Designing a STEM perceptions questionnaire for Venezuelan migrant children and youths

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Abstract*– Public perception of science and technology has been on the world agenda since 1950 in North America and Europe and since 1960 in Latin America and the Caribbean, so that since the 1980s there has been greater public exposure to the problems caused by techno-scientific development, which has forced governments to be publicly accountable. Since then, the National Science Foundation (NSF) in the United States and the Eurobarometer in Europe have been benchmarks for the Public Understanding of Science. In this context, the term STEM was coined in 1990 by the NSF, as an acronym alluding to policies, projects, or programs in the areas of Science, Technology, Engineering, and Mathematics (STEM). STEM has been developed for privileged populations, understood as those with access to the best schools and universities in the world, so its application to vulnerable populations such as migrants has not been studied. The migrant population, especially Venezuelan migrant children and youth, present a double vulnerability, a first vulnerability related to their condition as migrants, in the sense of less power compared to the residents of the transit or destination countries, and a second vulnerability associated with their age, which does not allow them to ask for protection and access to their right to education on their own, which would make it difficult for them to access formal education. This research seeks to design a questionnaire to collect the perceptions about STEM of Venezuelan migrant children and youth, to diagnose their level of approach to these disciplines, understand this approach as beneficial for the processes of innovation and development (R&D) of the destination country. For this purpose, the research adopts a quantitative approach to give a causal explanation of STEM as a promoter of R&D, through the design of a questionnaire that allows describing the trends in the opinions about these disciplines using the study of a random sample of Venezuelan migrant children and young people. The 24-question questionnaire is divided into three indicators: knowledge indicators, interest indicators, and attitude indicators. The questionnaire design includes the social context, double vulnerability, and age, to diagnose the level of approach of Venezuelan migrant children and youth to STEM disciplines, as a promoter of R&D and as an option for their higher education. It is recommended to implement the questionnaire, analyzing their responses in three dimensions, which the NSF and the Eurobarometer have referenced: the appropriation dimension, the attitudinal dimension, and the informational dimension.

Keywords*-- STEM, Public Understanding of Science, Education, Migration.

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I. Introduction

Science and technology are important for political decision-making [1], promoting citizen participation and participation in public management through participatory, open, and decentralized mechanisms [2].

This technoscientific knowledge began to be relevant in the Global North, where the public perception of science and technology became a concern in 1950, while in Latin America it originated in the social struggles of the environmental movements of the 1960s and 1970s that claimed for the effects of science and technology on the environment, through the production of scientific knowledge and the activism of social protest [3].

This led in the 1980s and 1990s to greater public exposure of problems related to technoscientific development, which resulted in public accountability [4].

Due to the global relevance of citizen participation in technoscientific knowledge, instructions for measuring scientific literacy were designed [5] through scientific literacy indicators that link perception indicators (statements on attitudes, beliefs, and values) and science and technology indicators (statements on institutional systems) [6].

Indicators designed by the National Science Foundation (NSF) of the United States in 1979 [7] and the European Union's Science and Technology Eurobarometer in 1992 [8], have since then been the benchmark indicators of public understanding of science or Public Understanding of Science. In Latin America, these international benchmarks have been used to measure perceptions of science and technology through national surveys in countries such as Argentina, Brazil, Colombia, Mexico, Panama, Uruguay, and Venezuela, surveys with a time series that allows longitudinal analysis (see Table 1).

TABLE I
NATIONAL SURVEYS OF PERCEPTIONS OF SCIENCE AND TECHNOLOGY IN LATIN AMERICA.

Country	Institution	First survey	Last survey	Last national survey
Argentina	Ministerio de Ciencia, Tecnología e Innovación de la Nación (MINCyT)	2003	2021	5ta Encuesta Nacional de Percepción Pública de la Ciencia y Tecnología 2021 [1]
Brasil	Ministério da	1987	2019	Percepcão Pública

	Ciência, Tecnologia, Inovações e Comunicações (MCTIC)			da C&T no Brasil 2019 [2]
Colombia	Minciencias y el Observatorio de Ciencia y Tecnología	1994	2015	IV Encuesta Nacional de Percepción Pública de la Ciencia y Tecnología 2015 [3]
México	Consejo Nacional de Ciencia y Tecnología (CONACYT)	1997	2017	Encuesta sobre la Percepción Pública de la Ciencia y la Tecnología (ENPECYT) 2017 [4]
Panamá	Secretaría Nacional de Ciencia y Tecnología, (SENACYT)	2001	2017	V Encuesta de Percepción Social de la Ciencia y la Tecnología 2017 [5]
Uruguay	Agencia Nacional de Investigación e Innovación (ANII)	2008	2014	III Encuesta de Percepción Pública sobre Ciencia, Tecnología e Innovación 2014 [6]
Venezuela	Ministerio de Ciencia y Tecnología	2004	2009	Tercera encuesta nacional de percepción pública de la ciencia, cultura científica y participación ciudadana 2009 [7]

Source: Authors own creation.

Considering the trends in national surveys on science and technology in Latin America, a questionnaire was designed to collect perceptions about STEM in Venezuelan children and young people, adapting the science and technology indicators, whose responses can be analyzed in the dimensions that will be explained below.

II. Methodology

A Public Understanding of Science arises from the 1980 paradigm of public understanding of science [16], from which the Royal Society published a report in the second half of the 1980s, worrying about the weakening of public interest in science and declining public support for scientists [17], which would give rise to European science and technology public communication programs that sought to mitigate the anti-science movement [16].

The technique for collecting perceptions about STEM is the questionnaire, which consists of a set of questions related to quantifiable variables [18]. The questionnaire was chosen because it provides a quantitative description of the perceptions of the migrant and refugee population through the study of a sample of children and young people from the same population [19].

According to Vargas Beal, the design of this questionnaire is conducive to responding directly or through an interview with a sample of Venezuelan migrant children and young people. Therefore, its design includes mostly closed-ended questions and some open-ended questions. More closed than open questions are included to achieve greater objectivity in statistically describing the studied phenomenon of perception of STEM [20].

As for the closed questions, although they limit the answers, they allow us to anticipate them with demanding wording and clarity. Open-ended questions are more explanatory but more difficult to code, classify and analyze, due to the presence of some biases and difficulties in their comprehension. The design of the questionnaire considered the definition of clear, precise, and understandable questions, as well as the use of a simple and direct vocabulary. In addition, the questions designed did not induce answers or use negations [21].

However, due to the double vulnerability of the target sample of migrant children and youth, the questions in the questionnaire use a subtle vocabulary, which does not induce racist or sexist prejudices and avoids introducing an emotional and complex load to the participant.

Therefore, a questionnaire was designed with 30 questions divided into three indicators explained below: knowledge indicators, interest indicators, and attitude indicators.

A. Knowledge indicators

The knowledge indicators are based on the studies of Jon Miller and John Durant (see Table 2), specifically Miller proposed a multidimensional scientific literacy model that is quantifiable in three dimensions: understanding of scientific concepts, understanding of the methods of science, and understanding of the impact of science on society [8].

TABLE II
DIMENSIONS FOR MEASURING SCIENTIFIC LITERACY.

Durant [9]	**Miller [10]**	**National Science Foundation [11]**
Understanding of scientific vocabulary	Understanding scientific concepts	Understanding the scientific construct
Understanding the scientific process	Understanding of scientific methods	Understanding scientific research
No	Understanding the impact of science	No

Source: Authors own creation.

From the indicators in Table 2, we selected the National Science Foundation (NSF) indicators that have been frequently used in NSF surveys from 1986 to 2009 and called them the "Index of Understanding of Scientific Construct" and "Percentage of Understanding of Scientific Research" [11].

The first indicator on the NSF Science Construct Comprehension Index seeks to measure the level of

understanding of scientific concepts, which includes open-ended and true/false questions such as "What travels faster light or sound, tell me in your own words, what is DNA, did early humans live at the same time as dinosaurs, did early humans live at the same time as dinosaurs?" [11].

The second indicator on the percentage of understanding of scientific research responds to three dimensions, in the first dimension a participant with an acceptable level of understanding or higher must correctly answer all probability questions, the second dimension is related to "theory testing" which must answer what it means to study something scientifically, and in the third dimension must correctly answer the open questions about scientific experimentation [11].

B. Interest indicators

The indicators of interest bring together a set of variables that measure interest in science and technology topics, the self-assessment of the participants' level of information, and the reported cultural and information consumption habits.

On the one hand, the National Science Foundation (NSF) classifies the participants of its surveys into three groups, according to their interest and reported level of information, the attentive public, the interested public, and the residual public. The first group of the attentive public comprises participants who report a high level of interest in a specific topic, are informed, and read a daily newspaper, a weekly news magazine, or a related magazine on the topic. The second group of the interested public is made up of participants who report a high level of interest in a specific topic but are not informed about it. The third group of residual audiences is made up of participants who report being neither interested in nor informed about the topic [11].

On the other hand, the Eurobarometer measures the level of interest in specific science and technology topics by asking participants about the level of information on these topics and the use of science and technology media. Therefore, the Eurobarometer analyzes the interest dimension in two parts, the first part analyzes participants' interest in scientific and non-scientific topics in the news and the level of information reported on these topics; and the second part analyzes articles in scientific journals, newspapers, and television programs, as well as visits to institutions such as museums and zoos [12].

C. Attitude indicators

Parallel 1988 surveys by Durant in the United Kingdom and Miller in the United States proposed the correlation between knowledge and attitude, with scientific understanding being a pre-attitudinal explanatory variable, while interest level served to measure attitude formation if participants interested in a topic are usually informed about it, and if they are well informed they tend to have a better attitude towards science and technology [13].

In the Eurobarometer, the attitudinal dimension has been analyzed through variables that measure attitudes about the benefits and risks of science and technology, attitudes towards specific technoscientific applications and their government funding, perceptions about the quality of science and its effects, public confidence in the scientific community compared to other institutions, the responsibility of scientists in the negative effects of science on society, among others. This has made it possible to investigate the general public's optimism and pessimism toward science and technology [14].

III. RESULTS

A questionnaire was designed to identify STEM perceptions in Venezuelan migrant children and youth, which is divided into two parts, a first part that asks participants about their sociodemographic classification and a second part that inquiries about the three dimensions of analysis.

A. Sociodemographic Classification

The questionnaire begins with a cover page (see Table 3), which seeks to characterize the sample of migrant children and youth, through an anonymized sociodemographic classification, which inquiries about gender, age, place of birth, current occupation, type of housing, and its public services, last grade of schooling and characteristics of entry to Colombia.

TABLE III
COVER PAGE OF THE QUESTIONNAIRE.

Sex	**Male** **Woman**
Age	Number in years completed
Place of birth	Name of country, state, and city of birth
Current occupancy status	Domestic work (care of family members) Full-time employee (30 hours or more per week) Part-time employee (between 9 and 29 hours per week) Casual or informal work Self-employed as a freelancer Unemployed Student
The type of housing where you currently reside is:	House Apartment Room No
Your home is:	Own Leased From a relative
Choose the utilities available in your home:	Electric power Aqueduct Sewage
Last grade of schooling	Sixth Seventh Eighth Ninth Tenth Eleven
Characteristics of entry to the country of destination (Colombia)	Date of entry to the country of destination (day/month/year) Departure from country of origin (day/month/year) Cause of departure from the country of origin (systematic violation of human rights, serious disturbance of public order or political opinion)

	State, city, and country of origin (country, state, and city) Form of entry to the country of destination (land or air) Type of entry (regular or irregular) Type of migration (individual, family, or group) Treatment by immigration authorities	

Source: Authors own creation.

B. Dimensions of Analysis

The questionnaire begins with a cover page (see Table 3), which seeks to characterize the sample of migrant children and youth, through an anonymized sociodemographic classification, which inquiries about gender, age, place of birth, current occupation, type of housing, and its public services, last grade of schooling and characteristics of entry to Colombia.

TABLE IV
ATTITUDE DIMENSION QUESTIONS.

In the coming years will the development of science, technology, engineering, and mathematics bring many, few, or no benefits? Choose only one answer.		**Many benefits Few benefits No benefits**
In the coming years will the development of science, technology, engineering, and mathematics bring many, few, or no risks? Choose only one answer.		Many risks Low risk No risk
Do you strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree with each of the following statements? Please answer each statement.	Science, technology, engineering, and mathematics are making our lives easier. Science, technology, engineering, and mathematics can solve any kind of problem. Science, technology, engineering, and mathematics are producing an artificial lifestyle. Science, technology, engineering, and mathematics are changing our way of life too fast.	Strongly agree Agree Neither agree/disagree Disagree Strongly Disagree
How much do you appreciate each of the following professions? Would you say you appreciate them a lot, a little, or not at all? Please answer for each profession.	Artist Judge Physician Businessman Religious Scientist Sportsman Professor Engineer Mathematician Journalist Technology professional	A lot A little Not at all
Who do you trust the most in forming your opinion? Choose only 3 in ascending order from most to least important.	Journalists Doctors Scientists Working for Industry Representatives of consumer organizations Religious Government representatives Scientists working for public institutes or centers Representatives of social or environmental organizations Politicians Military Writers Teachers Mathematicians Technology professionals	Option 1 Option 2 Option 3
What does a scientist look like to you? Choose only 2 options.	Distracted Passionate about his work Above average intelligence Solitary Rare An ordinary person with special training Someone who reasons logically Has an open mind to new ideas Curious Rigorous Likes to work in a team	Option 1 Option 2
What does a technology professional look like to you? Choose only 2 options.	Distracted Passionate about his work Above average intelligence Solitary Rare An ordinary person with special training Someone who reasons logically Has an open mind to new ideas Curious Rigorous Likes to work in a team	Option 1 Option 2
What does an engineer look like to you? Choose only 2 options	Distracted Passionate about his work Above average intelligence Solitary Rare An ordinary person with special training Someone who reasons logically Has an open mind to new ideas Curious Rigorous Likes to work in a team	Option 1 Option 2
What does a mathematician look like to you? Choose only 2 options.	Distracted Passionate about his work Above average intelligence Solitary Rare An ordinary person with special training Someone who reasons logically Has an open mind to new ideas Curious Rigorous Likes to work in a team	Option 1 Option 2
Which professions from	Artist	Option 1

the following list do you find most interesting? Choose only 2 professions in ascending order from most to least interesting.	Judge Physician Businessman Religious Scientist Sportsman Professor Engineer Mathematician Journalist Technology professional	Option 2
What is your image of the profession of a scientist? Would you say it is a profession...		Very attractive Attractive Unattractive Not attractive at all
What is your image of the technology profession? Would you say it is a profession...		Very attractive Attractive Unattractive Not attractive at all
What is your image of the engineering profession? Would you say it is a profession...		Very attractive Attractive Unattractive Not attractive at all
What is your image of the profession of mathematician? Would you say it is a profession…		Very attractive Attractive Unattractive Not attractive at all
What is your image of the profession of a scientist? Would you say it is a profession...		Very well remunerated Well remunerated Poorly remunerated
What is your image of the technology profession? Would you say it is a profession...		Very well remunerated Well remunerated Poorly remunerated
What is your image of the engineering profession? Would you say it is a profession...		Very well remunerated Well remunerated Poorly remunerated
What is your image of the profession of mathematician? Would you say it is a profession…		Very well remunerated Well remunerated Poorly remunerated
What is your image of the profession of a scientist? Would you say it is a profession...		Very prestigious Prestigious Not very prestigious Not prestigious at all
What is your image of the technology profession? Would you say it is a profession...		Very prestigious Prestigious Not very prestigious Not prestigious at all
What is your image of the engineering profession? Would you say it is a profession...		Very prestigious Prestigious Not very prestigious Not prestigious at all
What is your image of the profession of mathematician? Would you say it is a profession…		Very prestigious Prestigious Not very prestigious Not prestigious at all
Why do you think that for some young people a career in Science, Technology, Engineering, and Mathematics (STEM) is not attractive? Choose only 3 options.	It's a matter of taste, they think about other careers. They think STEM subjects are very boring. They think STEM subjects are too difficult. They prefer a job with more regular hours. As a STEM professional, it is difficult to become famous. Salaries in STEM professions are not good. There are few opportunities to get a job as a STEM professional. Jobs in STEM professions are not very stable. They do not like having to continue studying Indefinitely. They know that to get a good job as a STEM professional it is necessary to go abroad. They think that current research in STEM disciplines is too subject to economic objectives. Other reason (specify)	Option 1 Option 2 Option 3

Source: Authors own creation.

The appropriation dimension (3 questions) includes indicators on the use of technoscientific information and knowledge indicators (see Table 5).

TABLE V
OWNERSHIP DIMENSION QUESTIONS.

Knowledge in Science, Technology, Engineering, and Mathematics improves people's ability to make important decisions in their lives. Choose only one answer.		Strongly agree Agree Neither agree/disagree Disagree Strongly Disagree
Was the Science, Technology, Engineering, and Mathematics education you are receiving in school very good, good, average, bad, or very bad? Choose only one answer.		Very good Good Average Bad Very bad
How would you rate your overall grades in high school in the following subjects? Would you say they were "very good,"	Mathematics Chemistry Physics Biology	Very good Good Average Bad

"good," "average," "bad," or "very bad"? Answer for each subject.	Technology	Very bad

Source: Authors own creation.

The informative dimension (4 questions) inquiries about citizen interests in science and technology are present in the media and public discourse (see Table 6).

TABLE VI
INFORMATIVE DIMENSION QUESTIONS.

What news topics interest you the most? Choose only 3 in ascending order from most to least important.	Sports National Politics Economy Agriculture Science Health International Technology Entertainment Education Police Arts & Culture	Option 1 Option 2 Option 3
During the last 12 months, did you do any of these activities? Please answer for each activity.	Visit a science and technology museum. Visit a zoo or aquarium. Visit a botanical garden. Visit a national park, ecological or natural reserve. Attend a National Science Week activity. Visit a museum or art exhibit. Visiting a public library. Visiting historical sites or monuments. Go to the theater, movies, or other cultural activities. Attending a sporting event. Visiting a science and technology laboratory or institution.	Yes No
For what main reason did you visit a science and technology museum in the last year? Choose only one answer.	To learn something On the recommendation of an acquaintance I did it for my children/family and friends Because it's fun It was just by chance I like science and technology Because of a special exhibition or event that interested me I had nothing to do that day It is close to my home Other reason (specify)	
Do you do the following activities frequently, occasionally, rarely, rarely, or never? Please answer for each activity.	Watch TV programs or documentaries about science, technology, or nature. Read science news published in newspapers. Listen to sections or radio programs that deal with science and technology. Read popular science magazines. Read popular science books. Use the Internet to search for scientific information. Visit museums, centers, or exhibitions on science and technology.	Yes, frequently Yes, from time to time No, rarely or never

Source: Authors own creation.

IV. CONCLUSIONS

A questionnaire measuring perceptions of STEM in migrant children and youth was obtained. Therefore, its subsequent implementation will allow us to analyze the responses collected in three dimensions of analysis: attitudinal dimension, appropriation dimension, and informative dimension.

It is recommended to implement the questionnaire for children and young people in secondary education, to make correlations between the indicators of knowledge, interest, and attitudes towards STEM, to bring them closer to these disciplines, as an option for their higher education, which will reduce the deficit in STEM professionals in Latin America.

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