

Outreach and Impact of the Hyper-Kamiokande experiment in Mexico and Latin America from 2020 to 2023 in social media.

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Abstract

Outreach Hyper-Kamiokande Mexico has significantly boosted the visibility of the project and increased Latin American engagement. This paper evaluates the strategies and impacts of its outreach initiatives, emphasizing digital communication. Data indicates a significant uptick in engagement metrics, signaling growing scientific interest, driven by an inclusive communication approach. These results highlight the importance of localized outreach within global collaborations, showing how targeted engagement can elevate public understanding and support for large-scale scientific projects in Latin America.

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1 Introduction

Mexico's official participation in Hyper-Kamiokande was established in 2019 through the collaborative efforts of PhD professors Saúl Cuen-Rochin (Instituto Tecnológico de Estudios Superiores de Monterrey; ITESM) and PhD. Eduardo de La Fuente (Universidad de Guadalajara; UdeG), with the support of PhD. Akira Konaka (TRIUMF Laboratory, Vancouver) and PhD. Takaaki Kajita (Institute of Cosmic Ray Research, University of Tokyo). Subsequently, in 2024 the Universidad Autónoma de Sinaloa (UAS) and the Universidad Autónoma de Chiapas (UNACH) joined the Hyper-K México collaboration (see also 1).

Outreach Hyper-Kamiokande Mexico (Hyper-K MX) is the Mexican branch of the Hyper-K neutrino experiment to be installed in Japan. The purpose is to connect the breakthroughs of

11 the Hyper-K project with Mexico and Latin America, fostering a deeper understanding of neu-
12 trino physics and its broader implications. Through social media engagement, collaborations
13 with laboratories, public talks, and cultural and educational initiatives. Outreach Hyper-K
14 MX has reached a diverse audience, promoted scientific literacy, and ignited interest in fun-
15 damental research throughout the region. This article examines the impact of our outreach
16 efforts, highlighting our role in communicating advances related to this neutrino detector and
17 the contributions made by UdeG and the ITESM (1) from 2020 to 2023, even though the
18 dissemination of the project on social media began in 2021.

19 Monitoring social media engagement allows companies to gain insights into potential cus-
20 tomers. In business marketing the return-on-investment (ROI) metric is essential to justify the
21 money invested in marketing and the return on sales. While ROI is not an essential metric in
22 scientific outreach, others remain indispensable (2). Key performance indicators (KPIs) such
23 as audience reach and engagement rates allow us to evaluate the success of our outreach ini-
24 tiatives. Although a standardized metric across scientific accounts is not feasible, since every
25 account addresses unique projects and objectives, customized metrics may provide a frame-
26 work to understand engagement with science.

27 **2 Methodology**

28 **2.1 Research Approach**

29 This research focuses on evaluating the outreach initiatives carried out on social media plat-
30 forms by Outreach Hyper-K MX and comparing them with other outreach accounts on a na-
31 tional, institutional, and global scale. The approach adopted is quantitative, utilizing data
32 collected from 2020 to 2023.

33 **2.2 Data Collection and Processing**

34 Due to API restrictions, we manually collected public data from YouTube, Facebook, X, Insta-
35 gram, and TikTok. We processed the collected data using data analysis tools in Python. We
36 generated graphs and visualizations to compare the metrics of Outreach Hyper-K MX with
37 other global and national initiatives, as well as the general outreach efforts of Hyper-K.

38 **2.3 Comparison of Initiatives**

39 To conduct the comparison, we established three evaluation criteria based on the engagement
40 on social media for each outreach initiative (2). Shares and comments are key metrics, as they
41 indicate the value of the content(3).

42 The first metric assesses interaction growth by comparing total and normalized social me-
43 dia interactions across outreach efforts. Normalization is done by dividing yearly interactions
44 by the number of institutions managing the outreach of each experiment.

45 The second metric is the Exploratory Data Analysis (EDA) (4). We used measures such as
46 mean and standard deviation, to evaluate outreach performance describing social media data.

47 The third metric is the engagement of followers on each outreach initiative's social media.
48 The engagement rate (5) is defined as:

$$\text{Engagement Rate} = \frac{\text{Average number of interactions}}{\text{Number of followers}} \times 100. \quad (1)$$

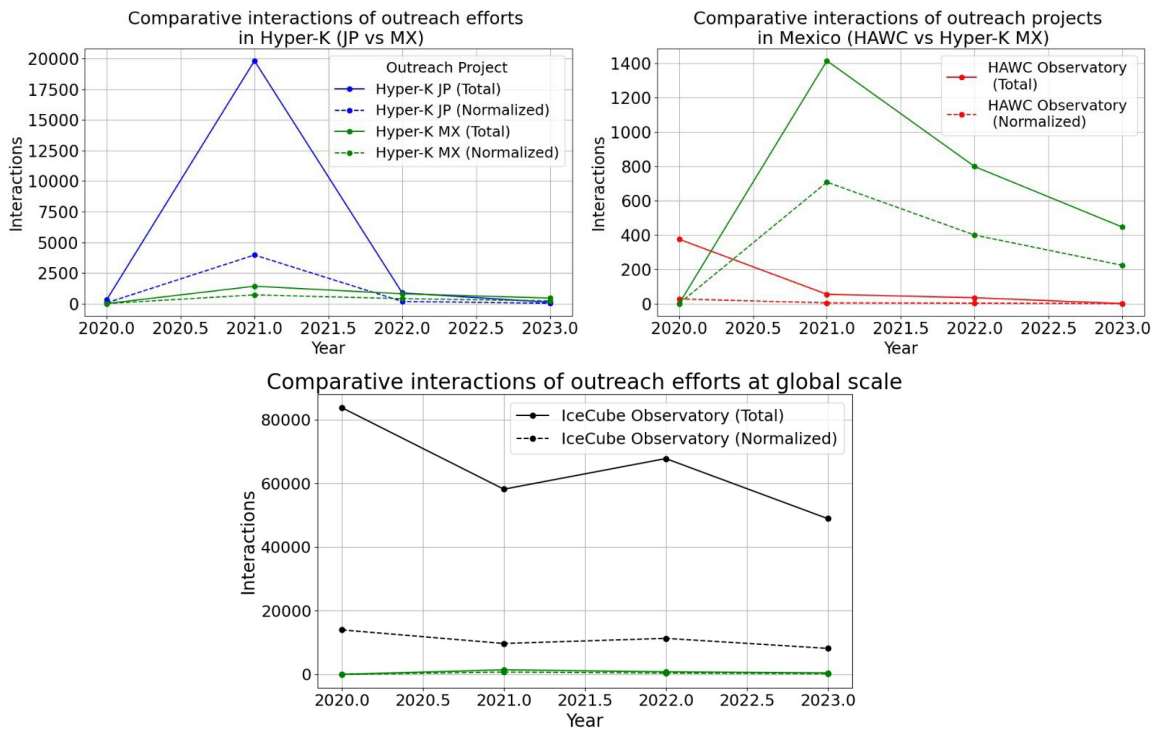
49 where interactions include comments, shares, likes, and views, among others.

50 **2.4 Limitations**

51 It is important to note that data collection through manual entry may present limitations, such
 52 as potential entry errors and changes in data access policies from social media platforms.

53 **3 Social Media Impact Results**

Figure 1: Annual interactions between HAWC (blue) Hyper-K MX (green), Hyper-K JP (red) and IceCube Observatory (black).



54 **3.1 Mexico and Hispanic America Outreach**

55 In 2024, despite the collaboration of Brazil in the Hyper-K project, a public search reveals that
 56 Outreach Hyper-K Mexico remains the only initiative of the Hyper-K project in the Americas.
 57 Therefore, to provide a comparative analysis, we need to look at another particle observatory
 58 within Mexico, such as the High-Altitude Water Cherenkov Observatory (HAWC)(6). The insti-
 59 tutions managing the social media pages of the HAWC in Mexico ¹ are led by the Universidad
 60 Nacional Autónoma de México (UNAM) and the Instituto Nacional de Astrofísica, Óptica y
 61 Electrónica (INAOE). At the top right of Fig.1 it is shown that Hyper-K MX generally achieves
 62 higher interactions than HAWC Mexico (HAWC MX).

63 **3.2 Institutional Hyper-K Outreach**

64 The main outreach initiative of the Hyper-K project (Hyper-K Japan) involves 5 main insti-
 65 tutions: The University of Tokyo, the High Energy Accelerator Research Organization (KEK),
 66 the Japan Proton Accelerator Research Complex (J-PARC), the Kamioka Observatory, and the

¹<https://www.hawc-observatory.org/collaboration/>

67 Institute for Cosmic Ray Research (ICRR). In the top left of Fig. 1, Hyper-K JP is shown to typ-
 68 ically have more interactions than Hyper-K MX, except in 2022 for normalized interactions,
 69 and in 2023, when Hyper-K MX exceeds in both total and normalized interactions.

70 3.3 Worldwide Outreach

71 To determine whether Outreach Hyper-K MX is having a significant global impact, we com-
 72 pare its number of social media interactions with those of other neutrino experiments with an
 73 international presence, such as the IceCube Neutrino Observatory, a detector located in Antarc-
 74 tica and led by the University of Wisconsin-Madison ² (USA)(7). At the bottom of Fig. 1, it
 75 is shown that IceCube generally surpasses Hyper-K MX in both total and normalized annual
 76 interactions.

77 3.4 Statistical analysis

78 Tab.1 shows unnormalized core participation metrics for key engagement measures, while
 79 Tab.2 presents normalized per-participant counts to determine efficiency across outreach ini-
 80 tiatives. Based on the EDA model, these metrics are essential for evaluating engagement suc-
 81 cess and facilitating comparisons between initiatives (4). In Tab.3, the engagement rate is
 82 provided for each type of post across different social media platforms. This rate reflects au-
 83 dience interaction relative to the follower count within a specified timeframe, offering insight
 84 into content appeal and reach on social media.

Table 1: Statistical Analysis of total social interactions (2020-2023).

Observatory	mean	std	min	25%	50%	75%	max	Total interactions
Hyper-K JP	5276.25	9701.23	101.0	261.50	592.0	5606.75	19820.0	21105.0
Hyper-K MX	665.25	597.81	0.0	334.50	622.5	953.25	1416.0	2661.0
HAWC	115.75	174.264885	0.0	25.50	44.0	134.25	375.0	463.0
IceCube	64605.25	14904.84	48822.0	55801.50	62937.5	71741.25	83724.0	258421.0

Table 2: Statistical Analysis of normalized interactions (2020 to 2023).

Observatory	mean	std	min	25%	50%	75%	max	Normalized interactions
Hyper-K JP	1055.25	1940.25	20.2	52.30	118.40	1121.35	3964.00	4221.00
Hyper-K MX	332.63	298.91	0.0	167.25	311.25	476.63	708.0	1330.5
HAWC	8.27	12.45	0.0	1.82	3.14	9.59	26.79	33.07
IceCube	10770.42	2480.08	8148.5	9303.13	10489.58	11956.88	13954.00	43081.67

85 Statistical analysis reveals differences in outreach interactions across projects. In Tab.1, the
 86 IceCube Neutrino Observatory leads with a mean of 64,605.25 total interactions, highlighting
 87 strong outreach effectiveness. By contrast, Hyper-K MX has a lower mean of 665.25, suggest-
 88 ing room for improvement in engagement approaches. Tab.2 presents normalized interactions,
 89 where the IceCube Neutrino Observatory maintains significant outreach with a normalized
 90 mean of 10,770.42, while Hyper-K JP and Hyper-K MX show lower values, at 1,055.25 and
 91 332.63, respectively. Tab.3 shows engagement rates in 2023 by platform, with Hyper-K MX
 92 achieving high rates on YouTube (538.9%) and TikTok (340.7%), where audience interactions
 93 are notably higher than on Facebook (7.2%).

²<https://icecube.wisc.edu/collaboration/institutions/>

Table 3: Engagement rate by each Outreach.

Observatory	Facebook	Instagram	YouTube	X	TikTok
IceCube	72.7%	242.4%	138.6%	57.9%	-
HAWC	0.0%	-	-	-	-
Hyper-K JP	0.0%	-	0.0%	5.4%	-
Hyper-K MX	7.2%	80.9%	538.9%	8.5%	340.7%

94 In social media analysis, engagement rates can sometimes surpass 100% due to the way
 95 they are calculated, as we can see in Tab.3. This often involves measuring interactions as
 96 a percentage of impressions or reach instead of total followers. When users engage multiple
 97 times—by liking, commenting, or sharing on the same posts—the engagement rate can exceed
 98 100%, particularly for content that goes viral or is viewed frequently. Research indicates that
 99 this elevated engagement typically signifies strong user interest and repeated exposure, rather
 100 than just unique interactions, offering a more nuanced understanding of online engagement
 101 trends (8).

Table 4: Outreach Hyper-Kamiokande Mexico’s Facebook and Instagram accounts including top follower’s information (Last 28 Days retrieved 25/oct/2024)

	Top Locations (%)						Age Range ¹	
	Mexico	USA	France	Germany	Colombia	Japan	Years	%
Instagram	86.2	3.8	1.7	1.4	1	-	18-24	56.6
Facebook	309	12	0	3	0	3	25-34	42.8

¹ The age range percentages represent the largest follower demographics on each platform. For further information: <http://hyperkamiokande.itesm.acsitefactory.com/es>.

102 These results in Tab.4 evidence the disparity in outreach effectiveness and highlight the
 103 need for targeted strategies to enhance engagement, particularly for Hyper-K MX and HAWC.
 104 It is important to mention that our objectives focus on engaging an audience aged 18 and
 105 older, as our outreach aims to communicate the Hyper-K advances to a broader community.

106 4 Discussion

107 Across the nation, Hyper-K MX performs slightly higher social media engagement and online
 108 presence than the HAWC Observatory. In contrast to Hyper-K JP, Hyper-K MX has lower en-
 109 gagement overall, although it has outperformed Hyper-K JP in the past two years, less posting
 110 frequency is the possible reason behind these results. Globally, Outreach Hyper-K MX exhibits
 111 lower engagement and efficiency than the IceCube Observatory, as shown in Tab.2. From Oc-
 112 tober 1 to October 25, 2024. Mexico has become the leading location for outreach engagement
 113 on Instagram and Facebook, comprising 86.2% of Instagram interactions and 309 interactions
 114 on Facebook. The United States and Germany represent 3.8% and 1.4% of Instagram inter-
 115 actions, along with 12 and 3 Facebook interactions, respectively. The 18-24 age group leads
 116 on Instagram with 56.6%, while the 25-34 age group is most active on Facebook with 42.8%.
 117 The gender distribution is similar on both platforms, with men representing 56.8% of inter-
 118 actions on Instagram and 56.5% on Facebook and women representing 43.2% and 43.5%,
 119 respectively. It is important to note that the Hyper-K project is still under construction, which
 120 affects the frequency and scope of our content, while also highlighting future engagement
 121 opportunities.

122 Our efforts have elevated the national visibility of the project, engaged diverse audiences,
123 and fostering scientific interest in Latin America. Using social media and community initia-
124 tives, Hyper-K Mexico is an impactful example of international scientific collaboration, show-
125 ing growth in online engagement and setting a strong foundation for future outreach. How-
126 ever, Outreach Hyper-Kamiokande MX has experienced a low and declining trend in the last
127 two years in annual interactions, exposing the need for revised engagement strategies to ad-
128 dress this issue in the coming years. For instance, increasing the posting frequency, as seen
129 with the outreach of IceCube Observatory, and adapting content to resonate with the Latin
130 American culture could enhance engagement.

131 5 Conclusion

132 Hyper-K Mexico has made significant progress in increasing the project's national visibility and
133 fostering public engagement through social media and community-focused initiatives. This
134 success is particularly evident in its strong outreach engagement within Mexico, especially on
135 Instagram and Facebook, where it has effectively connected with diverse demographics.

136 Although Hyper-K Mexico's global engagement remains lower than that of the IceCube Ob-
137 servatory, its recent performance has been notable, surpassing the annual interactions achieved
138 by the outreach efforts of Hyper-K JP.

139 However, the declining trend in annual interactions over the past two years highlights the
140 need for strategic adjustments. To address this, increasing posting frequency and developing
141 content tailored to resonate with the Latin American audience will be essential. As Hyper-K
142 continues its construction phase, these efforts will be crucial for building a solid foundation for
143 future engagement and ensuring the project's long-term success in fostering scientific interest
144 across Mexico.

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