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Knowledge and Sources of Information on COVID-19-Related Misconceptions among Chemistry Undergraduates

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ABSTRACT

Along with the problem of the COVID-19 pandemic, the world also faces a problem with misconceptions. These speculations can worsen the situation and wreak havoc on decisions made by the public. This study investigated the level of knowledge of Chemistry undergraduates on COVID-19-related misconceptions. A total of 153 undergraduates participated in the survey. Analysis revealed that the common misconceptions among undergraduates are the need to disinfect surfaces of food packaging, the transmissibility of the SARS-CoV-2 virus through the water while swimming, the need for quarantine for live animals imported from countries with a high prevalence of COVID-19 and getting infected through touching a communal bottle of alcohol-based sanitizer. Results also showed that the undergraduates mainly rely on internet browsing as their source of information about the COVID-19 pandemic. There are 3 students who obtained a score of less than 50% of the total points, thereby having poor knowledge regarding COVID-19. On the other hand, 55 students obtained a score between 50% to 75% of the total points, thereby having a moderate level of knowledge regarding COVID-19. Lastly, 95 students obtained a score above 75% of the total points, having good knowledge regarding COVID-19. Additionally, the usual way for students to address the misconceptions surrounding the COVID-19 pandemic is by depending on reliable sources and research.

Keywords: *misconceptions; chemistry education; COVID-19 pandemic*

INTRODUCTION

The novel coronavirus SARS-CoV-2 has spread to many other countries following its outbreak in Hubei Province, People's Republic of China. COVID-19 disease is transmitted through droplets of saliva or discharge from the nose of an infected person coughing or sneezing, respectively. Symptomatic patients afflicted with this COVID-19 disease manifest fever, cough, nasal congestion,

and fatigue (Velavan & Meyer, 2020). Like other viruses, SARS-CoV-2 evolves over time. The virus's properties, such as being highly transmittable and its severity, may be affected. There are more than 500 million confirmed COVID-19 cases globally. The highly contagious and deadly SARS-CoV-2 virus has already taken more than 6 million lives worldwide. As of this writing, there is still no cure discovered for COVID-19.

Many casualties brought by the COVID-19 disease cause desperation. The need for effective rapid treatment undermines the patience required to conduct appropriate studies. In the study of Brugger et al. (2020), a group of high-altitude researchers debunked the misconception regarding the effectiveness of the drugs administered in patients suffering from high-altitude pulmonary edema might be useful in treating COVID-19 as there are emergency physicians suggesting that there are pathophysiological similarities between COVID-19 pneumonia and high-altitude pulmonary edema. Similarly, Ivermectin was proposed as treatment and prophylaxis of COVID-19 disease in the early phase of the COVID-19 pandemic. According to Gonzalez et al. (2022), it has been used in Latin America mainly as a compassionate treatment with no evidence supporting its efficacy in the COVID-19 disease. According to Saxena et al. (2021), after administering a single dose of currently approved doses of Ivermectin there does not exist a significant virologic or clinical recovery in the COVID-19 disease.

Conspiracy theories circulating online exacerbate violence and lack of trust among healthcare workers. Hospitals are being vandalized and doctors are receiving death threats after their patients succumbed to the COVID-19 disease. Others are speculating that doctors are receiving a cash payment of around $16,975 for every dead patient with a COVID-19 diagnosis and that doctors are unnecessarily admitting COVID-19 patients to intensive care to receive an increase to their salaries (Taylor, 2020). Consequently, these fabricated stories have caused fatalities as patients avoid seeking care for fear of encountering unscrupulous doctors.

The mishandling of key information still thrives despite internet availability. In Africa, people living in rural areas tend to believe whatever information is trending in the community. Beliefs and culture can affect decision-making as regards following prevention strategies. A lot of sentiment and reverence for religious institutions and their leaders have been attached by people globally. According to Okereke et al. (2021), religious leaders have high credibility among their followers in Nigeria and Uganda. There is a risk that the congregation would violate health-promoting behaviors if a religious leader misunderstands scientific facts.

During this time of the COVID-19 pandemic, it is important for officials to be transparent and relay clear and truthful information to the public. Politicizing this COVID-19 pandemic is dangerous and messages from authorities must be consistent so that the public can regain trust in their respective government officials (Mian & Khan, 2020). Censorship on social media sites such as Facebook, Twitter, and YouTube has been ongoing to combat the prevailing misconceptions online. These include adding warning labels to sensitive content which is considered false and removing content contradicting health authorities (Niemiec, 2020).

The practice of healthy behaviors is being hindered by rumors and hoaxes regarding the COVID-19 pandemic. Poor physical and mental health outcomes ultimately result from the promotion of erroneous practices. Many people worldwide are panic-buying items, which are in some way related to sanitation to prevent the transmission of COVID-19. The use of hand sanitizers with greater than 60% ethanol or 70% isopropanol has been advocated by the Center for Disease Control. However, the misconception among the public that drinking alcohol-based drinks may be protective against COVID-19 resulted in more than 200 cases of methanol poisoning in Iran (Arasteh at al., 2020). This misconception in Chemistry regarding the COVID-19 pandemic is further elaborated in the next chapter.

According to Cha et al. (2021), it was reported that there is a strong relationship between health literacy and adverse health outcomes from infectious diseases. Debunking information is not spreading effectively and rapidly enough through the global population, which leads to misconceptions and causes further harm in other parts of the world. The current misconceptions surrounding the COVID-19 pandemic might prove to be especially harmful, as it tackles health-related behaviors that could lead to life-and-death consequences. Along with battling the COVID-19 pandemic, the world is also facing combat against misconceptions. These misconceptions could gain a strong foothold and overshadow reliable and trusted sources of health information. In line with this, information should be managed properly for accurate dissemination to the public.

This study explored the knowledge of COVID-19-related misconceptions among Chemistry undergraduates and how they applied their current learning experiences in dealing with and facing the misconceptions surrounding the COVID-19 pandemic. The research aimed to answer the following questions: (a) How well-informed are the Chemistry undergraduates regarding the COVID-19 pandemic? (b) How do Chemistry undergraduates react to and address the misconceptions surrounding the COVID-19 pandemic?

METHODS

Research Design. This study used a descriptive method of research. It was used to determine how well-informed the Chemistry undergraduates are about the COVID-19 pandemic, as well as how these Chemistry undergraduates react and respond when exposed to such misconceptions surrounding the COVID-19 pandemic.

Research Environment. This study was conducted at the University of Santo Tomas, the Royal Pontifical University of the Philippines, situated along Sampaloc, Manila, Philippines. The Department of Chemistry, under the College of Science, has a population of 252 students and 28 professors.

Research Respondents. The population for this study was undergraduate students, freshmen to seniors, majoring in Chemistry. The sample size was determined using the Raosoft sample size calculator, where certain parameters such as a 5% margin of error, 95% confidence level, and 50% response distribution were set and was based on the study of Bondah & Agyemang (2020). This study used simple random sampling with a sample size of 153 Chemistry undergraduates randomly selected. Each student number was assigned random numbers using Microsoft Excel. A random number table was made, with the numbers obtained using a random number generator.

Research Instruments. The research instrument used in this study consists of 3 sections - one test questionnaire and two different surveys. The test questionnaire consisting of 30 multiple-choice questions determined how well-informed the Chemistry undergraduates are regarding COVID-19. These are grouped based on 5 categories: Demographic, Diagnosis, Prevention, Transmission, and Treatment. The test questions mainly focused on the misconceptions surrounding the COVID-19 pandemic and were adapted from journal articles of Ali et al. (2021) and Baig et al. (2020). The first survey mainly focused on how the Chemistry undergraduates acquire such information regarding the COVID-19 pandemic, where they selected multiple answers while the second survey mainly focused on how the Chemistry undergraduates react and respond to the misconceptions surrounding the COVID-19 pandemic. They provided a short answer to these survey questions. The test questions adapted from Ali et al. (2021) and Baig et al. (2020) underwent a pilot study and Cronbach's alpha, which tested the questions' internal consistency, was found to be 0.80 and 0.81 respectively. Additionally, the research instruments were expertly validated by 2 Chemistry professors from local universities and 2 Chemistry professors from international universities. A few adjustments were made to the research instruments as per the advice of the professors.

Data Gathering Procedure. The selected Chemistry undergraduates were contacted through their school emails, informed about the objectives of the study, and given assurance of strict confidentiality. Filling out the questionnaire and surveys took about 10 to 15 minutes and implied their consent and permission to participate in the study. The research instruments were administered through Google Forms, where a short background of the study was included. The responses were limited to one and cannot be changed after submission. The data collection lasted for almost 2 weeks, starting from January 26, 2022, until February 6, 2022. The answers to the test questionnaire were checked and graded based on a scoring system shown in Table 1. On the other hand, the answers to the surveys were tallied and analyzed.

Treatment of Data. The test questionnaire scores were released immediately after submission. The students were able to view which questions were answered correctly and incorrectly. For each correct answer in the test questionnaire, one point was given. If the answer is incorrect, no point was given. Test questionnaire scores ranging from 1 to 14, which is below 50%, corresponded to poor knowledge, scores ranging from 15 to 22, which is 50% to 75%, corresponded to moderate knowledge, and test scores ranging from 23 to 30, which is above 75%, corresponding to good knowledge. Table 1 shows the interpretation of scores for the test questionnaire.

Table 1. Interpretation of Knowledge Scores

Score	Interpretation
1 - 14 (< 50%)	Poor Knowledge
15 - 22 (50% to 75%)	Moderate Knowledge
23 - 30 (> 75%)	Good Knowledge

The interpretation of scores was based on Baig et al. (2020). The data gathered from the test questionnaire and surveys were subjected to a statistical analysis using Microsoft Excel. To describe how well-informed, the Chemistry undergraduates are regarding the COVID-19 pandemic, frequency, percentage, mean, and standard deviation were used. The test questions with the greatest number of correct and incorrect marks were determined to evaluate what misconceptions were derived from the responses of students.

RESULTS AND DISCUSSION

Misconceptions of Chemistry Undergraduates about COVID-19. Among the misconceptions of Chemistry undergraduates about COVID-19, there are 4 frequently missed questions that garnered less than a 50% correct response rate. Results showed that students had the lowest correct response rate on the need to disinfect the surface of food packaging. Only 5.2% of the undergraduates answered this question correctly. Although reports claim that the SARS-CoV-2 virus thrives for up to 24 hours on cardboard and 72 hours on plastic in experimental setups under controlled humidity and temperature, there is still no evidence that contaminated food packages, which have been exposed to varying environmental conditions, spread the COVID-19 disease (Nakat & Bou-Mitri, 2021). As presented in **Table 2**, the order of misconceptions of Chemistry undergraduates regarding COVID-19 is arranged from the lowest correct response rate to the highest correct response rate. Most students (82.4%) believed that it is necessary to disinfect the surface of food packaging as the SARS-CoV-2 virus may be present in it. However, the current consensus is that the overall potential risk of transmission from contaminated food packaging appears to be very low as there are no known cases yet of contracting COVID-19 from food packaging (Anelich, Lues, Farber, & Parreira, 2020). It is more likely that an infected food handler will transmit the SARS-CoV-2 virus person to person rather than contaminated food packaging because the main mode of transmission of the SARS-CoV-2 virus remains primarily via respiratory droplets. Food businesses and authorities should ensure that good hygiene practices,

such as regular handwashing and effective hand sanitation, are still implemented despite the transmission of the SARS-CoV-2 virus through food packages is not identified as a risk factor. Other undergraduates (12.4%) believed that disinfecting food packages is not necessary because it may damage and contaminate the food inside.

Results also revealed that students had a low correct response rate on the transmissibility of the SARS-CoV-2 virus through water while swimming. Only 34.6% of the undergraduates believed that the SARS-CoV-2 virus cannot be transmitted through the water while swimming. Most students (39.9%) believed that the SARS-CoV-2 virus can be transmitted through the water while swimming as the respiratory droplets can spread in water. COVID-19 is not a water-dependent disease as health institutions already emphasized that there were no cases of SARS-CoV-2 infection through drinking recreational water of controlled quality such as water in swimming pools (Kowalski et al., 2021). Other undergraduates (25.5%) believed that the SARS-CoV-2 virus cannot be transmitted through the water while swimming because the SARS-CoV-2 virus dies when exposed to chlorinated water. The main problem associated with protection against the transmission of the SARS-CoV-2 virus in swimming pools is not related to water quality but rather the risk of infection posed by the human population itself (Kowalski et al., 2021). Hence, it is essential to limit the number of people staying in the facility at the same time and observe the principle of social distancing.

The other frequently missed questions among Chemistry undergraduates are with regards to the need for quarantine of live animals imported from countries with a high prevalence of COVID-19 and getting infected through touching a communal bottle of alcohol-based sanitizer. Mostly believed (46.4%) that food animals may be carriers of the SARS-CoV-2 virus, hence quarantine is needed for live animals imported from countries with high prevalence of COVID-19. Poultry such as chicken, turkey, duck, and quail are presumed to be not vulnerable to COVID-19 as they are not able to be experimentally infected (Hobbs & Reid, 2020). Also, the SARS-CoV-2 virus did not replicate in embryonated chicken eggs. Similarly, pigs are presumed to be not vulnerable to COVID-19 as they are also not able to be experimentally infected (Sreenivasan et al., 2021). Only 40.5% of the students believed that quarantine is not necessary for live animals imported from countries with a high prevalence of COVID-19 because they have not been implicated in the spread of the SARS-CoV-2 virus. Other undergraduates (13.1%) believed that quarantine is necessary for live animals imported from countries with a high prevalence of COVID-19 because quarantine is a health protocol that needs to be strictly followed.

Only 42.5% of the students believed that touching a communal bottle of alcohol-based sanitizer will not cause COVID-19 due to the sanitation of hands resulting in the disinfection of germs that may have been on the bottle. Other undergraduates believed that touching a communal bottle will cause COVID-19 because an infected person with the SARS-CoV-2 virus may have used it (30.7%) and due to the high risk of germs on communal items keeping everyone at risk (26.8%).

On the other hand, Chemistry undergraduates are most informed on the need for children and young adults to take preventive measures against the infection of the SARS-CoV-2 virus. All students (100%) believe that it is necessary for children and young adults to take precautionary measures against the infection brought by the SARS-CoV-2 virus. According to Miao et. al (2020), children are no exception when it comes to general susceptibilities in all groups. Current data reported that infected populations span from ages 36 h to 96 years having no significant difference in gender. The main mode of infection in children is close family contact.

Table 2. Order of Misconceptions of Chemistry Undergraduates about COVID-19

Questions	*Correct Answer*
Is it necessary to disinfect the surface of food packaging?	5.2%
Can the SARS-CoV-2 virus be transmitted through the water while swimming?	34.6%
Is quarantine necessary for live animals imported from countries with a high prevalence of COVID-19?	40.5%
Will I NOT get infected if I touch a communal bottle of alcohol-based sanitizer?	42.5%
Could shoes transmit the SARS-CoV-2 virus?	51.0%
Does the amount of alcohol-based sanitizer you use matter?	51.6%
Does rinsing the nose with saline NOT prevent COVID-19?	62.1%
If a person's COVID-19 test is negative, does it mean he/she is free from the SARS-CoV-2 virus?	63.4%
Could ascorbic acid (vitamin C) cure COVID-19?	66.0%
Can probiotics help prevent COVID-19?	70.6%
Can direct personal exposure to ultraviolet lamps protect me from COVID-19?	77.1%
Could COVID-19 be prevented through the consumption of ginger?	77.8%
Can spraying bleach all over my body protect me from COVID-19?	79.1%
Can healthy individuals infected with the SARS-CoV-2 virus wind up in hospital?	83.0%
Could sipping water every 15 minutes protect me against COVID-19?	84.3%
Could the SARS-CoV-2 virus be transmitted through houseflies?	84.3%
Can COVID-19 be prevented and treated using antibiotics?	86.3%
Is it safer to wear gloves than to frequently clean your hands?	88.2%
Can the SARS-CoV-2 virus be transmitted in areas with sunny and humid climates?	89.5%
Is Ivermectin an effective treatment against the SARS-CoV-2 virus?	90.8%
Could COVID-19 be avoided by frequent hand washing with soap?	92.8%
Can disposable face masks protect me against COVID-19?	92.8%
Can thermal scanners diagnose COVID-19?	93.5%
Does a symptomless patient transmit COVID-19?	94.1%
Are flu and pneumonia vaccines sufficient against the SARS-CoV-2 virus?	94.1%
Does being able to hold your breath for 10 seconds without coughing mean you are free from COVID-19?	96.7%
Should people who have contact with someone infected with the SARS-CoV-2 virus be immediately isolated in a proper place?	98.0%
Can any type of group activity spread COVID-19?	98.0%
Are females more susceptible to COVID-19?	99.3%
Is it necessary for children and young adults to take measures to prevent infection by the SARS-CoV-2 virus?	100%

Sources of Information Used by Chemistry Undergraduates Regarding COVID-19. The sources of information used by Chemistry undergraduates regarding COVID-19 are exhibited in Figure 1. Internet browsing had the highest votes among Chemistry undergraduates, garnering 134 votes. This is followed by social media obtaining 132 votes, health units with 113 votes, and television stations having 105 votes.

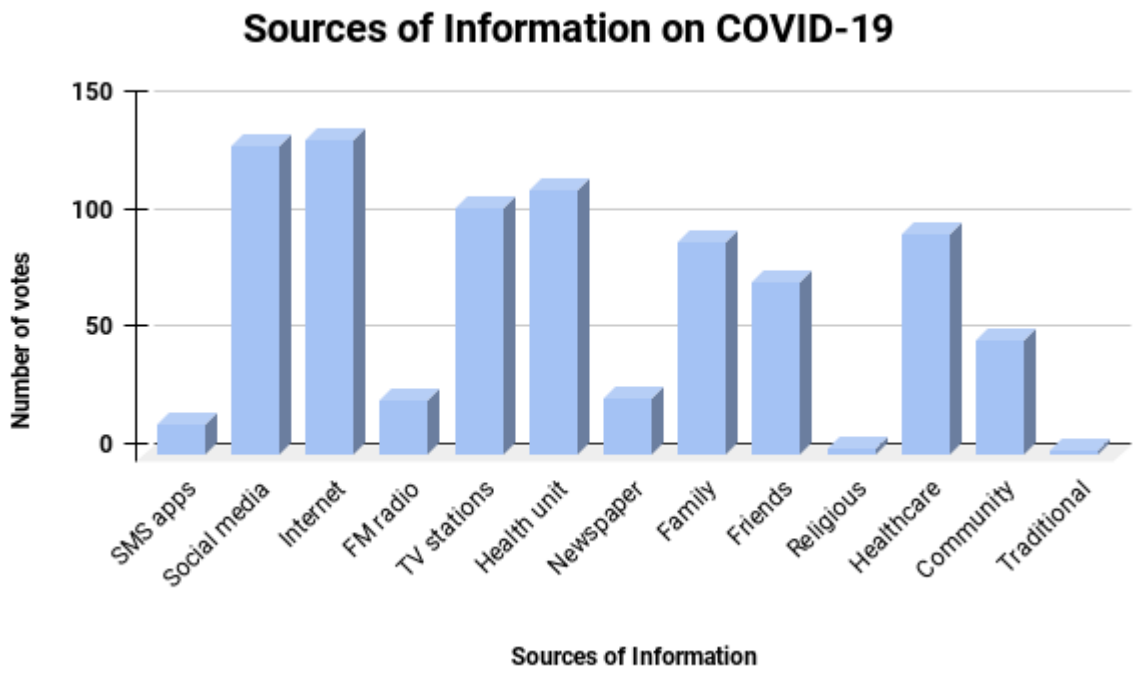

Figure 1. Sources of Information of Chemistry Undergraduates about COVID-19

In related studies, the Internet is the primary source of information for young patients afflicted with the SARS-CoV-2 virus in Wuhan, China (Zhong et al., 2021). According to Alwani et. al (2020), health units and social media are the two major sources of information about COVID-19 among nurses in Pakistan. According to Thomas et al. (2021), the most frequently reported source of information regarding COVID-19 for Australian adults is television stations. On the other hand, only 23% of Australian adults reported social media as a top 3 source of information regarding COVID-19 and less than a quarter ranked it as their first source of information regarding COVID-19. However, for university students in Jordan, their most common source of information about COVID-19 is social media followed by mass media such as television stations (Olaimat et al., 2020).

Other sources of information used by Chemistry undergraduates regarding COVID-19 are the following: healthcare workers (94 votes), family members (91 votes), friends (74 votes), community leaders (49 votes), newspapers (24 votes), radio stations (23 votes), and SMS apps (13 votes). Religious leaders and traditional healers garnered the lowest votes as sources of information regarding COVID-19 among Chemistry undergraduates, with 3 votes and 2 votes respectively.

According to Olapegba et. al (2020), mass media such as radio stations and newspapers are the most common sources of information about COVID-19 for Nigerians. According to Chandler et al. (2020), about 33% of Black women use family members, friends, and SMS apps as their source of information regarding COVID-19. On the other hand, according to Ebrahim et. al (2020), family members, friends, and newspapers are associated with a low COVID-19 information reliance among parents living in Bahrain.

Level of Knowledge of Chemistry Undergraduates About COVID-19. Statistical analysis showed 23 out of 30 as the average score obtained from the test conducted among Chemistry undergraduates with a standard deviation of 2.90. The frequency distribution of test scores is shown in Figure 2. There are 3 students who obtained a score between 1 to 14, thereby having a

relative frequency of 1.96% and a poor level of knowledge regarding COVID-19 since they obtained a score of less than 50% of the total points. On the other hand, 55 students obtained a score between 15 to 22, thereby having a relative frequency of 35.95% and a moderate level of knowledge regarding COVID-19 since they obtained a score between 50% to 75% of the total points. And lastly, 95 students obtained a score between 23 to 30, thereby having a relative frequency of 62.09% and a good level of knowledge regarding COVID-19 since they obtained a score above 75% of the total points.

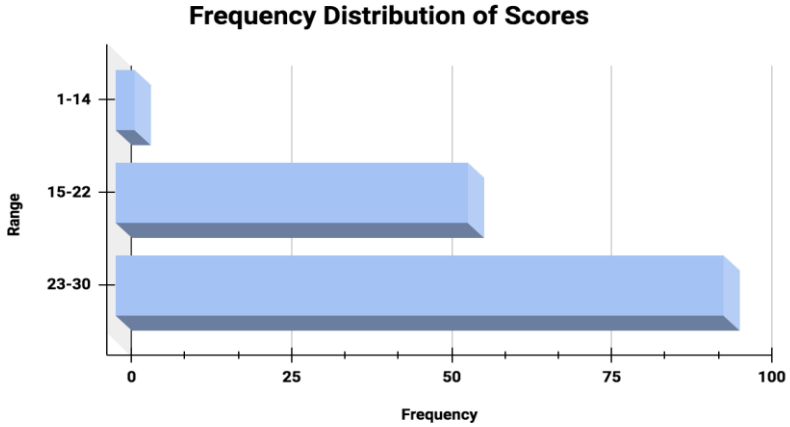

Figure 2. Frequency Distribution of Test Scores among Chemistry Undergraduates

Addressing the Misconceptions Regarding COVID-19. Based on the survey conducted among Chemistry undergraduates, reliance on reliable sources and research are the most frequent answers when asked what their ways are in countering misconceptions about COVID-19. Reliance to reliable sources is essential during this time of public health crisis to avoid serious and harmful consequences. According to Ferreira Caceres et al. (2022), information disseminated through a reliable source helps empower people to make important public health decisions. Researching can come in many ways and one of them is by using the "related articles" feature on Facebook. This feature suggests additional related readings on a user's news feed (Greenspan & Loftus, 2021). This is followed by fact-checking and source credibility checking as their ways to counter misconceptions about COVID-19. Misconceptions can be prevented by fact-checking information before sharing it or when encountered (Tully et al., 2021). However, it can be of limited use as people are motivated to defend their preexisting beliefs (Krause et al., 2020). Another problem is uncertainty, as new information continuously emerges, old information then becomes inaccurate. According to Lewandowsky et al. (2020), although people do not regularly track and evaluate source credibility, online evaluation of sources can be challenging but can be taught.

The Chemistry undergraduates also answered the following ways to counter misconceptions about COVID-19: educating other people, listening to experts, online campaigning, and information verification through credible sources. Online campaigning involves information sharing on digital platforms. Similar to the study of Hadlington et al. (2023), the students believed that sharing information regarding the COVID-19 pandemic on digital platforms benefits other people, in such a way that the students try to keep other people informed to protect themselves against COVID-19. Educating other people includes private conversations taking place with people the students believed would understand the information shared with them such as their family members and friends, whereas in online campaigning, the audience is much wider (Hadlington et al., 2023).

Information verification through credible sources is a strategy answered by Chemistry undergraduates to prevent misconceptions wherein the assessment of the accuracy of information is achieved by comparing facts across evidence sources. The students also believed that listening to experts is a countermeasure against misconceptions regarding the COVID-19 pandemic, which is similar to the study of Hadlington et al. (2023), wherein the students put a high value on the experiential information provided by qualified medical and other healthcare professionals through access to their on the ground experiences, which are the truest accounts of what to do and what is occurring about the COVID-19 pandemic.

Other answers among Chemistry undergraduates include reporting, ignoring, using different sources, and transparency as ways to counter misconceptions about COVID-19. A student answered that transparency about the whole pandemic situation can counter misconceptions surrounding it. The answer also emphasized that vagueness and opaqueness only fuel fear. According to Ferreira Caceres et al. (2022), the primary issue regarding this is the lack of relevant information. There is no quality information about COVID-19 by February 2020. Education resources are limited, and campaigns are often based on what is not accurate and evidence-based. Ignoring online misconceptions about the COVID-19 pandemic is a countermeasure wherein people distance themselves from such misconceptions to avoid confrontation and conflict due to other people's disagreement with interpretations of information (Hadlington et al., 2023).

The Chemistry undergraduates also believed that utilizing various sources of information can help prevent misconceptions wherein looking at other reports is an example. A clue that may be taken to identify content falsification is that other sources do not report the same information. The audience can trust a particular source of information if the content is reflected by many other sources. A strategy that is also provided by the students is reporting people who spread misconceptions online. Social media users can report anyone who spreads information that is not in coalition with public health information. The digital platforms will then assess and take necessary actions (Desai et al., 2021).

Implications to Chemistry Education. Chemistry education plays an important role in addressing misconceptions and misinformation in many aspects of societal issues, especially with the information on the Covid-19 pandemic. Chemistry education remains relevant to public health through such things as vaccines, biomaterials, drug design, drug delivery, chemicals for disinfections, and a plethora of new technologies to help improve life. Science teachers in general and Chemistry teachers in particular play a crucial role as they are the ones who are the first line of information available for students to learn the correct concepts surrounding many issues of the pandemic. Discussions on the effect of disinfectants especially for foods and food packages should be done in the class. Also, the correct percentage composition of disinfectants and sanitizers is necessarily discussed, as this may pose more harm than good. Chemistry teachers should develop in their students discernment and critical thinking when presented with the concepts and information they find on the internet by encouraging them to do thorough research from reliable sources such as scientific journals. Group tasks, such as group discussion, infographics, or reporting, can be done in class to bring out what students know and what misconceptions may arise during the discussion so that these will be addressed immediately. It is very salient for science educators to be updated on current issues so as to provide the correct and specific scientific basis for the issues at hand and mitigate misconceptions of students.

CONCLUSIONS

This study was able to determine the level of knowledge of Chemistry undergraduates on COVID-19-related misconceptions. There are 4 frequently missed questions among Chemistry students which are the need to disinfect surfaces of food packaging, the transmissibility of the SARS-CoV-2 virus through water while swimming, the need for quarantine for live animals imported from

countries with a high prevalence of COVID-19 and getting infected through touching a communal bottle of alcohol-based sanitizer. The main information source for Chemistry undergraduates about the COVID-19 pandemic is internet browsing. Overall, the undergraduates have a moderate to a good level of knowledge since they are exposed to several science courses and were trained to discern good and bad information from available literature despite being exposed to the internet and social media. The Chemistry undergraduates mainly address misinformation regarding the COVID-19 pandemic by depending on reliable sources and doing their own research.

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