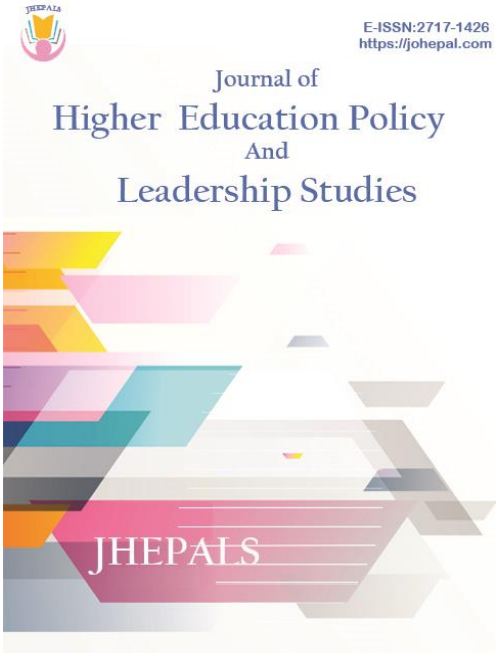
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Mexican Higher Education and the Production of Knowledge

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Abstract

Higher education is a central institution to formulate new responses and novel solutions to current social problems. In this context, the objective of this paper is to evaluate the production of knowledge carried out in the Technological Institutes of Higher Education (TIHE) in Mexico through online documentary research. Considering that most of the research is carried out based on international theories, a national evaluation system was taken into consideration to better understand the production of knowledge in this country. The results show that almost half of the TIHE professors have a BA degree, which make it impossible for them to be part of the national evaluation system and possibly do not have the required training to be producing quality knowledge. Only 2, 151 TIHE professors have the required PhD to participate in the national evaluation system; out of this total, only 769 TIHE professors were nationally recognized. Based on the findings, one can only question the role that TIHE have in the development of the country as an academic institution.

Keywords: Higher Education; Mexico; Production of knowledge; Technological Institutes; National System of Researchers (SNI)

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Introduction

In recent years, education has faced challenging questions about its role in society, culture, politics, the economy (Castaneda & Selwyn, 2018) and in solving current problems at the global and local level. This situation was further accentuated during the last year as a result of the COVID-19 pandemic, which brought with it new challenges. As a result of this situation, entire nations have been given the task of researching, proposing solutions and making optimal use of science and technology; while educational institutions, had to deal with educating millions of students at a distance and contributing to the solution of new challenges. In this context, we are interested in observing the work that the HEIs were doing prior to the Covid-19 contingency and during the pandemic in 2020. Until now, it is known that Higher Education Institutions in Northern countries published hundreds of books and articles on topics of current interest (Tight, 2018), so it is not surprising that once with the pandemic, their activity in scientific production and in problem solving continued.

The scientific production of the countries of the North is so extensive that it includes studies related to the countries of the South; however, as Guzmán-Valenzuela and Barnett (2019) mention, the results of these investigations are limited because theories of foreign origin are used. Consequently, the results lack the understanding of how the countries under study see and understand their own context. With the use of foreign theories to investigate specific contexts, two limitations arise (Guzmán-Valenzuela & Barnett, 2019): (1) foreign critical perspectives are used to address local problems (epistemic problematization); and (2) the theories of the North are taken as the basis for contextualizing the South (epistemic nuancing). Thus, the data produced has a diffuse and distorted perspective of what is happening in the south; therefore, a new configuration is needed, based on knowledge from and for the South.

Given this dynamic, the objective of this research is to identify the production of knowledge that takes place in a higher education sector in Mexico, taking into account local evaluation parameters with special attention to the following items: a) number of professors with recognition in the National System of Researchers (SNI) and b) their level within the National Assessment System. The results serve as the basis for addressing the discussions on the production of knowledge of higher education institutions in the Latin American region. In addition, at the national level, the results contribute to starting a discussion regarding the production of knowledge in higher education institutions in the Mexican context before and during the Covid 19 pandemic in 2020. The article is divided into Higher Education and knowledge production, National System of Researchers (SNI), Technological Institutes of Higher Education, methodology, results, discussion and finally, the conclusion.

Today's Higher Education

Nowadays, it is necessary to learn how to adapt and renew oneself in the face of a context characterized by constant and accelerated change in all areas of economic life, work, means of production, education and social relations. Nations and entire social institutions have had to adjust their way of working and production to respond to the needs that the current context demands. Bakhtiari and Shajar (2006, p. 95) add that "People can only contribute and benefit from global changes if they endowed with knowledge, skills and with the

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capabilities and rights needed to pursue their basic livelihoods. They need employment and incomes, and a healthy environment. These are the essential conditions which empower them to participate fully as citizens in their local, national and global communities". Higher education does not escape this context, since by nature, it should be able to adapt and respond to the demands of its environment (Ginés Mora, 2004; Bakhtiari & Shajar, 2006).

Bakhtiari and Shajar (2006) also point out that education should be a priority institution for all societies because it is at the heart of the change, it is in contact with new generations and in close relation with areas of science, technology, economics, and culture. Education, and mainly, higher education train youngsters in the foundation and essential driving forces of human and social development. Facer (2011) also refers to the fact that in the 21st century, humanity and, as a consequence, educational institutions, have two options: adapt to a world of high technology and global competition, where an institution keeps with the global changes and provides to the new normality or; stay behind, remaining obsolete, static and inactive. With these options, higher education can only orient itself and its students to the rapid changes of technology (Facer, 2011); while at the same time, it should become a leader in the changing world by producing knowledge, and providing innovating solutions to current (new) problems.

Unlike other public institutions with a single defined purpose; as for example in the health sector, higher education serves multiple purposes, like the production of knowledge, attention to the community (service) and the advancement of research (Duderstadt, 2007; Kerr, 1982; Maasen & Stensaker, 2011). Also, it provides education and training to the new young generations that will tackle and will have to solve future problems; which means that higher education is the indissoluble link between the generation of highly trained human capital and the future production and dissemination of knowledge (Fernández Fassnacht, 2017). For this reason, and especially in these times in which knowledge is fundamental for all social, economic and cultural activities, most countries make important efforts to have a higher education that complies with the best practices and international standards in the field of professional training, scientific research and technological development (Fernández Fassnacht, 2017).

Furthermore, it is not just about the production of knowledge without impact; but rather a production that guarantees a true sustainable and fair development for its country and its population (Unesco, 1998). Pérez-Cázares (2013) also suggests that knowledge production is a key element for a country to compete and integrate into the world order. In other words, higher education is required to carry out meaningful research that favors the development of local and international societies. The 21st century establishes a context in which the production of knowledge is a fundamental requirement for all those institutions that wish to stay at the forefront and be up-to-date with new scientific contributions, innovation proposals, solutions and leading positions.

The objective is to provide an innovative solution to current local and global problems such as poverty, education and health (Aedo & Walker, 2012). Thus, to offer solutions to current problems, both developed and developing countries, in theory, have to promote research in higher education, science and technology (ANUIES, 2018). In the Northern countries, the literature indicates that only during 2016, 86 journals were published solely

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on the topic of research in higher education in English (Tight, 2021). Chan (2019) found that people who research in the richest countries of the world occupy a privileged position in the production of knowledge; while, in another study (Chan, 2020), a lack of publications originating outside of North America was found.

Despite the main role that higher education has in the current context, and despite the demands that globality brings with it, Narro Robles & González García (2010) observed that the production of knowledge is not a priority for HEIs in Latin American countries. This disinterest is worrying because the countries of the region are condemned to dependency, technological and social stagnation, and scientific stagnation. In this regard, Kuleska, Brockova and Serafimovic (2020) warn that higher education, by remaining static and without scientific production, becomes an additional problem for the society in which it is established. It is suggested that HEIs, in some regions such as Latin America, do not respond effectively to the changes and needs required by today's society (Kuleska, Brockova & Serafimovic, 2020). In this sense, Tight (2018) proposes that higher education teachers should get out of their comfort zone with national publications and think, research and publish more globally. As Didou and Remedi (2008) point out, the lack of interest in the production of knowledge prevents the contribution that technology and science could have in the environments of the countries of the Latin American region.

Zamora Antunano, Zamora Aboytes and Cano López (2009) point out that the situation is more complex and problematic than a simple lack of interest, since aspects such as the academic training of teachers, economic income, multiple and heavy workloads, administrative activities that must be carried out, may be elements that affect the desire and need of teachers to produce knowledge. Being as dynamic and diverse as they are, HEIs also face challenges and particular characteristics; such as educating more students, maintaining stable fees, and enhancing prestige through quality while increasing enrollment (Fairweather & Blalock, 2015).

National Research System

The production of knowledge has become a focus of political interest around the world, since successful economies are constantly producing and using it for their benefit (Hazelkorn, 2009). At the international level, HEIs in Northern countries measure their quality through the quantity and impact of their published research. For example, the Academic Ranking of World Universities (2019) considers as part of its measurement: the frequency with which researchers from an institution are cited, the number of articles published and the number of Nobel prizes obtained.

In this evaluation system, the universities in the first three places correspond to Harvard (United States), Stanford (United States), and Cambridge (England); the only Mexican university to be placed within the 201-300 place was the National Autonomous University of Mexico (Academic Ranking of World Universities, 2019). Under this international evaluation system, that only one Mexican university manages to place itself within the top 300 places, lights a red focus for the rest of the country's HEI; because their quality and work in the production of knowledge are questioned.

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Mexican Higher Education

Nationally, there is an evaluation system for the production of knowledge called the National System of Researchers (SNI), which is an initiative that promotes scientific, technological and innovation development with a view to the benefit of Mexican society and global competitiveness (Conacyt, 2014). The SNI evaluates and recognizes, at the national level, the work of higher education researchers/professors who are dedicated to the production of knowledge. SNI operates through an economic monthly bonus which amount varies according to the level of production assigned in a ranking system of four categories: SNI III (seniors), SNI II (established), SNI I (early-stage), and candidates (young researchers) (Sandoval-Romero & Larivière, 2020). To be part of the SNI constitutes the most prestigious reward among researchers in the country.

The system is subdivided into knowledge areas as follows: area I physical mathematics and earth sciences, area II biology and chemistry, area III medical and health sciences, area IV humanities and behavioral sciences, area V science social, area VI biotechnology and agricultural sciences, and area VII engineering. Anonymous pairs from the same scientific area evaluate the production of knowledge and the level of productivity (III, II, I, C).

The main requirement to be part of the SNI is that the candidate should hold a PhD degree in order to submit their application. The SNI also has a series of guidelines for the appointment commissions of evaluators, pre-established procedures to evaluate the investigation activity and rules for the duration of the commissions of evaluators (Rodríguez, 2016). Rodríguez (2016) points out that the system (or evaluators) designates the SNI level of a professor based on the quality of the production, leadership of research groups, independence of judgment, citations obtained, thesis direction, publications with students, participation in editorial committees and international projection.

The SNI, in addition to evaluating professors individually, is an evaluation system for HEIsin terms of: graduate quality accreditation and a parameter to position an institution at the national level (Reyes Ruiz & Suriñachi, 2015); since it is considered that the greater the number of professors recognized with SNI, the better the institution. Altbach (2015) suggests that it is easier to evaluate achievements in scientific production than any other type of academic work, for example teaching, since the latter is difficult to define and quantify. Thus, the production of knowledge becomes the only semi-reliable tool for evaluating professors.

According to Pérez and Castro (2009), the SNI is also used as a means of individual quality legitimation, a hiring requirement tool, a tool to guarantee permanence and promotion in some institutions. During the first year of its creation in 1984, the SNI awarded the distinction to 1,396 researchers throughout the country; 1,143 men and 253 women. The number increased notably by 2016 with 25,072 professors; 15,992 men and 9,080 women (Rodríguez, 2016). Interestingly, Sandoval-Romero and Larivière (2020) show a greater concentration of SNI III researchers within the federal public higher education institutions, while early-stage and young researchers were mostly affiliated with states public universities.

It is also understood that professors with this distinction are responsible for producing the most important advances in terms of science and technology in the country (Reyes & Suriñachi, 2012), considering that they are in charge of disseminating their products in

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national and international arbitrated journals. In agreement with Didou and Gérard (2010, p. 40), the SNI "is a space for the congregation of recognized scientists and, therefore: a mechanism for differential assignment of prestige,… (which) cuts to a specific subgroup, to namely, a scientific elite different from that of Mexican academics in general, insofar as it is made up of highly qualified, highly productive, highly internationalized individuals."

Thus, the SNI becomes an individual and institutional system that evaluates the production of knowledge within Mexico; taking into account national parameters. The SNI counts as a system for evaluating the production of knowledge at the national level, which in theory, considers the Mexican HEIs contexts and surroundings. With this national evaluation system, it is necessary to measure the production of knowledge carried out in the country.

Technological Institutes of Higher Education (TIHE)

In Mexico there is a great diversity of public HEIs such as federal, state / decentralized universities, polytechnic universities, State Colleges, and Technological Institutes of Higher Education (Cruz López & Cruz López, 2008). This work focuses on TIHE which were designed on training engineers in aquaculture, agronomy, biochemistry, civil, industrial, mining, and nanotechnology with the purpose of promoting regional science and technology (TECNM, 2018). In addition, this type of institutions are settled nationwide and have physical presence in large and small cities.

TIHE recognize that its mission is to fully train competitive professionals in science, technology and other areas of knowledge, committed to the economic, social, cultural development and to the sustainability of the country (TECNM, 2018); which means that the TIHE seek to have an impact on the development of Mexico in terms of knowledge. The TIHE have a major human impact nationally due to the number of schools and student enrollment they receive annually. Official latest available data reported that only during the 2018-2019 period, 608,210 students received education through 254 TIHE campuses distributed throughout the country (TECNM, 2018). Considering the impact that technology has on the training of new generations of professionals, it is essential to know what is happening in these institutions in relation to the production of academic knowledge.

As part of their curricular model, TIHE recognize the current global context surrounding institutions of higher education by establishing an emphasis on flexibility, information and communication technologies. As part of its curricular model the TIHE propose:

1. Be consistent in the generic training of engineering professionals,
2. Be flexible and adaptable to the diversity of areas of specialization that exist throughout Mexico,
3. Incorporate the use of information and communication technologies (Gamino Carranza & Acosta González, 2016, p. 5).

Also, the TIHE maintain that professors are "the base for quality professional training in the fields of teaching, quality research, links with other institutions and the dissemination of knowledge" (TECNM, 2017, p. 91). It also establishes that the population (professors and students) must guide their actions towards the production of knowledge of quality

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(Dirección general de Educación Superior Tecnológica, 2012). Therefore, the TIHE establish a discourse in favor of the production of knowledge and recognize their impact on the training of students for current and future research at the region and national level.

However, despite the importance given to research and the production of knowledge; Villarruel-Fuentes and Pérez-Santiago (2015) found that TIHE students did not conform with the basic standards that science demands. According to these authors, the production of knowledge, made by students, was not congruent with the indicators demanded by the institution. Having this situation, it is important to investigate TIHE professors and their production of knowledge.

As stated in the latest TIHE Statistical Yearbook (TECNM, 2019), the country has 254 institutions throughout the country, of which 122 are decentralized and 132 are federal; in addition to six institutions with defined research purposes. The difference between federal and decentralized TIHE lies in economic bases, federal TIHE are those that have economic funds from the national government; while decentralized ones are those that mainly obtain funds from the local state government.

By 2021, the official TIHE website (https://sne.tecnm.mx/public/estadisticanacional) had not been updated, so no information could be collected for 2020. During 2018-2019 school year, when the national enrollment of TIHE reached 608,283 students out of a total of 3, 943, 544 students nationwide, including undergraduate and graduate students (Secretaria de Educación Pública and Tecnológico Nacional de México, 2018). That is, the TIHE absorbed 15.43% of the Mexican national population of students at the higher level. The distribution according to the type of technology and the level of study is presented in Table 1.

Table 1
Distribution of students by type of TIHE and level of study

Type of TIHE	Higher technician level	Undergraduates	Graduates	Total
Decentralized	173	250, 235	898	254, 495
Federal	102	352, 276	4, 599	353, 788
	275	602, 511	5, 497	608, 283

Source: Secretary of Public Education and National Technology of Mexico (2018).

Decentralized TIHE absorbed 42% of the students' population while Federal TIHE absorbed 58%; a difference of only 16% between these two types of institutions. The number of students was also larger regarding graduate students, Federal TIHE absorbed 84% and decentralized TIHE only 16%; however, when it came to the lowest level of instruction, in this case technical level, decentralized TIHE absorbed 63% of students and federal only 37%. In conclusion, despite having the same vision, mission and institutional objectives, federal TIHE reported a larger number of students at all levels, but mainly at the graduate level.

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Methodology

International evaluation systems, such as the Academic Ranking of World Universities, exist to position higher education institutions worldwide; however, this type of system only considers first world countries characteristics, leaving out local peculiarities. This research contributes to the global knowledge by using a geopolitical approach (Rizvi & Lingard 2010) with a national evaluation system (Guzmán-Valenzuela & Gómez, 2019). The SNI was taken into account to evaluate the production of knowledge in the Mexican TIHE. The research is descriptive (Hernández-Sampieri, Fernández-Collado & Baptista-Lucio, 2010) since it considers statistical properties, characteristics and the profiles of the professors working within a Mexican higher education system. The described characteristics are a) from the national total, the number of professors with a SNI recognition in TIHE and b) the level of their production within the SNI (C, I, II, or III). The data was taken from the most recent statistical report available on the official website of the National Technological Institute (TECNM, 2018).

Considering that the data is reported by the TIHE itself, triangulation was used as a method to increase the credibility and validity of the results (Noble & Heale, 2019). Thus, in addition to the statistical TIHE report, the official page of the SNI 2018 beneficiaries was reviewed[*]. This official website contains descriptors such as: full name, sex, research area and affiliation institution. The names of the institution was essential to identify researchers from the TIHE.

Results and Discussion

At the national level, the TIHE reported a total of 29, 579 professors with a distribution by sex as follows: 10, 287 women and 19, 292 men (Table 2); which included full time and part time professors (½ time, ¾ time, per hour) and full time professors. No information was found regarding the peculiar hiring characteristics of 15, 939 professors. Full-time professors were indicated with a total of 13, 640, with a distribution of 3, 426 professors working in decentralized TIHE (25%) and 10, 222 in federal TIHE (75%). Thus, although the difference between the two systems only reached 16% when talking about students, there was a marked difference with the number of full-time professors in the federal TIHE.

Table 2
Distribution of professors by sex and type of TIHE 2018.

Type of TIHE	Women	Men	Total
Decentralized	4, 201	7, 174	11, 375
Federal	6, 086	12, 118	18, 204
	10, 287	19, 292	29, 579

Source: Secretaria de Educación Pública & Tecnológico Nacional de México (2018).

[*] https://www.conacyt.gob.mx/Archivo-Hist%C3%B3rico.html ; https://www.conacyt.gob.mx/doc/varios/BENEFICIARIOS_2018.xlsx

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The academic level of the 29, 579 professors is described in Table 3. In the distribution by academic credentials; on the one hand, it is shocking that 51% of professors have only a Bachelor's Degree, which represents a total of 14, 997 professors teaching lessons (hopefully) at undergraduate level. By holding a BA, one cannot expect that these professors were producing new knowledge or even less, be part of the SNI, considering that a PhD degree is one of the requirements to be able to become members of the National Research System (Conacyt, 2014). On the other hand, only 2, 151 professors hold a PhD degree and would be able to train new generations of researchers at graduate levels. Data did not indicate the academic characteristics of the full/part time professors, this type of information would inform if TIHE prefer hiring full time BA professors over PhD professors to train new generations of students.

Table 3
Academic characteristics of the teaching staff.

	Bachelor's degree	Special B.A Formation	Master's degree	Studies of PhD Master's level		Studies of PhD level
Decentralized	6, 174	51	3, 803	684	548	115
Federal	8, 823	167	6, 732	737	1, 603	142
Total	14, 997	218	10, 535	1, 421	2, 151	257

Source: Secretaria de Educación Pública & Tecnológico Nacional de México (2018).

According to the nationwide data, only 769 out of the 2, 151 PhD professors working in the Mexican TIHE had the SNI distinction; which represented only a 2.6% of the total number of professors in this system. Current research suggests that institutions in Latin America do not produce knowledge (Narro, 2010); this research found that even using a national systems of evaluation, the production of knowledge was still reduced in this part of the continent. These 769 professors recognized in SNI were the only ones producing knowledge within TIHE; while the other 1, 382 professors with a PhD were lost in this national evaluation. The results coincide with Chan (2020) who pointed out the lack of authors with international publications and with Narro (2010) who suggested the scarce production of knowledge from Latin American countries. As stated above, no information was found regarding the school years 2019-2020 or even less 2020-2021.

The level of TIHE professors with a SNI reported a greater presence in Level 1 with 426 and with a representation of 12 professors at the highest level, which corresponds to the level 3 (Table 4). A greater number of professors with SNI is reported from federal TIHE, than in decentralized TIHE; with 624 and 145 respectively (Table 4). Results are similar to Sandoval-Romero & Larivière (2020), who found a greater concentration of seniors and established researchers within the federal public higher education institutions, while early-stage and young researchers were mostly affiliated with decentralized HEIs.

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Table 4
TIHE professors in the SNI.

	Candidate	Level 1	Level 2	Level 3	Total
Decentralized	91	52	2	0	145
Federal	184	374	54	12	624
Total	275	426	56	12	769

Data found suggest that even with the use of a local evaluation system little knowledge is produced in TIHEs in Mexico; which makes it wonder how adapted this system of education is to the global competition and the rapid changes of technology (Facer 2011). It seems that TIHE, and mainly decentralized TIHE stay behind, static and inactive; which means that TIHE is not a key element for Mexico to compete and integrate into the world order (Pérez-Cázares, 2013). With this limited production of knowledge in TIHE, whether it is federal or decentralized, one can only wonder about the training of those new generation of students who will deal with future national and international problems.

Conclusion

Higher education institutions worldwide have the responsibility of training future professionals for the changing world, the production of knowledge and the advancement of a society. According to research (Unesco, 1998; Didou & Remedi, 2008; Bakhtiari & Shajar, 2006), the production of knowledge is a key element for the development of a country as well; however, it seems that little research is produced within the Mexican TIHE based on a local system of evaluation. Thus, TIHE need to invest and analyze their role as an institution of higher education and its mission for the development of Mexico.

The fact that almost 15, 000 professors of a total of 29, 579 professors are teaching at a BA level with the same academic level, may explain the limited production of knowledge in this Mexican system of higher education. Further research should be made to understand how these BA professors are distributed within TIHE and their roles in forming future professionals. Also, it seems that, according to the SNI, only 769 TIHE professors, out of the 2, 151 with a PhD, are working towards the production of knowledge; the role of the remaining PhD professors then, should also bring into an academic discussion.

Mexico's technologists are indebted with the production of knowledge based on a national evaluation; but even more, decentralized TIHE which are at the top of training a larger number of students in the country. In this regard, Kukeska, Brockova, and Serafimovic (2020) warn that higher education, by remaining immobile, becomes an additional problem for society; this is more troublesome considering that students are (not) being educated to solve future problems. Based on the fact that present and future higher education must be based on the rapidly changing needs of society, the increasingly sophisticated demands of the labor market, the growing shortage of attitudes and skills necessary for problem solving, and the individuality necessary for leadership, independent thinking and creativity (Jacobs, 2014); it is not clear the role that TIHE play with 608, 283 students under their supervision.

It is recommended to carry out comparative studies between decentralized and federal institutions that analyze aspects such as economic income, number of students,

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workloads, and administrative activities (Zamora Antunano, Zamora Aboytes & Cano López, 2009); to better understand the limited production of knowledge. Qualitative studies should also be considered to analyze the context in which professors work, their specific needs and possible limitations to produce knowledge.

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