Participation of universities in the diffusion of metrology research: the case of the Metrology Symposium from CENAM

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Abstract. An exploratory study on the participation of universities on the CENAM Metrology Symposium was done. Nine editions of the symposium have been carried out since 2001 until 2016, mostly in a biannual scheme. Although the symposium has a high reputation in Mexico because it is organized by the national metrology institute, and even when there are more than 2 000 universities all over the country, less than 100 universities have been doing metrology research diffusion in that forum. Exploration of possible causes was done. Among the results, geographic localization, presence of metrology related research groups, and metrology related subjects in the careers offered arise as some of the reasons for the participation of universities in the CENAM Metrology Symposium.

1. Introduction

In Mexico, the scientific authority in metrology is the National Metrology Center (CENAM, for the Spanish ‘Centro Nacional de Metrología’), among whose functions are: “to promote and carry out research and technological development activities in the different fields of metrology, as well as to contribute to the formation of human resources for the same objective; and organize and participate, where appropriate, in congresses, seminars, conferences, courses or in any other type of events related to metrology” [1]. Even though metrology is a relatively young science in México (CENAM just celebrate its 20th anniversary in 2014), its diffusion has expanded due to its relevance and preponderant role in the scientific and technological development of the country.

By far, the most important metrology event in Mexico is the CENAM’s Metrology Symposium (CMS), which CENAM has been organizing since 2001, and since 2002 every other year, so that until 2016 nine editions of the symposium have been carried out. The CMS, an open event, has been showing to the Mexican metrological community the technological advances and the state of the art of the science of measurements. Given the youth of the discipline in the country, the participation of the scientific community in the CMS has been growing gradually (see figure 1). Naturally, in the first editions of the CMS, the participation was practically covered by the staff of CENAM and some guests of other national metrology institutes (NMIs), specially for plenary conferences [2].

Therefore, most of the Mexican universities have not been present at the CMS as presenters at the oral or poster sessions. Only few universities have carried-out science diffusion activities in the CMS. This paper aims to make an exploratory study about which universities have been participating in CMS, its research areas, frequency of participation, relation with the CENAM and even the geographical proximity to the CENAM location, in search of the reasons for their participation in the CMS.
2. Participation of universities in the CMS

Even when in fully developed countries the role of the universities in metrology is a primary one (e.g., in Denmark, the Technical University of Denmark owns a private metrology company [3]), in México it is not the same. To reach such levels of participation from the universities in the metrology research and development of México, there is a need to start disseminating research in metrology carried out by the universities. It is important to note that the concept of university here includes all kind of corporation of people that deals with teaching at undergraduate level and makes research too [4].

One of the indicators that can be used to monitor the participation of universities in metrology research activities is their participation in the CMS. Figure 2 shows the trend of the universities participation in CMS oral presentations, while figure 3 shows the universities participation in CMS poster presentations. As can be seen, it has been a growing trend in both universities participations since the first edition of the CMS in 2001.

Figure 1. General participation in the CMS [2].

Figure 2. Participation of universities in oral presentations in the CMS [2].
Figure 3. Participation of universities in poster presentations in the CMS [2].

However, it is important to note that average percent of poster presentations is higher by ten points than average percent of oral presentations. This could be natural for presentations coming from universities research groups, specifically in a metrology event hosted by the CENAM. Additionally, a kind of complementary behavior could be seen on the graphs, that is, more oral participation implies less poster participation and vice versa, this behavior follows the general trend in the CMS, as can be seen in figure 1. A graph of plenary sessions is not included because no speaker from any university has been invited to present a plenary conference in the CMS.

The next important question to answer could be: How many different universities originate the figures in figures 2 and 3? The answer is illustrated in figure 4, where can be seen that 50 % of the 306 works presented in the CMS with authors coming from universities, belong to only 12 of the 94 universities participants. From that 12 universities 3 of them are not Mexican ones [2]. It is important to note that there are almost 2 300 universities in Mexico, and more than 900 of them offer careers (e.g., Engineering, Physics) related with or that includes metrology or related subjects (e.g., instrumentation, physics laboratories, etc.) [5].

Figure 4. Distribution of the general participation of universities in the CMS [2].
3. Results and Discussion

Only twelve universities were responsible for the fifty percent of the works presented at CMS between 2001 and 2016. Figure 5 shows the relation between the participation in the CMS of the twelve universities and their general publications rate in Scopus® indexed journals (source: Scival®) [6]. Even when there seems to be a direct relationship between the number of articles published with a certain university affiliation, and the presence of that university in the CMS, it is not true for the Mexican universities UANL, UPSRJ or ITC, nor for the foreign university UCR (University of Costa Rica). Additionally, it must be considering the size of the university and its researchers population. Of course, there is the possibility that the researchers made most of its publications in journals not indexed in Scopus®.

![Figure 5. The twelve universities that own 50 % of universities’ presentations in the CMS [2].](image)

With respect of the localization of the universities that have been making diffusion in the CMS, figure 6 shows the number of presentations per localization in a Mexico map. It is clear that the nearness of CENAM has an important influence on participation, because the 3 most prolific states (Ciudad de México: 82 presentations, Guanajuato: 29 presentations, and Querétaro --where CENAM is--: 28 presentations). The exceptions, besides the foreign participations, are the next two more prolific states (Sonora: 16 presentations and Chiapas: 9 presentations), which are too far from the center of the country. It is worth to note that Mexico City houses UNAM and IPN, Guanajuato houses ITC and UG, and Querétaro hosts UPSRJ.

The other prolific national universities: UANL, UdeG, US, and UABC, are housed in the states Nuevo León (8 presentations), Jalisco (in the Pacific Ocean middle side, 6 presentations), Sonora and Baja California (norther point, 6 presentations), respectively. UNLP is from Argentina (9 presentations), UCR is from Costa Rica (8 presentations), and UTP is from Colombia (19 presentations).

Another possible cause for the participation of universities in the CMS is the presence of research groups related with metrology. One indicator about research groups present in a Mexican university is the presence of recognized researchers by the National System of Researchers (‘Sistema Nacional de Investigadores’, SNI for the Spanish term) [7]. SNI is divided in 7 areas and everyone has between
10 % and 17 % of the total Mexican recognized researchers. Area I includes Physics (16 %) and Area VII includes Engineering (14 %). The table 1 shows the presence of SNI researchers in the states with the most prolific metrology research presented in the CMS. Even when there is no way to claim that a causation exists, in the cases of Ciudad de México, Guanajuato and Querétaro, a good level of SNI researchers favors the higher levels of participation in the CMS.

Figure 6. Geographical distribution of 307 presentations in the CMS between 2001 and 2016 [2].

Table 1. Geographical distribution of SNI Researchers and States participation in CMS [7].

| State                  | SNI Researchers | Participation in CMS |
|------------------------|-----------------|----------------------|
| Ciudad de Mexico       | 7 524           | 82                   |
| Guanajuato             | 719             | 29                   |
| Querétaro              | 548             | 28                   |
| Nuevo León             | 857             | 8                    |
| Jalisco                | 1 083           | 6                    |
| Sonora                 | 454             | 16                   |
| Baja California        | 659             | 6                    |

Finally, a web-based research was carried out on the undergraduate programs of the 94 universities that have been participating in the CMS. Subjects called ‘Metrology’, ‘Instrumentation’ or ‘Laboratory of Physics’ were found in 87 % of the 94 universities. For the remaining 13 % it was not possible to find out a metrology related subject in the specific engineering or sciences programs.
4. Conclusions
Participation of universities in the CMS has been growing. The expected behavior of more participation in poster than oral, has reached 10 % average. However, a better diffusion of metrology research need to be done through more Mexican universities, provided that only 10 % of Mexican universities with engineering or sciences programs have been at least one time in the CMS. Some possible causes about this lack of participation were studied. Geographical localization was found as an important factor that promotes the participation in the CMS: in general, universities located near to CENAM are more participative in the CMS. The presence of nationally recognized metrology researcher, with the subsequent existence of a metrology research group in the universities was also analyzed, however it was not found as a determinant factor. May be this is because many of the works presented by the universities in the CMS had CENAM’s personnel as coauthors, so they provide the metrology expertise. Finally, on a web-based research a very high relation between the presence of a subject related with metrology in a university undergraduate program, and the participation in the CMS of that university was found, for the 94 universities that have been at least one time in the CMS.

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