



## Transportation Construction Inspector Education, Training and Certification: A Comparison of State Transportation Agencies and 3<sup>rd</sup> Party Consulting Firms

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State departments of transportation (DOTs) face significant challenges in retaining and recruiting construction inspectors (CIs) due to high attrition rates, budget constraints, and declining interest among younger generations. As a result, many DOTs have outsourced inspection to consulting firms to augment staff shortages. Hiring CIs through external sources may lead to variations and potential inconsistencies in CI knowledge, skills, and abilities. This study investigated CI education, training certification requirements, and delivery methods, as well as the challenges faced when administering these programs. A survey of 86 respondents from 46 state agencies and 27 firms revealed notable differences in formal education requirements and certification acceptance between DOTs and consulting firms. DOTs generally have lower education requirements and less acceptance of national certifications compared to consulting firms. Training methods also differ, with DOTs favoring internal programs and firms preferring third-party providers. Despite these differences, reported challenges in CI training remain similar to those identified a decade ago. The study highlights the need for standardization in CI qualifications and training to ensure consistency in knowledge and skills across the industry.

Keywords: Highway Construction, Construction Inspection, Education, Training, Certification Requirements

### Introduction

Construction inspectors (CIs) are the key workforce that ensures the quality of transportation infrastructure projects comply with design and contract requirements, and that the final products meet or exceed state and federal specifications and standards. Their responsibilities include testing materials, inspecting contract performance, and ensuring safety standards are met. High quality preparation and execution of construction tasks extend the lifespan of transportation assets, providing greater value to transportation agencies and taxpayers. However, the transportation construction industry is increasingly concerned about the inspection process due to a shortage of well-trained and experienced CIs. This shortage mirrors a broader issue of declining availability of construction workers across the industry. The retirement of the generation that built the U.S. interstate system and

later generations of transportation professionals who have maintained and expanded that system, coupled with recession-induced budget cuts and workforce reductions in state departments of transportation (DOTs), has resulted in fewer DOT employees with less experience managing more complex projects (Rush, 2021; Cai et al., 2019; Xu et al., 2019; Li et al., 2019).

Since the end of the Great Recession, the U.S. construction industry has faced substantial workforce shortages, training hurdles, and the need to attract new and diverse talent (AGC, 2018). The transportation construction inspection profession faces significant challenges in attracting and retaining qualified personnel. Employment for CIs is projected to grow 7% faster than other careers from 2018 to 2028 (U.S. BLS, 2021), and many states have already witnessed an increase in construction inspection and testing workloads (Warne, 2003; Cain et al., 2017). Despite this rising demand, there has not been a commensurate increase in qualified inspection personnel, and the experience level of inspectors has declined due to retirements and downsizing in transportation agencies (Wight et al., 2017; Jagars-Cohen et al., 2009).

#### *Transportation Inspector Demand, Education, Training, and Certification*

To be qualified to perform inspection tasks at the required level of competence, a CI must meet certain educational requirements. A high school graduate can enter the highway construction inspection workforce, but the ability to learn and competently apply new skills and knowledge is essential to stay on the job and advance during their career. Transportation CI-specific education and training are increasingly needed to qualify for advancement (Bergner, 2018). CIs should possess knowledge of various construction types, including underground construction stages such as earthwork, at-grade construction (landscaping, subgrade treatment, base, surface courses, pavements), structural construction, general and miscellaneous construction (lighting, signaling, markings, etc.), and maintenance activities, (CPII Job Analysis, 2019; Cain et al., 2019). CIs should possess skills to inspect job site materials for compliance, observe workmanship, read and utilize plans for construction methods, and verify and document quality assurance and quality control (QA/QC) tests (APWA CPII Job Analysis, 2024). Further, inspectors should have technical, technological, and professional abilities to review shop drawings and submittals, verify contractors' licenses and permits, estimate and measure quantities of construction material, coordinate with various agencies, review construction schedules, prepare change orders, record time and work, create and review as-built plans, utilize software programs (such as Excel, CAD, Word, BIM, scheduling software), compute estimates of quantities and work completed, review payments to contractors, and possess good communication skills (APWA CPII Job Analysis, 2024).

Several transportation agencies have developed qualification programs for their CIs. For instance, the Utah DOT (UDOT) created the Construction Inspection Training Program (CITP). The CITP is part of UDOT's Quality Assurance Program and is required by 23 CFR 667, which is a section of the Code of Federal Regulations pertaining to requirements for transportation infrastructure. This program is designed to ensure that UDOT personnel and consultants are well-trained and qualified to inspect construction projects (UDOT, 2019). The New York DOT (NYSDOT) has detailed requirements for inspectors. They must have a high school diploma or equivalent and at least four years of experience in construction, maintenance, and repairs. For specific CI roles, certifications from the National Institute for Certification in Engineering Technologies (NICET) are required. For example, senior-level engineer technicians must be certified by NICET, and entry-level inspectors must meet NICET levels I and II certification requirements. Additionally, inspectors must have formal training in Work Zone Traffic Control (WZTC) and other specialized areas depending on their specific duties (NYSDOT, 2024).

While there are several training and certification programs offered by national organizations, the literature review shows that the programs offered by these organizations are not uniform and lack cohesion in several ways (Cain et al., 2019). For instance, testing and inspecting training content are often separated, although they are closely related CI tasks. Courses in sampling and testing should be part of inspector training (Cain et al., 2019). National training programs are based on national rather than individual state specifications (Cain et al., 2019). The literature review indicated that it is important to develop national training and certification programs that cater to individual state-specific requirements and specifications. Several DOTs (e.g., Pennsylvania, California, Washington, Virginia, Iowa, Utah) have created their own training and certification courses for in-house construction inspectors, whereas other DOTs use resources from national organizations (e.g., National Highway Institute (NHI), American Concrete Institute (ACI)) (Marks and Teizer, 2016). For example, Connecticut DOT accepts existing regional and national CI certification programs, while Oregon DOT and California DOT use internally developed general and specific certification programs. In contrast, some other DOTs use a combination of agency-specific and regional/national certifications (Wight et al., 2017). For example, Colorado DOT uses a combination of regionally or nationally developed certifications such as the Western Alliance for Quality Transportation Construction (WAQTC), ACI, or NHI, and an internally developed construction inspector certification program for material and construction inspector certifications (Colorado DOT, 2007). Louisiana DOT uses internally developed construction technician training and certification programs (Louisiana Transportation Research Center, 2019). In contrast, Connecticut DOT accepts national certifications such as NHI and NICET for their CIs (Connecticut DOT, 2017).

### **Study Purpose and Research Questions**

Addressing the development of a competent construction inspection workforce requires transportation agencies and related training organizations to have a broad understanding of the educational requirements for CIs. Specifically, this information is important to guide the creation and selection of appropriate workforce development programs that can effectively prepare individuals for the CI role. However, limited research has focused on identifying these specific education and training needs for highway CIs. This study aims to bridge this gap by conducting a national examination of CI education, training, and certification requirements across various DOTs and third-party inspection firms. In addition, this research also investigated the most common challenges reported by DOTs and third-party inspection firms. This analysis can inform the development of robust educational pathways and training programs. Ultimately, this will ensure the availability of a well-qualified and experienced construction inspection workforce, capable of safeguarding the quality and longevity of critical transportation infrastructure investments. To address these objectives, the following research questions have been formulated:

RQ1: What formal education requirement do DOTs and third-party inspection firms require for CIs?

RQ2: What CI certifications are commonly accepted by DOTs and third-party inspection firms?

RQ3: What modalities do DOTs and third-party inspection firms implement to provide certifications to their CIs?

RQ4: What challenges to administering CI-specific education, training, and certification programs are reported by DOTs and third-party inspection firms?

### **Methodology**

The research methodology applied in this study comprises three phases. Phase I focuses on literature review, Phase II involves survey development and distribution, and Phase III includes result analysis and discussion. This research methodology was selected due to the quantitative nature of the research topic. A literature review was conducted, with key findings presented in the introduction section. Following this, a survey was developed and distributed among an appropriate target population as described below. Given the purpose of the proposed research questions, descriptive statistics were employed to analyze the quantitative data. Education and training requirements were stratified by CI position level (entry-, intermediate-, and senior-) to account for changing CI responsibilities throughout career progression.

### *Survey Development and Distribution*

The survey focused on current practices and experiences in CI training and certification based on the gaps identified in the data collected from existing studies and literature. While the survey also included items on CI core competencies, knowledge, skills, and abilities (KSAs), given the scope of this manuscript, the first step was to isolate survey items that quantitatively explored the current educational requirements, recognized certifications, and challenges to administering training programs among highway CIs.

The survey's target population consists of a defined group of senior CIs and agency representatives from DOTs and consulting firms responsible for recruiting, hiring, training, and retaining CIs across the United States. An electronically administered survey was deemed appropriate given the broad and geographically diverse group of professionals (Fernandez-Solis et al. 2013; Karakhan and Gambatese 2017). The survey instrument included items that addressed CI KSAs (including formal education requirements) and certifications corresponding to CI position (entry-, intermediate-, and senior-), as well as firm training modalities, and challenges to training program implementation. The questionnaire was developed through an exhaustive literature review and piloted with experienced industry representatives who served as the advisory panel for the research project. The piloting group provided comments and revisions to survey items and response options based on their professional experience in the transportation industry. Based on pilot committee feedback, adjustments to the questionnaire were made. The instrument comprised closed-ended dichotomous, rank, and Likert-scale structured items with an 'other' selection option. If 'other' was selected, an open-ended response option was provided where participants could include comments, explanation and/or inform variables which may not have been recognized during literature review. The survey was distributed through members of the American Association of State Highway and Transportation Officials (AASHTO) Committees on Construction, Pavement and Materials and Knowledge Management, which includes representatives of 50 state DOTs. The AASHTO committee then distributed the survey link to representatives who manage and perform transportation CI tasks, recruit, hire, train and retain CIs within their respective DOTs. For consultant firms, contacts were established by inquiring with state transportation agencies to gather contact information for third-party construction inspection firms who provide consulting services within their respective state.

## **Results**

The following section includes the results of the analysis by research questions with stratifications by CI position levels (entry-, intermediate-, and senior-) where appropriate.

### *Participant Sample, Data Cleaning and Screening*

After two follow-up requests to complete the survey, a total of 103 responses were received yielding a 92% response rate. Prior to analysis, participant responses were screened for outliers and missing or improbable but not invalid selections resulting from failure to follow directions (White and McBurney, 2013). Seventeen responses were culled, yielding 86 responses for analysis. For third-party consulting firms, the sample included 29 individuals representing 27 third-party consulting firms providing CI services in 46 States, Washington D.C., and Puerto Rico. Responses were not received from consulting firms providing CI services in Nevada, New Mexico, Oregon and Utah. Consulting firm respondents provided their years of experience (see Table 1). Results indicated that 96.5% of consulting firm participants reported 16 or more years, with 100% reporting 11 or more years of experience. For state DOTs, 57 individual responses representing 46 states were received. Responses were not received from Louisiana, Maine, Mississippi, or Montana DOT. State transportation agency respondents provided their years of experience (see Table 1). Results indicate that 68.40% of state transportation agency respondents reported 16 or more years, 94.7% reported 11 or more years of experience, and 100% reporting 6 or more years of experience.

**Table 1.** Study Participant Experience by State Agency and Consulting Firms

CI Consulting Firm			State DOTs		
Reported Experience	<i>n</i>	%	Reported Experience	<i>n</i>	%
0-5 Years	0	0.0%	0-5 Years	0	0.0%
6-10 Years	0	0.0%	6-10 Years	3	5.3%
11-15 Years	1	3.4%	11-15 Years	15	26.3%
16-20 years	5	17.2%	16-20 years	7	12.3%
More the 20 Years	23	79.3%	More the 20 Years	32	56.1%
Total	29	100%	Total	57	100.00%

#### *Educational Requirement*

Results revealed similarities and differences between DOTs and consulting firms' formal education requirements. Interestingly, while a minority response, several DOTs indicated that CIs could achieve intermediate- and senior-level positions with less than a high school education. While consultants reported that a high school or equivalent education was required for CIs of all levels. A bachelor's degree was noted as a requirement for a small portion of DOTs at all CI levels, however, a four-year degree requirement only appeared at and above the intermediate CI level for consulting firms.

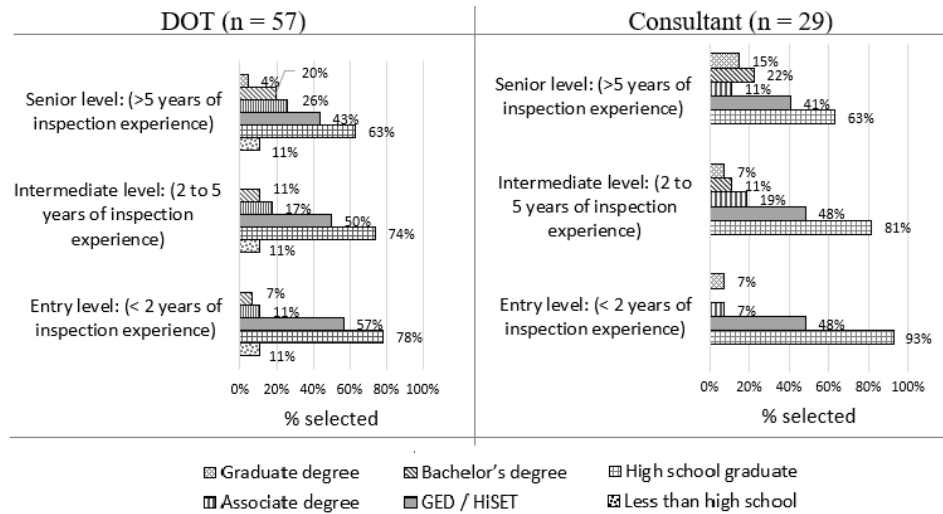


Figure 1. Minimum education requirements by CI employee level

*Accepted National CI Certifications and Training Modalities*

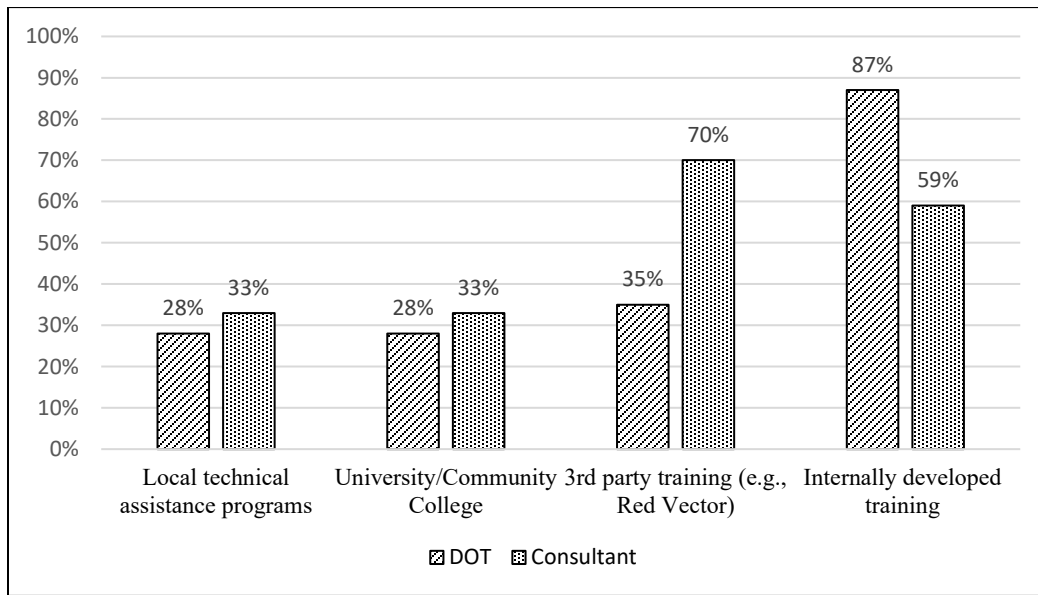
A review of industry reports revealed that CI certification requirements vary among transportation agencies, typically due to transportation agencies electing to use different methods to adhere to the requirements of 23 CFR 637b: Construction Inspection and Approval – Quality Assurance Procedures for Construction (Grogg, 2021). Table 2 provides the numbers of DOTs and consultant firms who report accepting national certifications as appropriate training for CI employees. The results confirm the assertion of Grogg (2021) regarding national certifications with the potential exception of ACI which was ranked 1<sup>st</sup> among DOTs, but still only received a 38.6% acceptance rating. On the other hand, more than half of the consultants reported accepting ACPA (82.8%), AASTHO TC3 (55.2%) and NHI (51.7%) certifications.

Table 2: Acceptance of National Certification by State Agencies and Consulting Firms

N0.	National Certifications	No. of State Agencies	No. of Consulting Firms
1	ACI – American Concrete Institute	22	8
2	TC3 – AASHTO Trans. Curriculum Coordination Council	15	16
3	NHI – National Highway Institute	15	15
4	ATSSA – American Traffic Safety Services Association	12	0
5	PCI – Pre-cast/Pre-stressed Concrete Institute	9	12
6	NICET – National Institute for Certification of Eng. Tech.	7	14
7	ACPA – American Concrete Pavement Association	4	24
8	NCAT – National Center for Asphalt Technology	2	7
9	NAPA – National Asphalt Pavement Association	2	6
10	APWA – American Public Work Administration (CPII)	0	9

The survey findings indicate that the majority of state transportation agencies and consulting firms employ multiple methods to deliver continuous improvement (CI) training (Figure 2). Departments of Transportation (DOTs) reported that internally developed CI training is the most frequently utilized

approach, with significantly lower reliance on training provided by third-party providers, Local Technical Assistance Programs (LTAPs), and higher education partnerships, in that order. Conversely, consulting firms primarily depend on third-party training providers, followed by internally developed CI training, and subsequently by Local Technical Assistance Programs (LTAPs) and higher education partnerships, respectively.



**Figure 2.** Methods utilized to achieve CI training by DOTs and Consultants

*Challenges to Administering Training Programs*

Providing the training needed to maintain and continue the education of proficient CIs presents challenges for DOTs and Consulting firms. A review of literature revealed the challenges in the implementation of inspector training, which include but are not limited to, insufficient training budgets, lack of travel time, and conflict between training classes and work schedules (Marks and Teizer, 2016 and Wight et al. 2017). Figure 3 presents the challenges noted by DOTs and consulting firms. The most frequently reported challenge by DOTs included training and work schedule conflicts, followed by lack of staff and funding which received the same response rate. For consulting firms, the most frequently reported challenge included training and work schedule conflicts, lengthy time commitment for training and lack of staff and lack of funding, respectively.

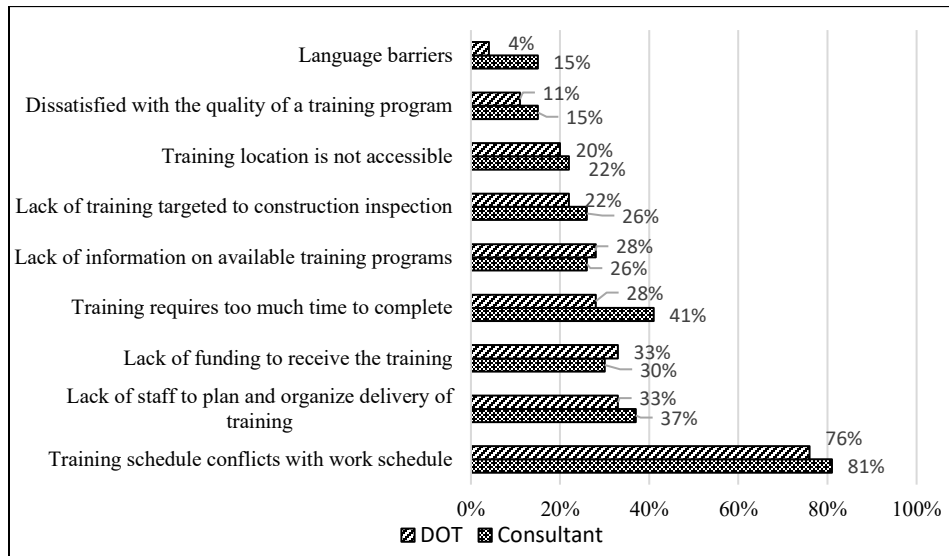


Figure 3. Challenges for CI education and training ranked by DOTs

### Discussion and Conclusion

CIs play a crucial role in ensuring that transportation infrastructure projects adhere to design and contract plans and specifications, and that the final products meet or exceed quality standards. High-quality construction extends the lifespan of transportation assets, offering greater value to both transportation agencies and taxpayers. However, the transportation construction industry faces growing concerns about the inspection process due to a shortage of well-trained and experienced CIs. This shortage reflects a wider issue of declining availability of skilled construction workers across the industry. This study offers a comprehensive analysis of the current landscape surrounding highway construction inspector education, training, and certification requirements in the United States, focusing on both DOT agencies and third-party consulting firms. In total, 46 state transportation agencies and 27 firms performing CI services in 46 states, Washington D.C., and Puerto Rico, responded to the developed and piloted survey. Several key points emerged from the survey analysis.

The findings revealed that the method and acceptance of education, training, and certification differed between Departments of Transportation (DOTs) and CI consulting firms. A notable difference was observed in formal education requirements between the groups. While some DOTs permit individuals with less than a high school education to hold intermediate and senior-level CI positions, consulting firms consistently mandate a minimum of a high school diploma or its equivalent for all CI roles. This discrepancy suggests a potential inconsistency in the baseline knowledge and skills of CIs working on similar projects, potentially affecting the quality of inspection work and the overall integrity of transportation infrastructure projects. Second, the acceptance of national CI certifications varies considerably between DOTs and consulting firms. DOTs generally show a low acceptance rate for most national certifications, with the ACI certification ranking highest at only 38.6% of acceptance. In contrast, consulting firms demonstrated a significantly higher acceptance rate for certain national certifications, such as ACPA (82.8%) and AASHTO TC3 (55.2%).



This divergence in certification acceptance highlights a lack of consensus on appropriate qualifications for CIs across the industry and raises questions about the transferability of skills and credentials between transportation agencies and states. Furthermore, the study revealed distinct preferences in training modalities. DOTs primarily rely on internally developed CI training programs, while consulting firms favor third-party training providers. Differences in training approaches and certification acceptance may result in variations in the skills and knowledge base of construction inspectors (CIs) across organizations, potentially affecting the uniformity of construction inspection practices. Such discrepancies underscore the value of a standardized framework for CI education, training, and certification across the industry. Establishing standardized practices could improve the quality and consistency of construction inspection, enhance workforce mobility, and help mitigate the increasing demand for qualified CIs amidst industry-wide labor shortages. Empirical investigation of these topics among transportation CIs represents a promising area of further research.

Notable similarities were observed between DOTs and Consultants on reported challenges and barriers to training implementation. For DOTs, training and work schedule conflicts, followed by lack of staff and funding which received the same response rate. For consulting firms, the most frequently reported challenge was training and work schedule conflicts, the lengthy time commitment for training and lack of staff and lack of funding, respectively. These findings align with those of Marks and Teizer (2016) and Wight et al. (2017), suggesting that perceptions of barriers and challenges in implementing CI training have remained consistent over the past decade. Both studies highlighted obstacles to effective training programs, including constraints related to time, staffing, and funding resources. In dynamic fields like construction workforce development/skills training which have received a great deal of attention in the recent past, confirmation of 'older' results is particularly important (especially to funding agencies) to establish that, despite efforts to address the workforce issues, barriers to training and challenges in implementing CI training remain largely unchanged.

In conclusion, this study provides an overview of the current landscape of transportation CI education, training, and certification requirements in the United States, among state transportation agencies and third-party consulting firms. The findings highlight considerable variations in practices between DOT agencies and third-party consulting firms on accepted certifications and preferred training modalities. The disparities in educational requirements, certification acceptance, and training modalities, coupled with nearly identical perceived challenges and barriers to CI training implementation, underscore the need for a more standardized approach to CI qualifications and development. Such standardization could enhance the quality and consistency of construction inspection across the country, facilitate workforce mobility, and address the growing demand for qualified CIs in the face of industry-wide shortages.

### **Limitations and Further Research**

The results of the study provide several valuable insights into transportation CI education, certifications, training, and the challenges related to the administration of such programs. However, there are limitations and opportunities for further research that should be noted. First, while the participant sample covered the vast majority of the United States, the actual number of respondents was limited to 1-2 persons per state. Second, the descriptive nature of the survey items utilized in this manuscript were limited to dichotomous responses. Specifically, the results only allowed for the presentation of responses selected or not selected limiting results to the existence of a training challenge, acceptance of a given national certification, or use of a given training method. These limitations provide opportunities to continue this research to clarify the results through a mixed-methods approach (interviews, focus groups, Delphi method, etc.) to confirm and increase the depth

of the findings to gain a more nuanced understanding of the topic and promote more widely generalizable results.

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