2023 Annual Conference & Exposition
Baltimore Convention Center, MD | June 25 - 28, 2023
The Harbor of Engineering Education for 130 Years
ASEE
Paper ID #39821

Board 44B: Work in Progress: TikTok Format Videos to Improve Communicating Science in Engineering Students

Samantha Elizabeth Paucarina
Josué David Batallas
Dr. Miguel Andres Guerra, Universidad San Francisco de Quito, Ecuador

MiguelAndrés is an Assistant Professor in the Polytechnic College of Science and Engineering at Universidad San Francisco de Quito USFQ. He holds a BS in Civil Engineering from USFQ, an M.Sc. in Construction Engineering and Project Management from Iowa State University as a Fulbright Scholar, a Ph.D. in Civil Engineering from Virginia Tech, and two Graduate Certificates from Virginia Tech in Engineering Education and Future Professoriate. MiguelAndrés's research includes sustainable infrastructure design and planning, smart and resilient cities, and the development of engineers who not only have strong technical and practical knowledge but the social awareness and agency to address global humanitarian, environmental, and social justice challenges. For him, social justice is a concept that should always be involved in discussions on infrastructure. Related to STEM education, Miguel Andrés is in developing and applying contemporary pedagogies for STEM courses, teaching empathy studies in engineering as a tool for innovation, and assessing engineering students' agency to address climate change. Currently, MiguelAndrés is validating his framework of a Blended & Flexible Learning approach that focusses on STEM courses and its practical adaptation to overcome barriers brought up by the COVID-19 pandemic.

Vanessa Guerra, University of Virginia

Work in Progress: TikTok Format Videos to Improve Communicating Science in Engineering Students

Samantha Paucarina[1], Josué Batallas[1], Miguel Andrés Guerra[2*], Vanessa Guerra[3]

[1] Undergraduate student, Universidad San Francisco de Quito USFQ, Colegio de Ciencias e Ingenierías, Departamento de Ingeniería Civil, Casilla Postal 17-1200-841, Quito 170901, Ecuador.
[2] Assistant Professor, Universidad San Francisco de Quito USFQ, Colegio de Ciencias e Ingenierías, Departamento de Ingeniería Civil, Casilla Postal 17-1200-841, Quito 170901, Ecuador.
[3] Assistant Professor, University of Virginia, School of Architecture, Department of Urban and Environmental Planning, Charlottesville, VA, 22904, USA.

* Correspondence: Miguel Andrés Guerra, MAGuerra@usfq.edu.ec

Abstract

Communicating is a skill humans practice early in life, in which they struggle when trying to communicate feelings, perceptions, and even more complex ideas. Research shows that engineers struggle to communicate technical ideas, even more to audiences outside of such technical knowledge. There are many efforts to support the development of communication skills. This project aims to contribute to such a direction by getting engineering students to communicate simple ideas concisely to a broad general audience. Notably, the researchers included a communication project as class credit. For this, researchers asked students to make a 1 min video explaining an assigned class topic. The video is a TikTok-Style Video for Improved Science Communication Science that will be uploaded to a class account on social media, with the setting of "public audience". A TikTok video includes specific characteristics such as being entertaining, catchy, and fun to watch videos. If one of the videos went viral, students will get extra credit in the class. This communication project was applied to three courses in civil engineering (Structures, Cost Engineering, and Construction Management), with a total of 55 students. At the end of the semester, researchers surveyed to learn students' perceptions and feelings regarding the assignment, and the challenges they faced making such a video. The results indicate students find short fun videos challenging to communicate a technical idea and practicing making one helped them to find new ways to communicate. The authors discuss the possible factors driving the results, and the next steps and explore the avenues academia could take to improve communicating science. Implications for research and practice are provided.

Introduction

Communication within the sciences plays a very important role in today's world because it is part of the formation of the scientific image and allows for a wide audience to understand complex ideas easily. Of course, technical communication is complicated among all majors, but this research focuses on engineering [1]. Generally, scientific language is not simple, so it is essential to promote a new way of learning in education where all those topics related to science can relate to means that promote the social appropriation of knowledge. The importance of the study lies in the fact that the use of novel pedagogy increases students' engagement with the subject and

therefore maximizes learning while teaching students to improve their communication skills [2], [3].

Teaching and learning through communication technologies have become something new in current educational programs, gaining importance in students' development. In this way, engineering students can expand their knowledge by making a TikTok-style video related to their subject [4]. Likewise, it is desired that they be able to innovate and promote knowledge not only for engineering specialists but also that a large audience can understand them. At the same time, it is sought that they learn to communicate since this activity makes the student much more involved in the subject through creativity, innovation, and autonomy.

However, it is important to mention that within the study, science pedagogy is complex but necessary for success in professional life. That is why the study is based on the development of communication skills using TikTok. Therefore, in the described context, it is observed that this objective is met since they deepen the understanding of the science associated with the use of technological applications that today integrate a large audience, in addition to adding the possibility of expanding knowledge [1].

Background

Because humans are social beings, communication is part of every aspect of life, even those related to workspaces. However, whatever the scenario, communication must be characterized by being harmonious, flexible, effective, and assertive because numerous actions, projects, achievements of goals depend on it [5]–[8]. That is why effective communication focuses on understanding different perspectives, but also making us understand our own. In addition, the communication aim is to share, receive and understand a message without altering the final objective, as it is usually done when the audiences, we are addressing, cannot be related to the topic that is going to be discussed. As Quaranta mention this linguistic element tends to become even more complex when the interlocutors belong to different "groups"; they establish their own, common languages and difficulties are accentuated [9], consequently, communication becomes a great challenge.

The communication of science plays a fundamental role in today's culture. First, the reason is that it is the main source from which educated people (not specialized in science) draw to obtain scientific knowledge, and second, because it is one of the main responsibilities for the formation of the scientific image both within the scientific communities themselves and outside of them [10]. Currently, social platforms have promoted the development of new media, increasing new and innovative methods for reading and writing, allowing the audience to increase as compared to traditional media. This is how the information is transmitted immediately and interactively, making the communication process more effective [11]–[15]. According to Pantoja "social networks provide new possibilities to compensate for the open imbalance between the needs of social communication and the means necessary for that communication" [16].

Since the inception of social media in the late 1990s, it has had an unprecedented influence on our personal and professional lives, impacting the way we communicate, stay connected, and share

information [17]. For instance, Tik Tok is an app that was launched in September 2016 in China and launched internationally later in 2017. Furthermore, it has evolved into a powerful means of communication in society today. In this way, it became one of the most downloaded applications in the United States and gained popularity in more than 150 countries, reaching a total of 800 million monthly active users worldwide. It is important to consider that most of the interaction, around 41%, is found in young adults between the age of 16 to 24 years old [18].

This social network allows people to create, edit and upload videos by merging two types of users: creators and consumers. Undoubtedly, its massive growth has managed to inspire and enrich the daily lives of users. This social platform offers a space for creative expression and knowledge acquisition in entertainment and interaction aspects. That is why it has evolved from focusing exclusively on short music videos to encompassing various contents. The fragmented video feature allows individuals to browse during their leisure time in life and work, thus greatly facilitating the acceptance and dissemination of information [19].

Additionally, Tik Tok has potentially contributed to learning as it is a striking application that allows sharing concerns and real needs. Moreover, it facilitates knowledge as it allows individuals to assimilate new information in a shorter period of time whilst interacting with a large and specific audience. It drives to approach its users as a community of practice, that is, as a group that learns through the practice of what they share in regards to the feedback that allows them to cultivate their community interest [20]–[22]. Given this panorama, it can be affirmed that the digital revolution implies an adaptation of teaching and learning strategies. Technological tools are not going to produce innovations alone, they need to be associated with novel educational methods and for this, changes in the mentalities and sociocultural practices of the main actors are required [23], [24]. For this reason, these tools should not be ignored in the educational field since their original establishment and fascination with the public, build a didactic possibility of learning due to the axis of all of them, which is linked to the interaction and ability to respond and communicate quickly and eloquently.

This research explains how effective communication through social platforms such as Tik Tok has has become an efficient learning tool. This way of communication enables people to share short and creative messages, allowing a large audience to understand a complex topic despite not being familiar with it. One of the most complicated goals to accomplish is to transform technical concepts into a short and easily understood presentation. [25]. In this way, effective communication is involved and present in the field of education, since through it, it is possible to transmit a message understandably and clearly way to the receiver without causing doubts or possible wrong interpretations.

Open communication, as an instrument of effective engagement of human resources, may be among the instruments of increasing the chances of organizations to maintain competitiveness [26]. In this context, it is pursued that students manage to connect both, their verbal and non-verbal communication so that their knowledge expands and can benefit them. The Digital Revolution has modified the forms of communication, due to the integration of social networks, which has made explicit language adaptations and has changed its original composition [27]. That is why it is important to dictate communication skills that allow us to understand the principal objective, be

clear and precise and get to know the audience, helping to lead the topic presented and making the knowledge deeper and beneficial [28], [29].

Methods

This study uses a qualitive and multiple-choice approach to measure how the Tik Tok style videos contribute to improving communication skills among civil engineering students. The data was collected during the Fall 2022 semester with students from the engineering courses Construction Cost (n=16), Construction Project Management (n=18), and Structures-1 (n=21) to a total sample size of n=55 students. For the study, the researchers conducted a survey with civil engineering students that fulfilled the task of the Tik Tok video. The survey contained both closed- and open-ended questions to understand their self-reported feelings and state of being during the activity in all phases—before, during and after the Tik Tok task. The unit of analysis for the study consisted of the days of the preparation of the video and to the moment when it was presented. The surveys were administered using Qualtrics software and cleaned up in the Excel software. The answers were coded for evidence of how videos with Tik Tok style contribute to improve communication skills in students. Students' answers were coded for content analysis using a priori and emerging codes following Saldana's and Yin's guidelines [30]–[32].

The sets of questions were divided into two phases. The first set of questions were five open questions that asked about how the students planned the video, what they learned, the challenges that were presented to them, the advantages of having made the video, and finally, they were asked what suggestions they would give to future students so that they can be successful in the Tik Tok task. On the other hand, the second phase was based on closed questions with five response options. This set consisted of nine questions in which the students responded with the options much more than, more than, the same, much less and a little less. These questions were based on how the students felt the activity of Tik Tok compared to traditional projects, for example, they questioned if they should think more about the audience, connect with the content of the message, express the idea more as a story than as a sequence of knowledge, look for similar examples, think about the language used and be aware of the message given.

All courses reported in this study had the same instructor who designed the project. The task that was implemented for the engineering courses had the same terms of difficulty, pedagogy, solving approaches, and themes. The Tik Tok task consisted of making a 30-second video in pairs in which they explained about a specific engineering course topic which was taught throughout the semester. In this way, the objective was for students to review the previously learned topic, plan the video together with their partner, be creative and dynamic to be striking on the platform and be careful with the language to use, since the goal was that every type of audience understood the content that was being transmitted despite not being specialized in the subject.

For the final phase of this activity, each course met, and the videos made were shown. This was done so that the students comment and give opinions on how successful the video of their classmates was. Especially, the instructor emphasizes if the message transmitted was understood. It is important to highlight that the responses found where that the creation of video was of great importance because it encouraged students to check and remember what they had learned during the semester and dissect the information, which caused them to retain the subject in the long term.

In addition, it was mentioned that they were able to develop their communication skills and know how to organize and plan a video so that the information given is correct and specific.

Results

After collecting all the data from the qualitative and quantitative questions, it was organized so that quantitative answers were first and qualitative responses were after them. The first table shows the responses to the quantitative questions provided by students. These six questions showed that the key things were organization and preparation. The qualitative style questions showed that different factors affected the assignment development. The main results for communication development were avoiding jargon, providing visuals, identifying the goals of communication, and developing an elevator pitch. These responses were mainly related to an improvement in public speaking, stage fright, organization, and planning.

Multiple choice results.

Multiple Choice results were developed based on how students felt with this assignment in comparison to traditional projects. (Response options: much more than, more than, the same, much less and a little less)

DESCRIPTION	A whole lot	A lot	Some	Not so much	Almost nothing
Think about your audience.	31	16	1	1	1
Develop and connect the content with the message.	30	16	3	0	1
Connect with the audience.	30	16	3	0	1
Express the idea more as a story than as a sequence of knowledge.	32	12	3	0	3
Searched for tips or examples of similar deliverables.	18	15	13	3	1
Think that my words and message should be "understandable."	31	9	9	1	0
Think about not including sensitive or controversial topics.	20	13	9	5	3
Be more aware of the accuracy of my words.	33	11	5	0	1
Do practice exercises (a script, a video attempt, a draft, a sketch of the idea, etc.)	33	9	7	1	0

Through the multiple-choice survey, where 6 questions were asked, it is observed that most participants indicated that this task needs more preparation and organization in comparison to traditional projects. For example, in the first question, 31 of the 50 participants indicated that they put more consideration about the audience when making the video. On the other hand, regarding the connection with the audience and how to connect with it through expressing ideas as a story instead of a sequence of knowledge, it is observed that around 60% of the students surveyed had to think much more on how to do it compared to a traditional project.

In addition, it is observed that the students had to think much more about whether the words and the message were understandable, so precision in the language became very important. However, it was also identified that 36% of the students looked for tips to carry out this activity and 40% of them thought about not including sensitive or controversial topics. Finally, 66% of the students having made this video encourages students to carry out practical exercises, that is, making a script, a draft of the video, a sketch of ideas, etc. that allows them to improve their communication skills.

Open questions results.

The first research question is how videos with Tik Tok style contribute to improve communication skills in students? The following table shows the results:

Avoid jargon	Tik Tok activity helped students review the subject assigned for the video.	➢ It helped them synthesize the subject and explain it. ➢ Made them search for additional information, and while summaries it with more colloquial language, they kept the key ideas of the topic.
	TikTok style video helped students use simpler terminology.	➢ Students prepared with diagrams and graphics that helped us get a better understanding of the topic.
Provide visuals	This activity made them learn how to use the platform and how to edit videos on Tik Tok.	➢ Views and the engagement. ➢ Use of certain viral trend. ➢ The fact that it goes viral depends not only on the content but also on the "trends", songs, and effects that are on trend.
Identify the goals of communication.	Develop certain skills like creativity to create a video for educative purposes.	➢ Try to make it recreational, to draw people's attention because, with it, they would be more likely to understand it. ➢ Try to tell every detail of the procedure. ➢ The video should be original. It could follow the trend, but it needs to have some originality so it could be differentiated from the other videos.
Develop an elevator pitch.	The limitation of time helped them organize all the ideas concisely.	➢ All the information on the subject was reviewed and the most important points were rescued. ➢ Allowed abstracting the concepts in a very concise way. ➢ A good script could help students to fulfill the task, help organize ideas, and learn more about the subject.
	Good organization helped many of them remember subjects or topics that they learned before.	➢ Summarizes and repeats the idea many times, as they were planning, writing, and practicing the script, which helped interiorize the idea for the long term.

		➢ Plan every second and try to make visual examples of what you are explaining so that it is clear even if it is technically. ➢ Focus on explaining one thing and try to make not only the text clear but also the vocalization.
	Communicative skills were improved a lot.	➢ Overcome the fear of speaking or appearing in a video. ➢ Various students mention they were afraid of talking behind a camera, and doing this assignment helped them get over it and improving in their self-confidence while talking.

First, student self-reported answers suggested that the TikTok activity helped students review the subject assigned for the video. One student reported, “It helped me synthesize the subject and explain it in a short video. In that way, I was able to transmit it to other people.” It also made them search for additional information, and while summaries it with more colloquial language, they kept the key ideas of the topic. Another student reported, “The main challenges were summarizing correctly the topic and proposing clear ideas.” Also, student self-reported answers suggested that the use of brainstorming, diagrams, and profound research helped them organize the video. One student reported, “We prepared ourselves with diagrams and graphics that helped us get a better understanding of the topic.” Also, students reported that getting feedback from people that know and don’t know the subject helped them organize and formulate a better way the main idea. “It helped me get a better understanding of some terminology. When I was preparing myself, I had to clarify some terminology, made up my ideas, and expose them to my family. They gave me feedback on what and how I could change so it could be more understandable.”

Second, student self-reported answers suggested that this activity made them learn how to use the platform and how to edit videos on Tik Tok. One student reported that the main problem was “Getting an external audience to understand me and in turn, use the app to make a Tik Tok. I had never done one, and it felt strange that my first Tik Tok was graded.” (Narayan, 2017) It was mentioned that it could help with the views and the engagement if the video follows certain viral trend. One student suggested this for future assignments related to this platform, “That they are more present on this network since the dynamism of each video and the fact that it goes viral depends not only on the content but also on the "trends", songs, and effects that are on trend. Therefore, the fact of adding a song that has gone viral or an effect in the video will make it have many more visits and be much more dynamic.”

Third, student self-reported answers suggested that it was needed creativity to create a video for educative purposes. One student reported, “We try to make it recreational, to draw people's attention because, with it, they would be more likely to understand us. And we try to tell every detail of the procedure.” Also, the video should be original. It could follow the trend, but it needs to have some originality so it could be differentiated from the other videos. “I had to correctly analyze an exercise, and I had to creativity develop at a higher level. All this is to show an original and interesting Tik Tok, with general knowledge of the subject studied in class.” For this matter,

the video should use language that can be understandable by everyone. “Seek to be as clear as possible with the subject to present. You must look for people to understand the topic not the same, but something like us. This can be achieved using friendly words and if possible, raising similarities to everyday life.”

Fourth, student self-reported answers suggested that one of the limitations that helped them organize all the ideas where that the video length should be 30 seconds or less. One student reported about the time length limitation, “Totally, since all the information on the subject was reviewed and the most important points were rescued, which allowed abstracting the concepts in a very concise way given the 30 seconds required.” It was mentioned that a good script could help the students to fulfill the task, help organize ideas, and learn more about the subject. "Making a script and reducing the words more and more, using simple and easy language, and practicing telling and showing the information to a younger sibling to see if they can understand it, and thus know that it could be explained simply". Also, student self-reported answers suggested that a good organization helped many of them remember subjects or topics that they learned before. One student reported, “That they plan well what and how they want to represent their subject so that later time is not an enemy. Besides that, they can be concise, that they give the correct information... no more, no less.” Also, it was mentioned that summaries and repeating that idea many times, as they were planning, writing, and practicing the script, helped interiorize the idea for the long term. “Plan every second and try to make visual examples of what you are explaining so that it is clear even if it is a technicality. Focus on explaining one thing and try to make not only the text clear but also the vocalization.” A student self-reported answers suggested that while doing the assignment they felt that their communicative skills were improving a lot. One student reported about the challenges he had, “Overcome the fear of speaking or appearing in a video and saying something that is not educational because what is said is not true.” It was mentioned by various students they have or was afraid of talking behind a camera, and doing this assignment helped them get over it and improving in their self-confidence while talking. “I lost my fear of speaking on camera a bit and part of speaking in public”.

Discussion

The results went according to expected. As was said before, the primary purpose of this assignment is to learn how to communicate knowledge students got in class. Learning how to communicate is a helpful tool for civil engineering students. The outcomes of this assignment were successfully achieved. Correct communication makes the students capable of understanding the concepts and interiorizing them in long-term memory.[33], [34] Nowadays it is seen that a new way to improve student performance is the use of social media. Engineering students and college students use social media almost every hour of the day while they are awake. Implementing social media on civil engineering assignments can change the view on their complexity of them. [35] The answers to the given questions in the study revealed that students have learned, analyzed, and research more about the topic assigned. Also, most of the students tested, use some creative skills because they had to do things they hadn’t done before. With that said, this assignment contributes to developing new forms of ideas and concepts that will help the students understand. It also helped the develop communication skills, important for expressing ideas, networking, and work interviews. As it is known communication is one of the most important skills when coming to showing knowledge in the real world. Teamwork such as oral presentations helps them in their communication skills such

as talking in public, talking without a script, and their corporal expressions. [36], [37] Part of learning how to deal with the industrial world involves developing social skills. This activity, a part of improving communication skills, improves communication among their peers. A good script and good planning made the performance better under the pressure of the time limit. For the time limit, it was expected that it made them rephrase the idea, so it could be expressed in the video. Students expressed that the limitation helped them make a concise and precise idea, and then reformulate it until they could fit it into the time proposed. [38] Finally, some students didn´t find the activity helpful, but there was the least number in the group. It is recommended that for the analysis and evaluation of the results, there must be two types of questions. Quantitative and qualitative questions should be formulated so it can be found what the experience was while the students were doing the assignment. Also, it is suggested to add a question with a single-word answer that explains how the project contributes to their learning process. In this way, it can be identified quickly what type of learning ability they use/acquired.

Conclusions

The main purpose of this Work in Progress was to introduce a pedagogic activity to improve science communication in engineering students. Communication is a desirable skill in the industry world. The TikTok-style videos assignment helped students to improve their public speaking, oratory skills, and communicating in general. Many students reported that their communication skills were improved, or they acquired new ones to help them complete the assignment. This research suggests that we can make huge changes in students' abilities by giving them the right tools to develop their skills in different ways. This activity also helped them with the organization and planning of a script that contains concepts and topics about the engineering subject. In addition, the pedagogic assignment also helped with planning skills and with the communication among peers. Future research will continue testing the assignment with a bigger sample and with students at different stages in their majors. Furthermore, the study will focus on what characteristics of the assignment influence the communication cognitive side of students, how such activities can also help instructors to improve their communications and to explore an assignment that help students practice throughout the semester.

References

[1] J. D. Bakos Jr, *Communication skills for the 21st century*. Journal of professional issues in engineering education and practice, 1997.

[2] R. F. Herrera, J. C. Vielma, y F. M. La Rivera, *Impact of microteaching on engineering students' communication skills.* International Journal of Engineering Education, 2018.

[3] R. Saleh, I. Widiasanti, y H. Hermawan, *Development of communication competency for civil engineering students.*, vol. 1402, 2 vols. Journal of Physics: Conference Series, 2019.

[4] J. L. Klosky, S. M. Katalenich, B. Spittka, y S. F. Freyne, *Inspiring student engagement through two-minute follies*. 2014 ASEE Annual Conference & Exposition, 2014.

[5] C. Bello, «Comunicación efectiva desde la gerencia educativa», *EPISTEME KOINONIA*, vol. 2, n.º 3, pp. 24-40, 2019.

[6] M. A. Guerra, H. Murzi, J. Woods Jr, y A. Diaz-Strandberg, «Understanding Students' Perceptions of Dimensions of Engineering Culture in Ecuador», 2020.
[7] H. Murzi *et al.*, «Cultural dimensions in academic disciplines, a comparison between Ecuador and the United States of America», en *2021 ASEE Virtual Annual Conference Content Access*, 2021.
[8] M. A. Guerra y C. Gopaul, «IEEE region 9 initiatives: supporting engineering education during covid-19 times», *IEEE Potentials*, vol. 40, n.º 2, pp. 19-24, 2021.
[9] N. Quaranta, «La comunicación efectiva: un factor crítico del éxito en el trabajo en equipo», *Enfoques*, vol. 31, n.º 1, pp. 21-46, jun. 2019.
[10] C. García, «La comunicación de la ciencia y la tecnología como herramienta para la apropiación social del conocimiento y la innovación», *J. Sci. Commun. América Lat.*, vol. 2, n.º 1, p. Y02, jun. 2019, doi: 10.22323/3.02010402.
[11] M. A. Guerra y Y. Abebe, «Pairwise Elicitation for a Decision Support Framework to Develop a Flood Risk Response Plan», *ASCE-ASMEJournalofRiskandUncertaintyinEngineeringSystems*, jul. 2018, doi: 10.1115/1.4040661.
[12] M. A. Guerra y T. Shealy, «Teaching User-Centered Design for More Sustainable Infrastructure Through Role-Play and Experiential Learning», *J. Prof. Issues Eng. Educ. Pract.*, feb. 2018, [En línea]. Disponible en: https://ascelibrary.org/journal/jpepe3
[13] C. Ubidia, M. Guerra, y H. Murzi, «Understanding Student's Perceptions of Cultural Dimensions in construction majors: Deconstructing barriers between architecture and civil engineering students», en *2022 ASEE Annual Conference & Exposition*, 2022.
[14] H. M. Matusovich, M. C. Paretti, B. D. Jones, y P. R. Brown, «How problem-based learning and traditional engineering design pedagogies influence the motivation of first-year engineering students», en *American Society for Engineering Education*, 2012.
[15] M. Mariño, C. Ubidia, M. Guerra, y F. Jativa, «WIP: Designing a First-Year Hands-on Civil Engineering Course to Reduce Students Dropout and Improve the Overall College Experience», en *2022 ASEE Annual Conference & Exposition*, 2022.
[16] A. Pantoja, «Los nuevos medios de comunicación social: las redes sociales». https://webcache.googleusercontent.com/search?q=cache:v6EHNlbLNIcJ:https://dialnet.unirioja.es/descarga/articulo/3737961.pdf&cd=1&hl=es-419&ct=clnk&gl=ec (accedido 19 de enero de 2023).
[17] C. Zhu, X. Xu, W. Zhang, J. Chen, y R. Evans, «How Health Communication via Tik Tok Makes a Difference: A Content Analysis of Tik Tok Accounts Run by Chinese Provincial Health Committees», *Int. J. Environ. Res. Public. Health*, vol. 17, n.º 1, Art. n.º 1, ene. 2020, doi: 10.3390/ijerph17010192.
[18] N. Becerra-Chauca, A. Taype-Rondan, N. Becerra-Chauca, y A. Taype-Rondan, «TikTok: ¿una nueva herramienta educativa para combatir la COVID-19?», *Acta Médica Peru.*, vol. 37, n.º 2, pp. 249-251, abr. 2020, doi: 10.35663/amp.2020.372.998.
[19] Y. Yang, G. Brosch, y B. Yang, «Dissemination and Communication of Lessons Learned for Project-Based Business with the Applications of Information Technology: a Case Study with a British Manufacturer», *Procedia Manuf.*, vol. 39, pp. 1899-1905, 2019.
[20] V. Tobeña, «Pensar el futuro de la escuela desde comunidades de prácticas. Claves desde TikTok», *Dilemata*, n.º 33, Art. n.º 33, sep. 2020.
[21] J. Acosta y M. A. Guerra, «Validating Guerra's Blended Flexible Learning framework for Engineering Courses», en *2022 ASEE Annual Conference & Exposition*, 2022.

[22] N. Granja, V. Guerra, y M. A. Guerra, «Give me a coffee break! Pilot study on improving exam performance and reducing student stress», en *2022 ASEE Annual Conference & Exposition*, 2022.
[23] M. A. Medina Angarita y A. Nolte, «What do we know about hackathon outcomes and how to support them?–A systematic literature review», en *Collaboration Technologies and Social Computing: 26th International Conference, CollabTech 2020, Tartu, Estonia, September 8–11, 2020, Proceedings 26*, 2020, pp. 50-64.
[24] C. Hayes, K. Stott, K. J. Lamb, y G. A. Hurst, «"Making every second count": Utilizing TikTok and systems thinking to facilitate scientific public engagement and contextualization of chemistry at home». ACS Publications, 2020.
[25] M. Miceli, «Say What?: The Importance of Effective Communication in Engineering - ProQuest». https://www.proquest.com/openview/5984cc516302322fb2aa8a7c35c01fdb/1?pq-origsite=gscholar&cbl=42295 (accedido 19 de enero de 2023).
[26] Z. Stacho, K. Stachová, J. Papula, Z. Papulová, y L. Kohnová, «Effective Communication in Organisations Increases their Competitiveness», *Pol. J. Manag. Stud.*, vol. 19, pp. 391-403, jun. 2019, doi: 10.17512/pjms.2019.19.1.30.
[27] G. C. T. Reyes, E. I. V. S. Martín, F. I. R. Cea, J. E. de L. R. Maldonado, y R. P. de León, «Características del lenguaje y la comunicación en redes sociales en estudiantes de enseñanza básica», *Rev. Reflexión E Investig. Educ.*, vol. 2, n.º 1, Art. n.º 1, jul. 2019.
[28] C. Ubidia, M. Guerra, V. Guerra, y C. Gallardo, «Work in Progress: Collaborative Environments in Architecture and Civil Engineering Education–Case Study», en *2022 ASEE Annual Conference & Exposition*, 2022.
[29] H. Velásquez, M. Guerra, y M. Jimenez, «Exploring Interdisciplinary Contributions to More Sustainable Solutions in the Built Environment and Infrastructure Development Students», en *2022 ASEE Annual Conference & Exposition*, 2022.
[30] R. K. Yin, *Case study research: Design and methods*. Sage publications, 2013. Accedido: 23 de abril de 2017. [En línea]. Disponible en: https://books.google.com/books?hl=en&lr=&id=OgyqBAAAQBAJ&oi=fnd&pg=PT243&dq=use+study+research+yin&ots=FaN1gdj45i&sig=EMc6lWrXmburXS1-mI3XSvyxfiY
[31] J. Saldana, *The Coding Manual for Qualitative Researchers*. SAGE, 2015.
[32] M. A. Guerra y T. Shealy, «Operationalizing Prototyping as a Design Method for More Sustainable Infrastructure Projects», en *Proceedings of the 16th Engineering Project Organization Conference (EPOC 2018)*, Brijuni, Croatia, jun. 2018, pp. 148-157. [En línea]. Disponible en: http://www.epossociety.org/EPOC2018/proceedings.htm
[33] P. Pourmand, B. Pudasaini, y M. Shahandashti, *Assessing the benefits of flipped classroom in enhancing construction students' technical communication skills.* Journal of Civil Engineering Education, 2021.
[34] W. J. Walley y P. D. Hedges, *An approach to the integration of communication skills development within an undergraduate civil engineering program.* Journal of technical writing and communication, 1990.
[35] R. Cassin, *Leadership and communications in civil engineering: Past, present, and future.* Leadership and Management in Engineering, 2003.
[36] R. Fries, B. Cross, J. Zhou, y C. Verbais, *How Student Written Communication Skills Benefit During Participation in an Industry-Sponsored Civil Engineering Capstone Course.* Advances in Engineering Education, 2017.

[37] A. Jennings y J. D. Ferguson, *Focusing on communication skills in engineering education*. Studies in Higher Education, 1995.
[38] S. Narayan, C. Gardent, S. B. Cohen, y A. Shimorina, *Split and rephrase*. 2020.