondents, the academic track and the senior high school where the students graduated from were not revealed in this study.

RESULTS AND DISCUSSION

Table 1 shows the extent of using technology in chemistry instruction based on the responses of the students and faculty. It was shown from the table that on the part of the students, technology was always used when preparing their own PowerPoint presentation during reporting, when their teacher uses a projector to project a diagram from a laptop onto the wide screen and when their discussion is done through PowerPoint presentation.

Table 1. Extent of Using Technology in Chemistry Instruction

Indicators	Students		Teachers		Over-all	
	WM	I	WM	VI	WM	VI
1. Students are assigned to watch short video lectures at home before the classroom session (Flipped Learning)	2.09	Se	1.8	Se	1.94	Se
2. Students are required to make digital recordings of broadcasts available for downloading to a computer or mobile device with the use of internet (Podcasting)	1.87	Se	1.8	Se	1.83	Se
3. Students are asked to record or transmit video of data displayed on the screen of a computer or mobile device with accompanying video (screen casting)	2.08	Se	1.6	Se	1.84	Se
4. Students are made to edit information from Wikis	1.53	Se	1.4	N	1.46	N
5. During class discussion, students are allowed to use laptops and other mobile devices	3.93	O	3.8	O	3.86	O
6. Discussion is through PowerPoint presentation	4.8	A	4.8	A	4.8	A
7. Students are assigned to prepare their own PowerPoint presentation during reporting	4.96	A	4.4	O	4.68	A
8. Teacher uses projector to project a diagram from a laptop onto the wide screen	4.89	A	4.2	O	4.55	A
9. Teacher do lecture through video conferencing	2.11	Se	2	Se	2.06	Se
10. Teacher posts reminders and announcement through group chat or messenger	3.49	So	3.8	O	3.64	O
11. Online assignments are given to students	3.39	So	2.8	So	3.1	So
12. Lectures are sent to students online	4.26	O	2.6	So	3.43	So
13. Students are required to answer online quizzes	3.44	So	2.8	So	3.12	So
14. Teacher uses televisions to play educational and instructional DVD's or videos	2.15	Se	1.6	Se	1.88	Se
15. Teacher facilitates distance learning to students from far places	2.4	Se	1.6	Se	2	Se
Composite Mean	3.17	So	2.73	So	2.95	So

Legend: 4.50 – 5.00 = Always (A); 3.50 – 4.49 = Often (O); 2.50 – 3.49 = Sometimes (So); 1.50 – 2.49 = Seldom (Se); 1.00 – 1.49 = Never (N)

However, on the part of the faculty, it was only during discussion when technology was always used in a PowerPoint presentation. As to their overall responses, the item with the highest weighted mean was discussion is through PowerPoint presentation (4.8), followed by students are assigned to prepare their own PowerPoint presentation during reporting (4.68) and teacher uses projector to project a diagram from a laptop onto the wide screen (4.55).

According to the students, technology was seldom used

in editing information from Wikis, in podcasting, screen casting, in flipped learning, and video conferencing. According to them also, their teacher seldom used televisions to play educational and instructional DVD's or videos and seldom facilitate distance learning. On the part of the faculty, they never ask students to edit information from Wikis. As to their overall responses, the item with the lowest weighted mean was students never edit information from Wikis (1.46) followed by podcasting (1.83) and screen casting (1.84). The

overall composite mean was 2.95 which means that technology was sometimes used in chemistry instruction.

The result implies that technology was not always used in chemistry instruction possibly because the teachers are not so digitally literate to integrate technology in their teaching. They might be familiar with some technological tools for teaching, but they are not aware on how to use them.

Teachers are not ready to use technology in the different aspects of their instruction. This conformed to what Crawford et al., [4] stated that teachers must be prepared as confident users of technology by effectively integrating technology to transform student learning. Educators must find ways to identify the effective pedagogical approaches and strategies to make the teaching-learning process more meaningful. In addition to this, Chittleborough [6] said that for a teacher to teach chemistry, one should be equipped with technological knowledge aside from the fundamental pedagogical knowledge about chemistry concepts.

The level by which knowledge in Chemistry was transferred to students using technology was revealed in their performance in the Achievement Test that was shown in Table 2. As shown in the table, 133 students or 42.50% of the total student respondents had a very good performance in chemistry, 92 or 29.4% had an outstanding performance.

Table 2. Performance of the Students in Chemistry

	Frequency	Percentage
Outstanding	92	29.40
Very Good	133	42.50
Good	60	19.20
Average	20	6.40
Needs Improvement	8	2.60

Further, 60 or 19.20% had good performance, while 20 or 6.40% had an average performance, while 8 students or 2.60% had a performance that needs improvement.

The result indicates that by using technology, knowledge in chemistry can be transferred to students at a very good level. This could be since students are more technologically inclined and more interested in exploring the different tools used for learning because they are aware that they can use their digital literacy in their future profession. This finding is like what Persaud [7] claimed that students are welcoming technology with open arms because it is technology that plays a major role in education. Students utilize different technological applications because in the real world, students will apply what they learned in their future job to become successful in a technological job market.

Table 3.1. Positive Impact of Using Technology to the Teaching and Learning Process in Chemistry

Indicators	Students		Teachers	
	f	%	f	%
1. Students can visualize a concept in a better way such as in a video where a 3D model can be easily understood unlike when in a book	212	67.73	4	80
2. A PowerPoint presentation can summarize a vast chapter thereby making students comprehend the topics easier	304	97.12	5	100
3. There are many educational sites where teachers and students can find a particular topic	245	78.27	2	40
4. Teachers and students have an instant access to fresh information that can supplement their learning experience.	206	65.81	4	80
5. Teachers and students can easily research anything they want to know online	279	89.14	4	80
6. Teachers and students can use LAN to receive instant information so that time spent on research is reduced and analysis of information is increased.	188	60.06	4	80
7. Through video conferencing teachers and students can connect with others from different parts of the world.	57	18.2	-	-
8. Teachers and students can upload and share the lesson through e-mail and services like Dropbox	184	58.8	4	80
9. E-books help teachers and students to get rid of textbooks and from lifting their weight as well.	118	37.7	-	-
10. Teachers and students can use the internet to virtually attend web seminars organized by different educational institutions.	84	26.8	1	20

Table 3.1 represents the positive impact of using technology to the teaching and learning process in chemistry. It was revealed from the table that 304 students or 97.12% of the student-respondents said that a PowerPoint presentation can summarize a vast chapter thereby making them comprehend the topics easier, 279 students or 89.14% said that teachers and students can easily research anything they

want to know online and 245 students or 78.27% said that there are many educational sites where teachers and students can find a particular topic. Fifty-seven students or 18.2% said that through video conferencing teachers and students can connect with others from different parts of the world, 84 students or 26.8% said that teachers and students can use the internet to virtually attend web seminars organized by

different educational institutions and 118 students or 37.7% said that E-books help teachers and students to get rid of textbooks and from lifting their weight as well.

On the other hand, all the five teachers or 100% stated that a PowerPoint presentation can summarize a vast chapter thereby making students comprehend the topics easier; 4 teachers or 80% stated that students can visualize a concept in a better way such as in a video where a 3D model can be easily understood unlike when in a book, teachers and students have an instant access to fresh information that can supplement their learning experience, teachers and students can easily research anything they want to know online, teachers and students can receive instant information so that time spent on research is reduced and analysis of information is increased and teachers and students can upload and share the lesson through e-mail and services like Dropbox. None of the teachers stated that through video conferencing teachers and students can connect with others from different parts of the world and E-books help teachers and students to get rid of textbooks and from lifting their weight as well. Only one of the teachers or 20% stated that teachers and students can use the internet to virtually attend web seminars

organized by different educational institutions. Two of them or 40% stated that there are many educational sites where teachers and students can find a particular topic.

It was reflected from the results that using technology like PowerPoint presentation and internet has a positive impact on the teaching and learning process in chemistry. This could be since chemistry is a difficult subject that requires simplified presentation of concepts and a vast of information is needed to supplement the knowledge gained from the classroom. By using a PowerPoint presentation, students can readily understand the concept that can be summarized in a simplified manner. Additional information can be readily accessed from the internet that will enhance the understanding of a particular topic. This is like what Soffar [8] stated that organization of a topic can be done in a PowerPoint presentation by reducing complicated information and focusing only on the main ideas. Furthermore, Barski [9] claimed that all types of information from library resources all over the world can be accessed from the internet. This information enhanced the learning potential of students because the information is tailored to the needs of the learners.

Table 3.2. Negative Impact of Using Technology to the Teaching and Learning Process in Chemistry

Indicators	Students		Teachers	
	f	%	f	%
1. Students are experiencing social anxieties when it comes to face-to-face interactions, but are perfectly fine socializing online	67	21.41	2	40
2. Technology in the classroom can be a distraction	127	40.6	3	60
3. Technology can disconnect students' social interactions with their classmates.	98	31.3	2	40
4. Students have no equal access to technological resources	86	27.5	3	60
5. The quality of research and resources may not be of good quality.	132	42.2	1	20
6. Students heavily rely on technology to access information so that they become lazy in their studies.	109	34.82	4	80
7. Students were not able to develop and use basic literacy, math and communication skills due to technology	51	16.3	3	60
8. Teachers and students encountered problems in the classroom due to failure of technology as in poor internet connection	166	53	5	100
9. Students prefer discussion where the teacher write the concept on the board instead of presenting it in a PowerPoint presentation	113	36.1	2	40
10. Cellphones make students not concentrate fully in their lesson.	168	53.67	4	80

The negative impact of using technology in the teaching and learning process in chemistry is shown in Table 3.2. It was revealed from the table that 168 students or 53.67% responded that cellphones make students not concentrate fully in their lesson, 166 students or 53% responded that teachers and students encountered problems in the classroom due to failure of technology as in poor internet connection, and 132 students or 42.2% responded that the quality of research and resources may not be of good quality. Fifty-one students or 16.3% responded that students were not able to develop and use basic literacy, math, and communication skills due to technology, 67 students or 21.41% responded that

students are experiencing social anxieties when it comes to face-to-face interactions but are perfectly fine socializing online and 86 students or 27.5% responded that students have no equal access to technological resources.

On the part of the teachers, all the five teachers said that teachers and students encountered problems in the classroom due to failure of technology as in poor internet connection, 4 teachers or 80% said that students heavily rely on technology to access information so that they become lazy in their studies and cellphones make students not concentrate fully in their lesson. Three teachers said that technology in the classroom can be a distraction,

students have no equal access to technological resources and students were not able to develop and use basic literacy, math and communication skills due to technology. Only one teacher or 20% said that the quality of research and resources may not be of good quality while 2 teachers or 40% said that students are experiencing social anxieties when it comes to face-to-face interactions but are perfectly fine socializing online, technology can disconnect students' social interactions with their classmates, and students prefer discussion where the teacher write the concept on the board instead of presenting it in a PowerPoint presentation.

It was revealed from the result that the most common responses of the students and the teachers with regards to the negative impact of technology to the teaching and learning process in chemistry are that teachers and

students encountered problems in the classroom due to failure of technology as in poor internet connection and cellphones make students not concentrate fully in their lesson. This might be due to poor bandwidth that hinders the student engagement to learning and, since students are allowed to use cellphones in the classroom, their interest is diverted to the use of other applications in their phones instead of concentrating in their lesson. This conformed to Taylors [10] findings that students cannot comply with their course if they have a poor internet connection and for education to be fair, all schools must provide equal opportunities for all in terms of bandwidth connection. In addition to this, Gautam [11] stated that multitasking is a side effect of mobile phones, thus mobile learning content must be designed in a way that will address distracted learning.

Table 4. Relationship Between the Extent of Using Technology and Performance in Chemistry

	λ^2_c	p-value	I
Extent of Using Technology in Chemistry Instruction vs. Performance in Chemistry	53.066 ^a	0.000	HS

Legend: Significant at p -value < 0.05; HS- Highly Significant

The relationship between the extent of using technology in chemistry instruction and the level by which knowledge was transferred to students is shown in Table 4.

Based on the result, there was a significant relationship between the extent of using technology in chemistry instruction and the level by which knowledge was transferred to students since the obtained p -value of 0.000 was less than 0.05 alpha level. This means that the students' performance in Chemistry was affected by how frequent the students and teachers used technology in their class. This could be since if the class activity requires the use of technology but the access to technology is limited then students will not be able to comply with the requirements thus affecting their performance.

This is like the findings of Khanlarian and Singh [12] that software is more useful for lower scoring students than those who scored higher on examinations. In contrary to these findings, Harris et al., [13] claimed that technology will not increase student academic achievement, instead it is still the teacher's strategy that will make students learning meaningful. Technology cannot replace the best practices in teaching and learning process.

The difference in the responses of the students and teachers on the extent of using technology in chemistry instruction was displayed in Table 5.

It was observed from the table that the obtained p -value of 0.093 was greater than 0.05 alpha level, thus the researchers fail to reject the null hypothesis. This means that there was no significant difference existing between

the responses of students and teachers and implies that the responses do not differ statistically.

Table 5. Difference of Responses of Students and Teachers on the Extent of Using Technology in Chemistry Instruction

	Group	Mean	t-value	p-value	I
Extent of Using Technology	Students	3.17	1.685	0.093	NS
	Teachers	2.73			

Legend: Significant at p -value < 0.05; NS- Not Significant

The findings maybe, the teachers introduce only those technology available in the classroom and those which are easily accessible to students. Teachers are not trained well in using other technologies that's why they do not explore the appropriate tools for their learning activities. This conformed to the findings of [5] that to prepare teachers to teach chemistry, one should be equipped with technological knowledge aside from the fundamental pedagogical knowledge about chemistry concepts.

Proposed Action Plan for Enhancing the Teaching and the Learning Process in Chemistry

An action plan (refer to Table 6) was proposed for the purpose of motivating teachers and students to integrate technology in their lessons and to overcome the negative impacts brought about by technology in chemistry instruction. With the given strategies, it is expected that using technology will enhance the teaching and the learning process in chemistry.

Table 6. Proposed Action Plan for Advancing the Teaching and the Learning Process in Chemistry

KRA / Objectives	Strategies	Performance Indicator	Persons Involved
Extent of using technology in the teaching and learning process in chemistry/ To motivate teachers and students to always integrate technology in every lesson in chemistry.	<ul style="list-style-type: none"> • Conducting trainings on how to integrate various technologies in different topics in chemistry; Orientation in the use of virtual laboratory simulation • Peer Mentoring or Collaboration among teachers and among students in the use of technology • Creation of a technical support system in every school that will assist teachers and students whenever problems arise in the use of technology • Offering Educational Technology as one of the required courses in every program 	<ul style="list-style-type: none"> • Developed expertise in the use of different technological tools • Sharing of skills or techniques in using different technology • Ability to become better users of technology by learning how to solve technological problems • Transition to digital curriculum 	<ul style="list-style-type: none"> • Human Resource Director/ Dean/ Chemistry Faculty/ Students • Chemistry Faculty/ Students • Chem Faculty/ Students/Technical Support Staff • School administrators
Negative Impacts of Using Technology in chemistry instruction/To overcome the negative thinking of teachers and students in the use of technology	<ul style="list-style-type: none"> • Teachers must create engaging, inspiring, and stimulating lesson plans that incorporate technology; Laboratory activities may utilize videos of experiments and virtual simulations • There must be an open communication among administration, faculty, and tech vendors that will justify the benefit that teachers and students will get from the use of a particular device, platform, or program • Schools must invest on technology where teachers and students will have an equal access like faster internet connection so that technological disparity will be avoided • Teachers should educate students on the responsible use of technology. • Strict monitoring of students on how they complete their exams and assignment using technology without cheating 	<ul style="list-style-type: none"> • Students are more engaged and more encouraged to participate in the classroom discussion and in doing experiments • The use of technology in the classroom will be enhanced and the negative thought that technology has a little value in education will be overcome • No student will be left behind in their learning so that their performance will be enhanced. • Students can concentrate fully in their lessons instead of being distracted by other applications embedded in their technological devices • Students perform in class with credibility and integrity. 	<ul style="list-style-type: none"> • Chemistry Faculty/ Students • School administrators/ Faculty/ Technology vendors • School administrators • Chemistry faculty/ Students • Chemistry Faculty/ Students

CONCLUSION AND RECOMMENDATION

The teachers and the students sometimes use technology in the teaching and learning process in chemistry. The students had a very good performance in chemistry although technology is used sometimes only in the teaching and learning process. The use of power point presentation

and internet has a positive impact on the teaching and learning process in chemistry while the negative impact of technology to the teaching and learning process in chemistry are that teachers and students encountered problems in the classroom due to failure of technology as in poor internet connection and cellphones make students not

concentrate fully in their lesson. There was a significant relationship between the extent of using technology in chemistry instruction and the performance of the students in chemistry. There was no significant difference existing between the responses of students and teachers to the extent of using technology in the teaching and learning process in chemistry. The researchers were able to propose an action plan to advance the teaching and the learning process in chemistry.

Teachers may undergo extensive training on the use of technology especially at this time where there is an outbreak of COVID-19 pandemic not only for the continuity of learning but also in order to enhance the performance of students in chemistry. The negative impact of technology can be minimized by learning the proper use of each tool that is appropriate to the learning outcome, activities and assessment of the course. Chemistry teachers may discover for themselves other teaching strategies such as discussion through video conferencing using different platforms and giving assignments using learning resources as electronic books. The University may continuously support the faculty and students by providing them with technologies necessary for the teaching and learning process. The strategies in the proposed action plan may be implemented by the school administrators, chemistry faculty and students in order to advance the teaching and the learning process in chemistry. Future researchers may conduct further research in this time of pandemic in order to compare the effect of purely online teaching to the performance of students in chemistry with the present study.

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