

STUDENTS' PERCEPTION OF DIGITAL TOOLS USED WITH ONLINE TEACHING METHODOLOGIES IN A PANDEMIC CONTEXT: A CASE STUDY IN NORTHERN CHILE

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Abstract

In 2020, in the context of the COVID-19 pandemic, it is of interest to understand how students perceived the access, use, and utility of digital tools in online teaching. This study provides an insight into the needs of students in adjusting to online teaching.

This study presents the methodological design of the course “Industrial Hygiene I,” part of a technology-based engineering bachelor’s degree from Universidad Católica del Norte (Chile). Once the theoretical framework was established, three surveys were designed throughout the course to measure students’ perceptions of the access, use, and utility of digital tools used in online teaching during the pandemic. Thirty-five students participated in this quantitative study.

Following a data analysis, it was observed that 46% of students use their cell phones to access virtual classes and more than 50% are dissatisfied with the internet connection; therefore, it was necessary to adapt the learning methodology. After that, more than 50% of the students said that they preferred a flipped classroom over traditional methodology. In addition, the quality of the course was not affected by using the internet (60%), and the methodology generates advantages in terms of learning (72%).

These findings have several implications in both the design of different subjects in the engineering degree and the practice of different learning methods. Future hybrid teaching designs require taking up the challenges of both improving technology-supported teaching and assessing competence in the same context.

Keywords – Learning methodology, Digital tools, Student perception, Flipped classroom, Virtual teaching, Pandemic.

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1. Introduction

While competency-based designs are currently widely used in the planning of educational documents, the literature indicates that teaching has not yet fully complied with the principles of competency development. For instance, many assessment practices still follow a traditional approach. The use of complex and contextualized methods in the implementation of Competency-Based Assessment (CBA) is still insufficient. The reasons for this include (1) a lack of teaching practices to contrast student performance with defined competencies (Bautista, Santa-María & Córdova, 2021) (2) institutional impediments (e.g. implementation of learning plans, weak teacher coordination) (Sánchez-Santamaría, 2011) and (3) insufficient evaluative literacy and counterproductive evaluation concepts (Baughan, 2020). The above situations constituted a problem in face-to-face educational settings, which were exacerbated by the first closure due to COVID (García-Peñalvo, Corell, Abella-García & Grande, 2020).

Furthermore, good evaluation and feedback practices have been noted (Evans, 2013). Together with students' learning outcomes, transparency, diversity, and participation, these practices contribute to improving performance and fostering the development of skills (Pereira, Flores, Simão & Barros, 2016). The methodological strategies, supported by the learning conditions of the recipient, help improve the quality and performance of the knowledge acquired (Sánchez-Otero, García-Guiliani, Steffens-Sanabria & Hernández-Palma, 2019). In this context, both a change of mentality in students and dynamics inside the classroom must be gradually promoted for an adequate transition towards non-traditional education methods (Reinoso-Tapia, Collazos-Martínez, Martínez-Martínez & Delgado-Iglesias, 2021). Spector, Ifenthaler, Samspon, Yang, Mukama, Warusavitarana et al. (2016), Pinto and Leite (2020), and Abtokhi, Jatmiko and Wasis (2021) consider that available technologies can help develop new skills such as critical thinking, motivation, and problem-solving, which contribute to improved performance. But achieving this goal is a matter of pedagogy, not technology. It's about designing new learning environments that provide personalized support to students. However, despite the benefits of virtual assessment practices that have already been pointed out, technology could have a transformative role in evaluation processes, but it seems that this purpose is not achieved (Gros & Cano, 2021).

The COVID-19 pandemic led to the sudden suspension of face-to-face classes, and in response, a new teaching-learning scenario was created. Despite the progress of the twenty-first century, virtual teaching is not a requirement in many universities. However, this scenario generated an opportunity to change the classroom (Tang, Zhao, Xie, Zhong, Shi, Liu et al., 2020) and to implement experiences in which students' autonomous work was given a more active and committed role. However, as the change was abrupt, online learning experiences were not carefully planned and even less so the assessment practices to understand the personal situation of every student. Alshou, Abbas and Alfayly (2022) stated that the sudden change to an online methodology failed to identify those students with: (1) little interest in electronic learning platforms, (2) poor or no internet connection, (3) technical problems in the student's day-to-day life.

After the first semester of the pandemic, universities had to incorporate combined learning, with both synchronous and asynchronous scenarios, devices, and strategies in order to prevent future short-term lockdowns or even individual isolation. Consequently, assessment practices should be designed following the principles of e-learning and not directly importing face-to-face practices. Synchronous sessions, for example, had to adjust duration, content and encourage peer interaction with discussions and activities in small groups rather than general speech. In addition, assessment activities and learning activities had to integrate the formative purpose of lifelong learning, i.e. assessment for learning, and the peculiarities of e-learning. But to do so, it is necessary to know the situation and perception of students.

During the lockdown semester and even the consecutive academic year, teachers' interests in online assessment have sometimes focused more on electronic monitoring devices and strategies than on promoting formative assessment and scaffolding strategies to adjust online teaching in the virtual context. First, there is a need to promote technology-based assessment systems (Biggs, 2003; Chernov, Klas & Furman-Shaharabani, 2021) aligned with the active methodologies that many instructors already use in

face-to-face teaching (e.g. project-based learning, problem-based learning, flipped classroom, cooperative learning). Second, the pandemic highlighted the importance of developing generic competencies. For example, lifelong learning competency, responsibility, and communicative competency, among others, have become fundamental during this period. Indeed, it is necessary to understand the perception of students in order to design new and efficient (and not reused) evaluation proposals, adjusted to the situation and according to the agenda.

This global health emergency highlighted the vulnerabilities and challenges that are facing our communities. A clear picture of existing inequalities has been visualized, and an even clearer picture of the path we must follow, “the main one aimed at the education of more than 1.5 billion students whose learning has been hindered by the closure of schools” (UNESCO, 2020a: page 3). In fact, “about 40% of low- and lower-middle-income countries have not taken any measures to support students at risk of exclusion during the COVID-19 crisis” (UNESCO, 2020b: page 1).

The situation of isolation, together with the digital divide and mental illness caused by the pandemic, generated greater sensitivity towards the need for inclusive frameworks. In tertiary education, alternatives have been proposed to continue learning at a distance, but, according to Ordorika (2020), the replacement of face-to-face has posed enormous technological, pedagogical, and competence challenges. The confinement of students in their homes impacts their education, influencing academic performance and university dropout (Giannini, 2020; Giannini & Ablrectsen, 2020).

This study focused on the course “Industrial Hygiene I,” part of the degree in technology-based engineering from Universidad Católica del Norte. The students enrolled in the degree are frequently from urban centers, as well as from rural areas. Training professionals in these characteristics implies developing the acquisition and application of knowledge and skills that allow them to be constantly up to date and demonstrate initiative to adapt flexibly to the demands of the environment. That is why in the current curriculum, there are basic science courses, to contribute to competencies, such as the development of deductive logical thinking; providing tools to successfully face problems that require analytical capabilities and innovation and obtaining sufficient capacity. Engineering science courses seek to help the student to integrate into multidisciplinary groups, to study and to solve basic engineering problems. Applied engineering courses provide the preparation and tools needed to update and deepen knowledge in the degree area. Finally, general training courses contribute to competencies in ethical values, continuous learning, and communication.

In 2020, due to the COVID-19 pandemic, Chilean universities were forced to close their doors and switch to virtual classes, with students attending classes from their homes (Avendaño, Luna & Rueda, 2021). This situation forced universities to review and design strategies, create methodologies and didactic resources appropriate for the teaching-learning process, and consider the profile of the students, some of whom come from rural areas. COVID-19 affects everyone, without distinction of social status, but its consequences are different depending on socioeconomic position and place of origin (Herrero, 2020). That is why it is necessary to analyze the internet network connectivity, computer equipment, and student skills in using electronic devices.

The suspension of face-to-face classes made it necessary to propose other options for students to attend university classes from home. Entrusting all the teaching methodology to online lessons, educational platforms, digital resources, apps and student WhatsApp groups can be somewhat dangerous because there are homes without a computer, families that have to share a computer with all members of the household and families that do not have an Internet connection (Asuar, 2020; Nogueira, 2020). The economic deficit as a result of the pandemic caused many households to go through periods of unemployment. In addition to this, lockdowns forced people to simultaneously establish work, family, and student activities in the same space, causing obstacles in the reconciliation between work, family and studies which are emphasized by the limitations of personal space that favor focus at home. These events led to increased levels of stress, anxiety, and depression in university students (Vivanco-Vidal, Saroli-Aranibar, Caycho-Rodríguez, Carbajal-León & Noé-Grijalva, 2020). In this context, it became

necessary to empathize with, understand and care for the educational space, if we want to avoid a new socio-educational gap that causes greater inequality in access to learning and fewer educational opportunities for all students.

Therefore, this study analyzed students' perception of access, use and utility of digital tools during the pandemic. This was addressed through a dynamic study on the needs and requirements of students and involved implementing immediate measures such as (1) supporting the early detection of students without access or with low internet connectivity, (2) knowing the devices with which they access the internet, thus being able to adapt methodological tools to their competences and, (3) finally, adapting these tools to the student's internet skills (scaffolding).

2. Design/Methodology/Approach

The "Industrial Hygiene I" course is taken in the first semester of the third year of the degree and consists of 5 SCT-Chile credits. In 2020, there were 35 students enrolled (22 women and 13 men), with an average age of 23.1 ± 3.4 years. Of the total number of students, 17.14% were enrolled for the second time, 11.43% for the third time and 71.43% were taking the course for the first time. In all their courses, the students used the learning management system (LMS) EDUCA, developed by Claroline, as an e-learning platform and occasionally used a tool called Kahoot! in face-to-face classes.

In 2020, 82% of the students who took the course were most frequently came from urban centers in the Atacama and Coquimbo region, and 18% from rural areas. In rural areas, internet connectivity is low-quality and access is expensive. Given this socio-economic reality, 70% of students accessed financial support scholarships, which is also part of the 60% of families that receive lower income in Chile (Arzola, 2021). In addition, as teaching was drastically digitalized due to the pandemic, the university provided additional scholarships on top of the traditional ones, to support internet access and thus improve distance learning. In this scenario, 27% of the students in the course accessed this type of support. Along with the above, and given the restriction of face-to-face meetings, virtual informal communication amongst students through social networks was enhanced.

The methodology used was the flipped classroom, planning for 17 weeks with a direct academic load of 2.25 hours (3 sessions of 45 min) and 5.25 hours of weekly autonomous work. Pedagogically, two types of sequential work were designed: autonomous work and synchronous virtual work via Zoom (Figure 1).

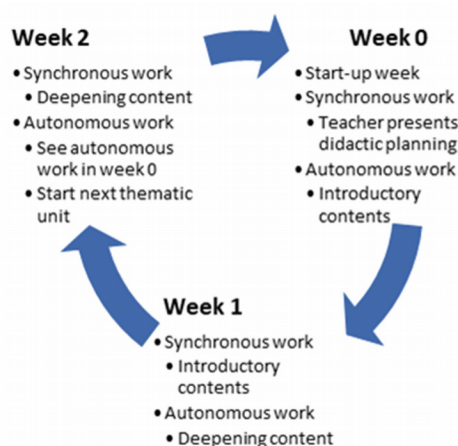


Figure 1. The temporal sequence of autonomous work and synchronous virtual work during the flipped classroom semester

Autonomous work consisted of a review of theoretical contents before the start of each unit through the use of Google Sites and practical activities using tools such as Google Forms, Edpuzzle, Kahoot!, Socrative, and Youtube videos made by the teacher. In order to optimize the synchronous sessions, using a

Google form, the students evaluated their work, declared the hours occupied for the activities and the doubts they had in their execution. The sequence of autonomous work is shown in Figure 2.

During synchronous work, sessions were planned with three phases, as shown in Table 1.

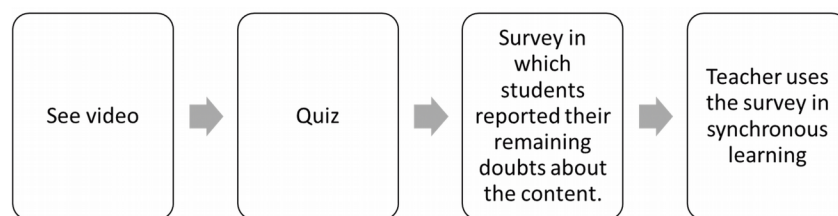


Figure 2. The sequence of activities in the development of the student's autonomous work

Phase	Methodology used	Purpose	Duration
Beginning	Exhibition	Feedback on autonomous work	15-20min
Middle	Problem-based learning	Deepen the concepts addressed in group work	15-20 min
Final	Conclusion and Group Discussion	Generate meaningful learning based on discussions. Use the debate as input for the next freelance work.	5-10 min

Table 1. Phases of a synchronous class

Based on the characterization obtained from the students and the need to use digital tools given the context of the pandemic, three types of surveys were applied (Figure 3) to analyze the perception of the students. All were registered using the Google form, with open and closed questions with a Likert scale without a neutral category (Hernández-Sampieri, Fernández-Collado & Baptista-Lucio, 2013). In the closed questions section, to evaluate the statements about their perception, they were quantified from 1 to 4, where:

- 1: Strongly disagree
- 2: Moderately disagree
- 3: Moderately agree
- 4: Totally agree

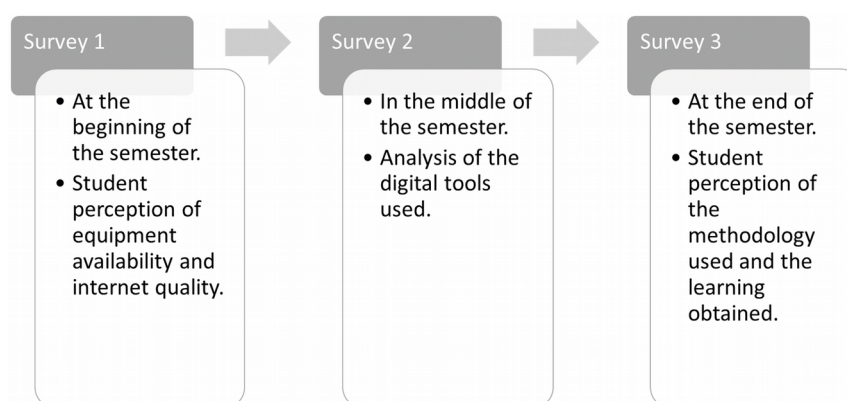


Figure 3. Description of the surveys applied in the course

On the first day of class, students were surveyed regarding their attitudes on the use of computer devices, access to and quality of internet connection, availability and self-efficacy in managing the devices. The questions referring to these factors described by Zambrano (2016) were used and adapted to the specific context of this study, as shown in Table 2.

Survey 1: Student attitude	
Analysis factor	Questions
Perception of the virtual system	(A) It is easy for me to manage web platforms. (B) It's easy for me to learn how to use web platforms (C) It's easy for me to get a web platform to do whatever I want. (D) It is easy for me to use a web platform.
Perception of virtual utility	(E) I usually do the activities on a mobile phone before other means such as a tablet or notebook. (F) The use of web platforms will improve my performance in the course. (G) Using web platforms will increase my productivity. (H) Web platforms are useful for the course. (I) This course assesses my learning in many different ways (quizzes, deliverables, oral tests, etc.).
Device availability and internet quality	(J) I am satisfied with the speed of my Internet connection. (K) I feel that the quality of communication over the Internet is not good. (L) I feel that the cost of Internet connection is very expensive. (M) I feel that it is easy to connect to the Internet. (N) I usually connect using my mobile data.

Table 2. Dimensions analyzed in survey 1 (Zambrano, 2016)

Based on the results obtained in survey 1, tools were selected that the students in the course could access, which were free applications available on the Internet. Their use was adjusted based on the students' needs and realities (device availability and internet connectivity). In the middle of the semester, survey 2 was taken to evaluate their perception of the tools used, based on what was described by Salcide-Talledo, Cifrián-Bemposta, González-Fernández & Viguri-Fuente (2019), as shown in Table 3.

Survey 2: Students' perception of computer tools
Have the following materials, methodologies and platforms used during the course helped me in the subject?
<i>Closed questions</i>
(A) Videos with lesson development (Screencast)
(B) Complementary activities in class (exercises, explanation of concepts that are not clear in the videos...)
(C) Kahoot!
(D) Socrative
(E) Nearpod
(F) Crossword puzzles
(G) Information provided on the online platform.
(H) The information provided on the Google Site (Ex: https://sites.google.com/view/agentesqumico/home)
(I) Group work
(J) Do you prefer a “flipped classroom learning” teaching method over the traditional teaching of lessons in class and individual activities at home?
<i>Open-ended questions</i>
Select those 3 tools that have helped you the most in your learning.
Comments on the different materials, methodologies, and platforms used.
Indicate perceived advantages and disadvantages in each of the tools used. Indicate the tool (Kahoot!, Socrative, videos, etc.) when commenting.
Regarding the role of the student in the use of the tools
(K) Have I watched all the videos before the classes?
(L) Do I always use the videos about the contents of the course at home?
(M) Do I take notes when I watch the videos related to the course?
(N) The information I have received on the application of this methodology has been clear, concise and complete.
(O) I prefer “flipped classroom learning” teaching method over the traditional teaching of lessons in class and one-on-one activities at home.

Note: (1) The online platform is the LMS used in 2020 by the Universidad Católica del Norte, developed by Caroline

Table 3. Dimensions analyzed in survey 2 (Salcide-Talledo et al., 2019)

Table 4 shows survey 3, based on other studies, which was given to students on the last day of classes to find out their perception of both the methodology and their own learning process (Zambrano, 2016; Salcide-Talledo et al., 2019).

Survey 3: Students' perception of the various methodologies
<i>Closed questions</i>
(A) The methodology used is a new classroom concept that has helped me to better understand the part of the course in which I used it. (B) I believe that with this methodology I have learned more than in the traditional methodology. (C) I consider that with this methodology I have had additional advantages in learning such as increasing the ability to use the materials learned, interest and aptitude towards the subject. (D) The introduction of this methodology has helped update the course. (E) I am more motivated to study Industrial Hygiene I when I do a flipped classroom. (F) The methodology used gives me better opportunities to debate with my colleagues.
<i>Student's perception of internet use and tools</i>
<i>Closed questions</i>
(G) My overall assessment of the videos used in the course is very positive. (H) Comparing your learning experience of face-to-face and virtual classes, do you think that the teacher of this course correctly uses the web to teach? (I) The use of the Internet in this course has improved its quality compared to other courses. (J) The quality of the course was not affected by using the Internet. (K) I feel that the information technologies (computers, cell phones, Internet connection, etc.) used in the courses have been easy to use. (L) I feel that the information technologies used in Internet courses have many useful functions. (M) I feel that the information technologies used in internet courses are flexible to everyone's time. (N) I feel that the information technologies used in internet courses are easy to access.
<i>Open-ended questions</i>
Comments and Opinions on the "Flipped classroom learning" methodology, Indicate advantages and disadvantages.

Table 4. Dimensions analyzed in survey 3 (Zambrano, 2016; Salcide-Talledo et al., 2019)

2.1. Data Analysis

To validate the internal consistency and reliability of the surveys, the Cronbach α Index was calculated in the three surveys applied (Zambrano, 2016).

The data collected from the surveys were analyzed descriptively using percentage graphs. For the analysis, the answers "moderately in agreement" and "agreement" were grouped into a single answer: "in agreement." This was also done with the questions "moderately in disagreement" and "disagreement," into a single answer: "in disagreement." For the statistical analysis, contingency tables were used to observe if there is a dependency relationship between the variables and the Mann-Whitney U test to determine if there are significant differences, both at 95% confidence. For both statistical analyses, the free software Past 2 was used. To perform the analyses, the variables gender and number of times enrolled were used and compared with the questions referring to:

- The perception of the virtual system of the survey 1
- Survey Tool Preferences 2
- The perception of the students regarding the methodology used in the survey 3.

If the contingency tables showed relationships of statistical dependency, Cramer's V was calculated to establish the degree of dependence.

3. Results

The results of the study were divided into four parts. First, the reliability of the surveys taken and the scales selected were analyzed (section 3.1.). In the case of obtaining high reliability in the tool used, a descriptive and statistical analysis was carried out for each of them (section 3.2., 3.3., 3.2.).

3.1. Survey Consistency

The Cronbach α Index showed a high internal consistency, greater than 0.7 (Kline, 2013), as shown in Table 5.

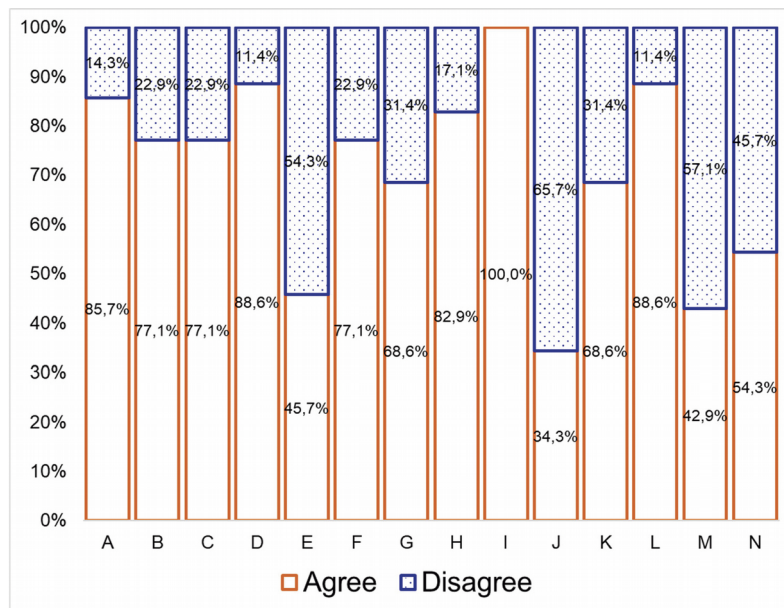
	The attitude of students towards the perception of the virtual system and the availability of devices (Survey 1)	Students' perception of computer tools (Survey 2)	Students' perception of the various methodologies (Survey 3)
α Cronbach	0.984	0.989	0.984

Table 5. α Cronbach from the surveys used

All surveys presented a Cronbach α index greater than 0.984. This result shows that they have high internal consistency and there is a high correlation between each question. That is, a very high Cronbach α index, as in the one obtained in this study, indicates that the questions asked in each of the surveys meet the objective for which they were designed.

3.2. Descriptive and Statistical Analysis on Students' Perception of the Use of Virtual Systems and Device Availability (Survey 1)

The results of the students' attitude towards the use of computer devices; access and quality of the Internet; availability and self-efficacy in using the devices are shown in Figure 4.



Note: A: It is easy for me to manage web platforms. B: It's easy for me to learn how to use web platforms. C: It's easy for me to get a web platform to do whatever I want. D: It's easy for me to use a web platform. E: I usually do the activities with on a cell phone before other means such as a tablet or notebook. F: Using web platforms will improve my performance in the course. G: Using web platforms will increase my productivity. H: Web platforms are useful for the course. I: This course assesses my learning in many different ways (quizzes, deliverables, oral tests, etc.). J: I am satisfied with the speed of my internet connection. K: I feel that the quality of communication over the Internet is not good. L: I feel that the cost of internet connection is very expensive. M: I feel like it's easy to connect to the internet. N: I usually connect using my mobile data.

Figure 4. Survey 1 results: the perception of the use of virtual systems, device availability and internet quality.

In all the questions related to the perception of the use of virtual systems (questions A to D), more than 70% reported that they agreed. Regarding the perception of the usefulness of virtual spaces (questions E to I), more than 69% reported that the use of these spaces improves performance,

productivity, utility and diversifies the methods of evaluations. However, when asked about the mobile devices used to access virtual media, 46% stated that they used their mobile phone (E). This fact caused teachers to select tools suitable for use in these devices. About the questions related to device availability and internet quality (question J to N), more than 50% of the students were dissatisfied with the speed, quality, and ease of communication and the costs associated with internet consumption and access. Specifically, 68.6% reported their disagreement the question on communication using the Internet (K). This fact caused teachers to redesign the methodology to reduce group activities. The autonomous activities, originally group activities, were redesigned to be executed as individual activities and to fit SCT-Chile credits. The videos originally designed for viewing on Drive were instead uploaded to YouTube as they consumed less internet. Activities in the synchronous virtual sessions were maintained as group activities.

The statistical analysis (contingency table and Mann Whitney U test) showed that there are no dependency relationships or statistically significant differences between the perception of the virtual system (question from A to D) and the gender of the student, nor between the perception of the virtual system and the number of times the student had enrolled in the course.

Once the first survey was analyzed, the indicated methodology was maintained and the tools were selected as shown in Figure 5. For autonomous work, individual activities were designed. To explain the basic concepts, videos were prepared and uploaded to YouTube, as shown in Figure 6. Along with the videos, basic questionnaires were prepared to strengthen key ideas using assessment questionnaire platforms. The synchronous sessions were held via Zoom and were structured in two parts; expository classes to resolve doubts and group work to solve problems.

In the week of expanding concepts, problems were presented on the Google Site platform and were answered in Google form. Synchronous classes on deepening concepts were designed in the same way as synchronous classes on basic concepts.

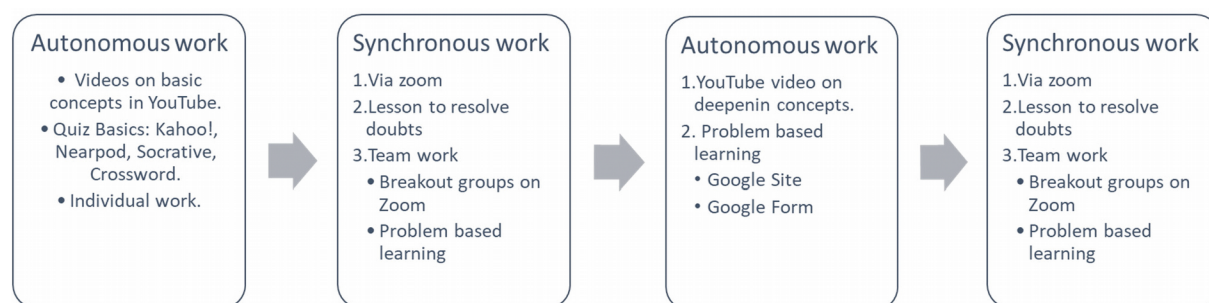


Figure 5. Selection of tools according to the initial survey for a learning sequence

3.3. Descriptive and Statistical Analysis on the Use of Digital Tools (Survey 2)

To determine if the tools were useful for student learning, a second survey was conducted in the middle of the semester on the digital tools used in autonomous work. More than 50% of the students agreed that the tools were helpful for the course (questions A, C, D, E, F, H) (Figure 7). Particularly in respect to videos, more than 90% used them (questions K, L) and also took notes on them (question M).

When the students were asked about their preferences among the tools, the class videos, the Kahoot! and feedback from synchronous classes were the most selected by students, 26%, 21%, and 8% frequency, respectively. The statistical analysis showed that there are neither dependency relationships nor statistically significant differences between the preference of the tool and the gender of the student, nor between the preference of the tool and the number of times enrolled in the course.

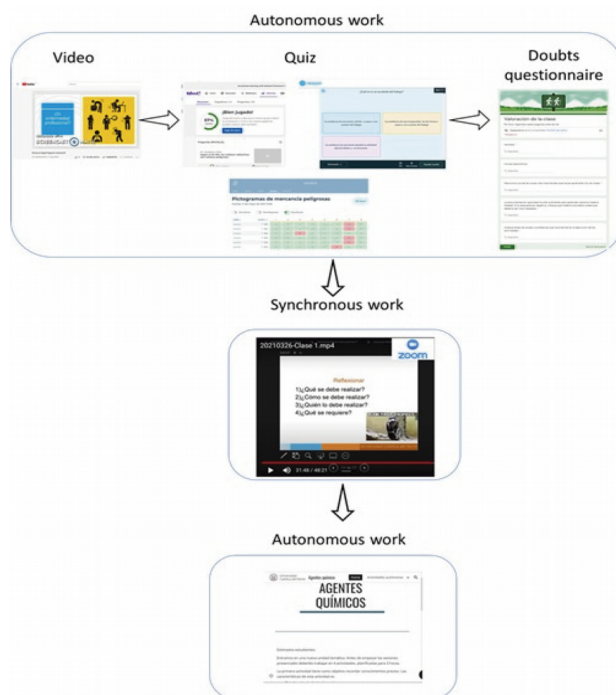
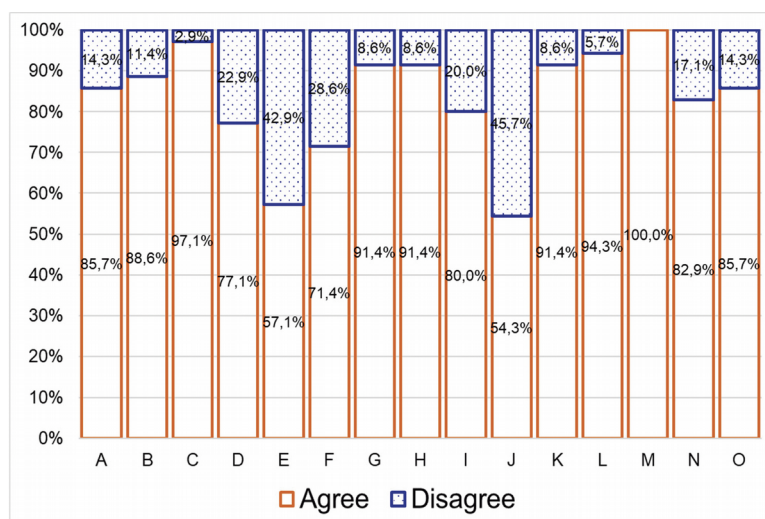


Figure 6. Example of activities and tools used in a learning sequence

Regarding synchronous work, complementary activities (question B), master classes (question O), and group work (a question I) were useful, obtaining more than 80% of agreement. On the other hand, for more than 90% of the students, the information provided on the online platform served them for their learning (question G). Finally, more than 80% of the course considers that the application of this methodology has been clear, concise, and complete (question N) and more than 50% were inclined to prefer the flipped classroom learning method over traditional teaching (question J).



Note: A: Videos with lesson development (Screencast). B: Complementary activities in class (exercises, explanation of concepts that are not clear in the videos). C: Kahoot!. D: Socrative. E: Nearpod. F: Crossword puzzles. G: Information provided on the online platform. H: Information provided on the Google Sites (e.g., <https://sites.google.com/view/agentesquimico/home>). I: Group Work. J: Do you prefer a “flipped classroom learning” teaching method over the traditional teaching of lessons in class and one-on-one activities at home? K: I watched all the videos before the classes. L: I always use videos about the contents of the course at home. M: I take notes when I watch the videos related to the course. N: The information I have received on the application of this methodology has been clear, concise and complete. O: Lessons in class

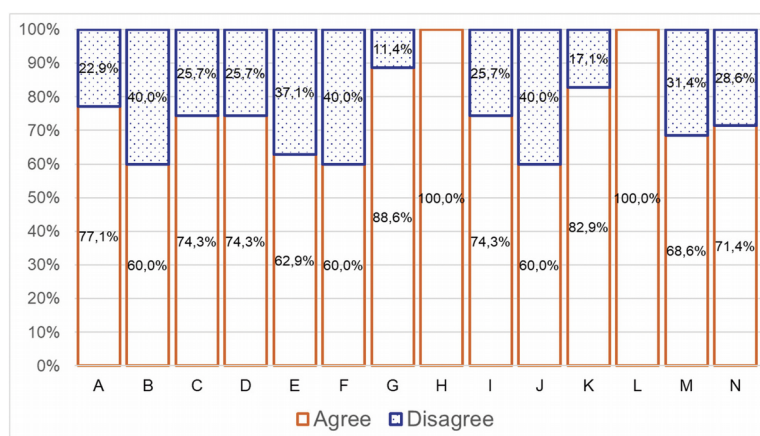
Figure 7. Survey 2 results: perception of the applicability of the tools, their use, and the information of the content

3.4. Descriptive and Statistical Analysis of Students' Perception of Methodologies, Internet and Tools (Survey 3)

At the end of the semester, regarding the analysis of students' perception of the various methodologies (questions A to F), more than 60% indicated that learning was beneficial (Figure 8). Particularly, more than 70% agreed that the methodology favors learning, interest, and aptitude towards the course (question C). Also, more than 60% reported being more motivated to study using flipped classroom as a learning methodology (question E).

More than 80% of the students positively valued the use of videos in the course (question G). If the learning experience between face-to-face and virtual classes is compared, 100% stated that they agreed that the teacher correctly used digital tools in the teaching process (question H), which agrees with the perception that the quality of the course has improved when using the internet compared to other courses (more than 70% agree).

About 60% of students stated that information technologies are easy to use, flexible to everyone's time, and easy to access (questions K, M, N). All of them valued the usefulness of these technologies.



Note: A: The methodology used is a new concept of class that has helped me to better understand the part of the course in which I have used it. B: I think that with this methodology I have learned more than in the traditional methodology. C: I consider that with this methodology I have had additional advantages in learning such as increasing the ability to use the materials learned, interest, and skills towards the course. D: The introduction of this methodology has helped update the course. E: I am more motivated to study Industrial Hygiene I when I do a Flipped classroom. F: The methodology used gives me better opportunities to debate with my colleagues. G: The overall assessment of the videos used in the course is very positive. H: Comparing your learning experience between face-to-face and virtual classes, do you think the teacher of this course correctly uses the web to teach? I: The use of the Internet in this course has improved its quality compared to other courses. J: The quality of the course was not affected by using the Internet. K: I feel that the information technologies (computers, cell phones, Internet connection, etc.) used in the courses have been easy to use. L: I feel that the information technologies used in Internet courses have many useful functions. M: I feel that the information technologies used in online courses are flexible to everyone's time. N: I feel that the information technologies used in online courses are easy to access.

Figure 8. Survey result 3: Students' perception of the various methodologies

The statistical analysis (contingency table and Mann Whitney U test) showed that there are no dependency relationships, nor statistically significant differences, between (1) the perception of students against the various methodologies (questions from A to C) and their gender; and (2) the perception of students against the various methodologies and the number of times enrolled in the course.

4. Conclusions

The findings of this study, in line with Al-Labadi and Sant (2021), lead to the conclusion that the use of technology improved the overall learning experience for students. The results indicate that 69% of

students agreed that virtual spaces improve performance, productivity, and utility as well as diversify assessments. Likewise, 46% said they use their mobile phones to access these spaces, making evident that these devices are important search tools for academic information (Figuroa-Portilla, 2016). Nonetheless, most of the population has experienced difficulties in accessing this type of learning scenario (Aguilar-Gordón, 2020), which was evident in the fact that 50% of students indicated that they were dissatisfied with internet speed, quality, costs, and access.

Based on what was stated in the previous paragraph, it was decided to select a method that would accommodate both the teaching styles of teachers and the needs of the students, (example: the origin of 82% of the students of urban centers and 18% of the rural environment), applying an eclectic approach, that is, a combination of approaches (Camacho, Patiño-Domínguez & Castañeda-Tibaquirá, 2018), and considering both deductive methods, such as the expository class, as well as inductive ones, such as the flipped classroom.

During the application of the methodology, it was observed that videos are the tools most used by students, as they contribute efficiently to learning (Aljaraideh, 2019). Likewise, more than 77% indicated that the methodology helped them better understand the course contents (Al-Labadi & Sant, 2021).

The use of the flipped classroom methodology shows improvements in academic performance and motivation among students (Ismail & Abdulla, 2019) and has a significant impact on engineering students (Toto & Nguyen, 2009). In addition, it favors the student learning and helps them feel more prepared to take the evaluations (Aljaraideh, 2019). This is consistent with the results of this study since more than 50% expressed their preference of this methodology over the expository class. Likewise, the results of the study reveal a positive perception about students' autonomous work during the pandemic, a situation that is in line with what was reported by González, de la Rubia, Hincz, Comas-Lopez, Subirats, Fort et al. (2020).

This study showed inequality related to internet access in the group of students surveyed, information that helped to adapt online teaching. In addition, it pointed out a favorable assessment of the usefulness of feedback and the digital tools used for teaching during the pandemic, especially videos, Plickers and Kahoot!. The latter are compatible and suitable as didactic resources for the implementation of the flipped classroom as a teaching methodology. As challenges, certain topics emerged that need to be studied in order to evaluate the effectiveness of active learning during the pandemic, such as measuring the autonomous work process (Romero-García, Buzón-García & Touron, 2018), the time required by the teacher to implement active learning and create didactic material (Toto & Nguyen, 2009), evaluating delayed learning outcomes as a result of COVID (Cao, Fang, Hou, Han, Xu, Dong et al., 2020) and, evaluating education platforms from the perspective of multiple subjects (e.g. students and teachers) (Chen, Peng, Yin, Rong, Yang & Cong, 2020). Furthermore, it is important to assess the adverse effects of learning during pandemics; as a result of socioeconomic uncertainty, space limitation and low family reconciliation, which cause stress, anxiety (Sahu, 2020) and decreased sleep quality (Martínez-Lezaun, Santamaría-Vázquez & Del Líbano, 2020) in university students.

Finally, in relation to the limitations, it should be noted that this research has been conducted in an unforeseen pandemic situation, which has influenced its results. In the future, it is necessary to analyze and contrast the same object of study in a non-pandemic situation. However, and considering that this study provides quantitative data about the perception of students, it would be advisable to provide qualitative data to justify, deepen and understand their assessments.

Declaration of Conflicting Interests

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