ANALYSIS OF CIVIL ENGINEERING POSTGRADUATE STUDENTS' PERCEPTION ABOUT CONTEMPORARY ISSUES

V. Yepes, A. Brun-Izquierdo, L. Yepes-Bellver

ICITECH. Dept. Ingeniería de la Construcción y Proyectos de Ingeniería Civil. Universitat Politècnica de València (SPAIN)

Abstract

This article aims to check the level of information presented by postgraduate students in civil engineering concerning other population groups. This paper analyses the perception that postgraduate civil engineering students at the Universitat Politècnica de València have about the current world. For this purpose, the Factfulness Quiz by Hans Rosling was used. In this test, thirteen questions with three possible answers aim to measure the perspective on topics recurrently covered in the media. Thousands of people have answered this questionnaire, making it possible to compare groups of students. Fifty students, representing more than 75% of those enrolled, answered the survey. They correspond to students of two master's degrees related to civil engineering. The questionnaire consists of three sections. First, generic information about individuals. Next is the a priori opinion regarding current problems, both their own and world leaders and journalists. Finally, the questionnaire is completed with thirteen questions that appear randomly. A statistical analysis of the responses collected by each group was carried out to compare the results with those of previous studies. We also studied whether there are relevant differences between the groups of students. The statistical packages Microsoft Excel and SPSS were used. The results obtained show a success rate of 31%, an average of four correct answers per person, and a mode of three. The results show a somewhat lower success rate than an utterly random response. Among the questions asked, one stands out for having been answered correctly by more than 96% of the participants. It refers to climate change's effect on the planet's temperature. The study concludes that students do not have a clear and up-to-date view of contemporary problems. However, the results obtained in this study reflect the need to incorporate actions in the training of our students that allow them to be aware of their limitations when interpreting complex issues. From this new perspective, students would be more receptive to understanding the mechanisms that have led them to assimilate these unfounded and widely shared social beliefs through overexposure to current media. Therefore, there is a need for postgraduate students to improve competence related to knowledge of contemporary problems.

Keywords: Civil engineering, virtual teaching, COVID-19, Likert-scale, postgraduate education.

1 INTRODUCTION

In recent decades, technical and transversal competencies have gained prominence in engineering education. The reason is that changes in the demands of society and employers require recent graduates to possess these skills [1], [2]. Torres-Machí et al. [3] analyzed the perceptions of civil engineering students on the educational gaps that influence their employability. Yepes et al. [4] analyzed the curricula of courses related to civil engineering and the demands of the labor market. Passow and Passow [5] explored the competencies that graduates in various engineering fields receive as the most critical for professional life. Meier et al. [6] researched the relevance of many competencies for engineers perceived by company managers. Leadership, teamwork, efficient communication, problem-solving, and communication were considered necessary in all these studies. Passow and Passow [7] corroborated these results in their systematic reviews.

Transversal competencies, also known as transferable competencies, represent a relevant element of the professional skills profile of undergraduate and graduate programs. They are outstanding competencies for students to increase their employability. They involve cognitive and metacognitive skills and instrumental and attitudinal knowledge of great value to society.

The Universitat Politècnica de València (UPV) is no stranger to these demands, so within the UPV2020 strategic plan, it developed a project to accredit transversal competencies. The focus of this project is to accredit the transversal competencies of graduates in all official degrees offered at the UPV [8]. In this context, one of the 13 transversal competencies defined by the UPV is the CT-10, called "knowledge of contemporary problems." TC-10 aims for students to identify and interpret contemporary problems in

their area of knowledge and other areas of expertise, with particular attention to issues concerning sustainability. This competency deals with students' need to understand contemporary social, political, legal, and environmental problems and values and the mechanisms of expansion and dissemination of knowledge. The objective is to develop the ability to "keep abreast" of contemporary issues in their area of specialization and society in general.

However, and even though current generations have mass media based on information technologies, it seems that knowledge of current problems is far from desirable. As Rosling et al. [9] point out, the problem is not so much that the correct information is not accessed, but that many people distributed across different countries have wrong views of the world. These cognitive biases have been well studied in previous work and show some common tendencies when interpreting the environment and its information [10], [11].

The incorrect perception of what is currently happening in our environment may be due to many causes [12]. On the one hand, there is a certain saturation of information in the digital media, where false news and the lack of criteria or time to contrast data from different sources bias the knowledge of contemporary problems. To this cognitive bias, we should add that journalists, world leaders, business people, and other actors who must make critical decisions have a vision of the world anchored in the education received in their youth.

Thus, as Rosling et al. [9] have found, the image that the general population usually has of today's world is much worse than it is. For this purpose, these authors designed a questionnaire with 13 general knowledge questions with three possible answers each. They found that the correct answers in the questionnaire were significantly lower than a chimpanzee choosing answers at random.

The question, therefore, is to know if the students of graduate courses related to civil engineering had sufficient knowledge of contemporary problems. This research question relates to the acquisition of the transversal competence CT-10, but it would imply redirecting the teaching of these courses to acquire this ability in the students. Therefore, the change in teaching strategy would consist of getting our graduate students to learn to make decisions based on objective data that have been contrasted in reliable sources. This strategy would avoid the danger of making important decisions in their professional future based on prejudices and unverified information obtained from the Internet.

Our Department lectures on civil engineering and its management topics and has conducted numerous researches in this field [13], [14]. These courses have two main parts: a theoretical part in which professors present the concepts of construction procedures and management of civil engineering works and a second part in which students solve practical problems. Our students have multiple opportunities to make sound decisions based on reliable data. These topics are directly involved in research in the area of optimization [15]-[18], multi-criteria decision-making [19], [20], and life cycle assessment [21], [22]. This study evaluates different issues related to virtual teaching in graduate civil engineering courses. For this purpose, an anonymous questionnaire was provided to undergraduate civil engineering students at the UPV. This questionnaire was based on the one designed by Rosling et al. [9], adding three items based on a Likert scale to know the a priori opinion of the students regarding their degree of knowledge, that of world leaders and journalists of the contemporary world.

2 METHODOLOGY

This work aims to measure the degree of knowledge about the world of a representative sample of students of two postgraduate courses related to civil engineering developed at the UPV. For this purpose, the test designed by Rosling et al. [9], which asks general questions about the current state of the world, is going to be replicated. In this anonymous survey, thirteen questions are asked with three possible answers that aim to measure not so much the specific data. However, the perspective that one has in front of issues is recurrently addressed in the media. To this end, questions about poverty, climate change, demographic evolution, life expectancy, natural disasters, access to electricity, schooling, vaccination, and nature conservation are addressed.

In addition to the 13 questions of the Rosling et al. [9] test, three items have been included to ascertain the a priori opinion of the degree of knowledge of self, journalists, and world leaders about current world problems. This information will allow contrasting the a priori opinion with the percentage of correct answers from each group. The Likert scale used here is a five-point scale used for the individual to express to what extent he/she agrees or disagrees with a given statement. These are scaled-based answers 1 to 5 as described next: 1) strongly disagree, 2) disagree, 3) undecided, 4) agree, 5) strongly

agree. Several studies demonstrate that parametric statistics are robust concerning Likert scales [23]. The data mining and statistical analysis tool is SPSS 17

A non-probabilistic convenience sample was taken from the students of the Master's Degree in Civil Engineering Planning and Management (MAPGIC) and the Master's Degree in Concrete Engineering (MUIH). MAPGIC aims to create a management knowledge base that will enable an analysis of infrastructure and utilities, accelerate adaptation to new environments, provide leadership and human resource management skills, and enable optimal decision-making in the construction industry. The primary purpose of the MUIH is to promote a thorough knowledge of concrete as a structural material and the expertise necessary for the design and analysis of concrete structures.

A statistical analysis of each group's responses was performed to compare the results with previous studies. We also examined whether there are any significant differences between the groups of students. Microsoft Excel and SPSS statistical packages were used.

3 RESULTS

This section provides the results obtained from the questionnaire. Out of a universe of 64 people, 50 responses were obtained. 54% of the participants belong to MUIH, 46% belong to MAPGIC. The confidence interval is 95%, with p=q=0.5, implying a sampling error of 13.9%, considering that the sample characterizes an infinite population. 62% of the students sampled are male. In terms of nationality, the vast majority were international students (mainly from Latin America); 20% of respondents were from Colombia, 18% from Peru, and 12% from Ecuador.

The results show a degree of knowledge of the current problems somewhat higher than expected, although below that of answers given at random. Let us first look at the respondents' a priori opinion and then contrast this opinion with the results achieved.

Table 1 shows how the opinion on the degree of knowledge of the world around us is higher among the respondents and lower among journalists and the media. In addition, the standard deviation is smaller the higher the mean of the survey scores. The degree of self-confidence in the knowledge of current problems is high, with a lower dispersion than the other items.

Table 1. Mean and standard deviation of opinion on the degree of information about essential things in the world around us.

Item	*Average*	*Stdev.*
I1 In my opinion, I am informed about the essential things in the world around me.	3.56	.884
I2 I think that world leaders are informed about the essential things in the world around us.	3.52	1.182
I3 I think journalists and media are informed about the essential things in the world around us.	3.20	1.245

The distribution of responses to these items is highly skewed to the right. The samples do not pass the Kolmogorov-Smirnov test for normality. Therefore, Welch's nonparametric test was performed to test for differences between means. As the p-value = 0.24>0.05, there is no evidence to reject the null hypothesis of equality of means. Tamhane's T2 test also failed to detect differences between the one-to-one means. Fig. 1 shows the Box and Whisker plot for each Likert scale item. Here we observe the asymmetry in the distributions and the smaller range of variation for item I1 referring to self-confidence concerning knowledge of current problems.

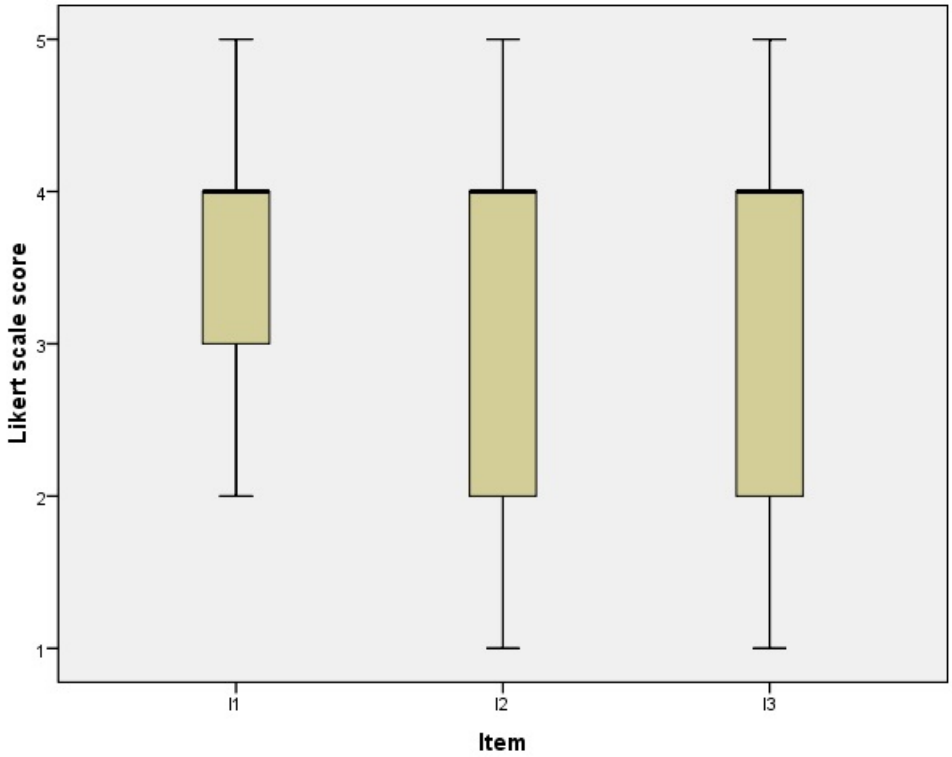

Figure 1. Box and Whisker plot for item averages.

Let us now analyze the a priori opinions of each group that participated in the questionnaire. MAPGIC students believe they have more information about the world today (3.83) than MUIH students (3.33). Similarly, males believe they have more information (3.61) than females (3.47). When it comes to the degree of information that world leaders have, MAPGIC students, have a more favorable opinion (3.83) than MUIH students (3.26). Similarly, women have a more favorable opinion (3.63) than men (3.45). When asked about the degree of information journalists and the media have, MAPGIC students have a more favorable opinion (3.61) than MUIH students (2.85). In this case, men are the ones who give a more favorable opinion (3.35) than women (2.95).

Therefore, MAPGIC students consistently rate the degree of knowledge of the current world higher than MUIH students do. The difference between the profiles of the two types of graduate courses is that MAPGIC students are more oriented towards business management, and MUIH students are more focused on calculus and design. This difference in profiles could explain the greater confidence of one group concerning the other regarding the degree of knowledge of the current world.

Interestingly, men have greater self-confidence in their knowledge of today's world and have more confidence in journalists and the media. On the other hand, women are more confident in the degree of knowledge of today's leaders.

Even though the MAPGIC students are more optimistic about the degree of information they have about the world today, the reality is that, of the 13 questions, they only surpassed the MUIH students in six of them. Similarly, the men, who were more self-confident a priori, only got five questions right compared to the women. Therefore, a positive a priori confidence bias on the knowledge of current problems is detected in the MAPGIC students and the men.

Table 2 shows the questions of the questionnaire, as well as the percentage of correct answers obtained for each academic group. Data obtained from Rosling et al. [9] are also included. It is observed that the total percentage of correct answers between MAPGIC and MIUH is practically the same, although there are differences concerning some of the questions. It also appears that the average percentage of correct answers of our students is slightly higher than that obtained in the data provided by Rosling et al. [9] for the world and, in particular, for Spain. Nevertheless, in all cases, the percentage of correct answers is less than 33%, which would be the correct answers if the questions were answered randomly.

Table 2. Percentage of correct answers associated with each question.

No.	Questions from Rosling et al. [9]	MAPGC+ MIUH	MAPGIC	MIUH	World	Spain
Q01	In all low-income countries across the world today, how many girls finish primary school?	8%	13%	4%	9%	3%
Q02	Where does the majority of the world population live?	28%	22%	33%	13%	13%
Q03	In the last 20 years, the proportion of the world population living in extreme poverty has...	12%	17%	7%	10%	9%
Q04	What is the life expectancy of the world today?	58%	52%	63%	26%	24%
Q05	There are 2 billion children in the world today, aged 0 to 15 years old. How many children will there be in the year 2100, according to the United Nations?	26%	30%	22%	20%	13%
Q06	The UN predicts that by 2100 the world population will have increased by another 4 billion people. What is the main reason?	28%	35%	22%	28%	23%
Q07	How did the number of deaths per year from natural disasters change over the last hundred years?	28%	22%	33%	26%	26%
Q08	There are roughly 7 billion people in the world today. Where do they live?	40%	43%	37%	7%	4%
Q09	How many of the world's 1-year-old children today have been vaccinated against some disease?	12%	9%	15%	15%	21%
Q10	Worldwide, 30-year-old men have spent 10 years in school, on average. How many years have women of the same age spent in school?	24%	22%	26%	22%	14%
Q11	In 1996, tigers, giant pandas, and black rhinos were all listed as endangered. How many of these three species are more critically endangered today?	2%	0%	4%	37%	41%
Q12	How many people in the world have some access to electricity?	42%	48%	37%	9%	7%
Q13	Global climate experts believe that, over the next 100 years, the average temperature will...	96%	96%	96%	87%	92%
AVERAGE NUMBER OF SUCCESSES		31,08%	31,46%	30,69%	23,77%	22,31%

It is worth noting that our students significantly failed question Q11 regarding endangered species. The percentage of correct answers in Spain or the world is much higher. On the other hand, students were more accurate in the question about where the current population lives (Q08) concerning the answers for Spain and the world. The same can be said for question Q12 related to the number of people who have access to electricity. Among the questions asked, one stands out for having been answered correctly by more than 96% of the participants. It refers to climate change's effect on the planet's temperature. This atypical response is observed in Fig. 2. Welch's nonparametric test does not allow us to discard the null hypothesis of a difference between means (p-value = 0.78 > 0.05).

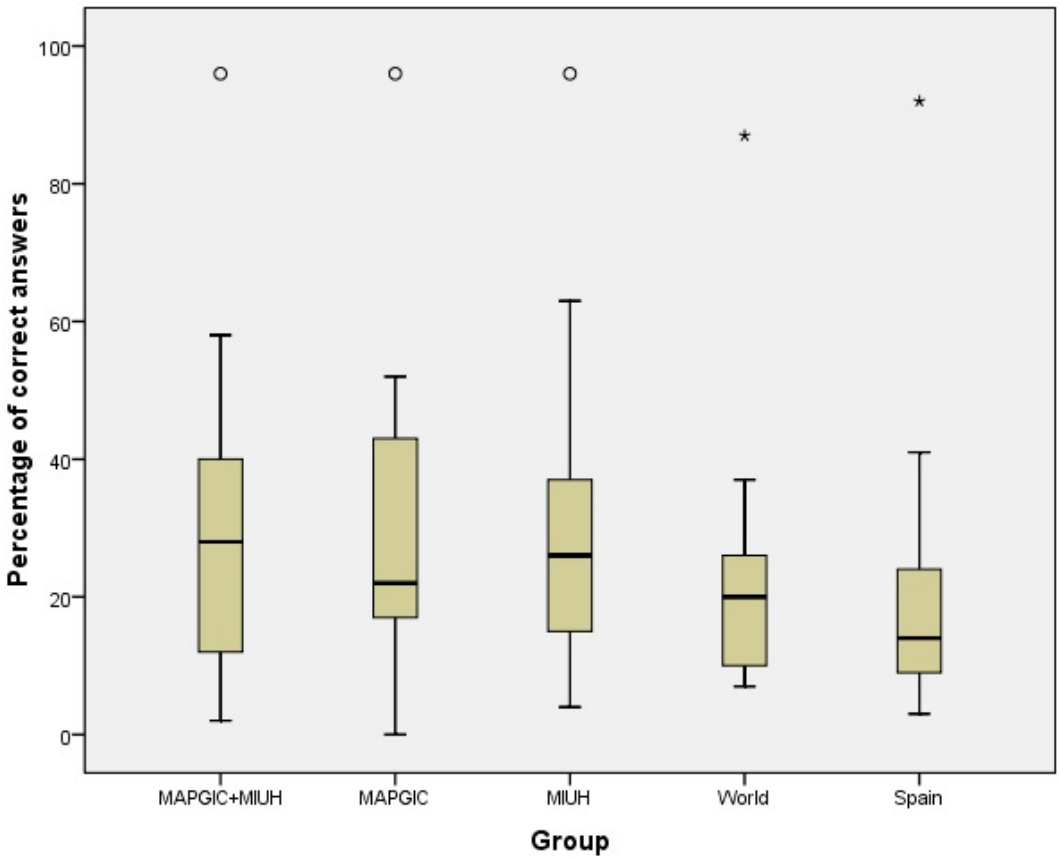

Figure 2. Box-and-whisker plot for group averages.

Table 3 shows the sample distribution according to the number of successes. Out of 13, three correct answers are the most frequent value among all groups, although, in the case of the MIUH, the number of correct answers is higher. One student from MAPGIC stands out who got all but one of the questions right. This case is atypical and would require a more detailed analysis. It is possible that this student has read the answers on the Internet or that he/she is a person with a very high level of information about the current data. Perhaps it would have been advisable to limit the time for answering the questionnaire and thus prevent respondents from finding out about the questions. However, this was not considered necessary, as it was an anonymous questionnaire.

Table 3. Percentage of people by the number of successes.

	0	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	***11***	***12***	***13***
MAPGIC	0%	4%	17%	35%	9%	17%	9%	0%	0%	4%	0%	0%	4%	0%
MIUH	0%	7%	11%	15%	26%	26%	11%	4%	0%	0%	0%	0%	0%	0%
Total	0%	6%	14%	24%	18%	22%	10%	2%	0%	2%	0%	0%	2%	0%

4 CONCLUSIONS

One of the transversal competencies that graduate students in civil engineering should attain is knowledge of contemporary problems. To determine whether our students have a clear vision of the current world, they were given a questionnaire with 13 questions designed by Rosling et al. [9]. Three items were added to this questionnaire to ascertain the a priori opinion that students themselves, world leaders, and journalists have of today's world. Fifty responses were obtained from a universe of 64 people. The ultimate goal is to identify whether teaching strategies need to be modified to improve students' acquisition of this competency.

The study concludes that students do not have a clear and up-to-date view of contemporary problems. In addition, there has been an aprioristic overestimation of knowledge of current problems. There were

only 31% correct answers. Considering that there were three possible responses, the results were even worse than randomly answering the questions. Students associated with a postgraduate course in construction management (MAPGIC) were more optimistic about knowledge of current problems than students associated with a postgraduate course in concrete engineering (MUIH).

The results also show that men are more confident in their knowledge of today's world and trust journalists and the media more. In contrast, women are more confident in the degree of knowledge of today's leaders. However, there are no significant statistical differences between the means of the various groups. In any case, it seems that the more calculus-oriented students and the females have a more realistic opinion.

On the other hand, except for one of the questions related to climate change, the percentage of correct answers was low. It is curious to note that our students have failed significantly in the question related to endangered species. The percentage of correct answers in Spain or the world is much higher. However, there was insufficient evidence to reject the null hypothesis of equality of means between MAPGIC, MIUH students, or the answers given by respondents in Spain and worldwide.

The present work results are statistically similar to those obtained by Rosling et al. [9] and show that UPV graduate students have an idea of the world, just as distorted as most of the population living in similar socioeconomic contexts. This circumstance supports the need to incorporate actions in the training of our students that allow them to recognize their limitations when interpreting complex issues. From this new perspective, students would be more receptive to understanding the mechanisms that have led them to assimilate these unfounded and widely shared social beliefs through overexposure to current media. Therefore, there is a need for postgraduate students to enhance competencies associated with understanding contemporary issues.

The consistency between the results obtained by our students and the rest of the participants in this questionnaire reveals a high disconnection between the actual data affecting humanity and the opinion held about it. There may be many factors involved in this disconnection. However, it seems clear that over information or fake news on the Internet, the lack of updating in teaching or learning, or the lack of habit in contrasting data or seeking reliable sources are, among many others, the possible causes of this misinformation. Understanding why people, after long periods of training, continue to have distorted views of everyday realities is a good start to understanding how knowledge is generated and acquired. Future research should delve deeper into these causes.

Considering that our students will soon be making important decisions that may affect many people, it is necessary to increase their competencies in the knowledge of contemporary problems. Therefore, it is essential to develop in the academic environment strategies that allow our students to deepen their knowledge of the current world and have critical thinking about it.

ACKNOWLEDGEMENTS

Grant PID2020-117056RB-I00 funded by MCIN/AEI/ 10.13039/501100011033 and by “ERDF A way of making Europe.”

REFERENCES

[1] L. J. Shuman, M. Besterfield-Sacre, and J. McGourty, “The ABET ‘professional skills’—Can they be taught? Can they be assessed?” *Journal of Engineering Education*, vol. 94, no. 1, pp. 41-55, 2005.

[2] S. Cassidy, “Developing employability skills: Peer assessment in higher education,” *Education and Training*, vol. 48, no. 7, pp. 508-517, 2006.

[3] C. Torres-Machí, A. Carrión, V. Yepes, and E. Pellicer, “Employability of Graduate Students in Construction Management,” *Journal of Professional Issues in Engineering Education and Practice*, vol. 139, no. 2, pp. 163–170, 2013.

[4] V. Yepes, E. Pellicer, and A. J. Ortega, “Designing a Benchmark Indicator for Managerial Competences in Construction at the Graduate Level,” *Journal of Professional Issues in Engineering Education and Practice*, vol. 138, no. 1, pp. 48–54, 2012.

[5] H. J. Passow and C. H. Passow, “Which ABET competencies do engineering graduates find most important in their work?” *Journal of Engineering Education*, vol. 101, no. 1, pp. 95-118, 2012.

[6] R. L. Meier, M. R. Williams, and M. A. Humphreys, “Refocusing our efforts: Assessing non-technical competency gaps,” *Journal of Engineering Education*, vol. 89, no. 3, pp. 377-385, 2000.

[7] H. J. Passow and C. H. Passow, “What competencies should undergraduate engineering programs emphasize? A systematic review,” *Journal of Engineering Education*, vol. 106, no. 3, pp. 475-526, 2017.

[8] Universitat Politècnica de València, “Proyecto competencias transversales UPV,” [Online]. Available: https://www.upv.es/entidades/ICE/info/Proyecto_Institucional_CT.pdf

[9] H. Rosling, O. Rosling, and A. R. Rönnlund, *Factfulness: ten reasons we’re wrong about the world and why things are better than you think*. London: Sceptre.

[10] A. Tversky and D. Kahneman, “Judgment under Uncertainty: Heuristics and Biases,” Science, vol. 185, no.4157, pp. 1124-1131, 1974.

[11] I. Yarritu, H. Matute, and D. Luque, “The dark side of cognitive illusions: When an illusory belief interferes with the acquisition of evidence-based knowledge,” *British Journal of Psychology*, vo. 106, no. 4, pp. 597-608, 2015.

[12] J. B. Bayon and A. A. Baranda, “Analysis of future teachers' perception about the current state of the world,” *Revista Interuniversitaria de Formación del Profesorado-RIFOP*, no. 95, pp. 197-211, 2020.

[13] E. Pellicer, V. Yepes, C.L. Correa, L.F. Alarcón, “Model for Systematic Innovation in Construction Companies,” *Journal of Construction Engineering and Management*, vol. 140, no. 4, p. B4014001, 2014.

[14] C. Torres-Machí, A. Chamorro, C. Videla, E. Pellicer, and V. Yepes, “An iterative approach for the optimization of pavement maintenance management at the network level,” *The Scientific World Journal*, vol. 2014, 2014.

[15] I. Paya-Zaforteza, V. Yepes, F. González-Vidosa, and A. Hospitaler, “On the Weibull cost estimation of building frames designed by simulated annealing,” *Meccanica*, vol. 45, no. 5, pp. 693–704, 2010.

[16] F. J. Martinez, F. Gonzalez-Vidosa, A. Hospitaler, and V. Yepes, “Heuristic optimization of RC bridge piers with rectangular hollow sections,” *Computers & Structures*, vol. 88, no. 5-6, p.p. 375-386, 2010.

[17] C. Carbonell, F. Gonzalez-Vidosa, and V. Yepes, “Design of reinforced concrete road vaults by heuristic optimization,” *Advances in Civil Software*, vol. 42, no. 4, pp. 151–159, 2011.

[18] T. Garcia-Segura, V. Penades-Pla, and V. Yepes, "Sustainable bridge design by metamodel-assisted multi-objective optimization and decision-making under uncertainty," *Journal of Cleaner Production*, vol. 202, pp. 904-915, 2018.

[19] C. Torres-Machí, A. Chamorro, E. Pellicer, V. Yepes, and C. Videla, "Sustainable Pavement Management Integrating Economic, Technical, and Environmental Aspects in Decision Making," *Transportation Research Record*, vol. 2523, pp. 56-63, 2015.

[20] I. Zamarrón-Mieza, V. Yepes, and J. M. Moreno-Jimenez, "A systematic review of application of multi-criteria decision analysis for aging-dam management," *Journal of Cleaner Production*, vol. 147, pp. 217-230, 2017.

[21] I. J. Navarro, V. Yepes, J. V. Martí, and F. González-Vidosa, "Life cycle impact assessment of corrosion preventive designs applied to prestressed concrete bridge decks", *Journal of Cleaner Production*, vol. 196, pp. 698-713, 2018.

[22] J. J. Pons, V. Penadés-Plà, V. Yepes, and J. V. Martí, "Life cycle assessment of earth-retaining walls: An environmental comparison", *Journal of Cleaner Production*, vol. 192, pp. 411-420, 2018.

[23] G. Norman, "Likert scales, levels of measurement and the "laws" of statistics," *Advances in Health Sciences Education*, vol. 15, No.5, pp. 625-632, 2010.