Collaborative survey construction for national data collection: Coordination, negotiation, and delivery

Edward Berger*†¶, Allison Godwin*, Matthew Scheidt*, John Chen‡, Ryan Senkpeil*, Julianna Ge*, Jim Widmann‡, Brian Self‡, Ann Gates§
*School of Engineering Education, Purdue University, West Lafayette IN 47907
†School of Mechanical Engineering, Purdue University, West Lafayette, IN 47907
‡Department of Mechanical Engineering, California Polytechnic State University, San Luis Obispo CA 93407
§Department of Computer Science, University of Texas at El Paso, El Paso TX 79902
¶MEERCat: The Mechanical Engineering Education Research Center at Purdue
Corresponding author email: bergere@purdue.edu

***Abstract*—This research-to-practice full paper describes the deliberate and arduous process we recently went through to develop a national survey to study the non-cognitive traits of undergraduate engineering and computing students. The goal of this survey is to characterize student profiles in order to develop and examine particular interventions to guide students toward success in engineering and computing majors. This survey measures non-cognitive attributes including personality, sense of belonging, engineering or computing identity, study skills, well-being, and a variety of other constructs that are not routinely measured in engineering populations nor integrated into admission decisions, advising processes, or academic curricula. Prior research indicates that these non-cognitive attributes are important for students' academic success and retention. However, no studies have examined a comprehensive set of non-cognitive traits holistically to understand how they influence student success. This collaborative project, funded by three linked NSF grants, merges the interests of researchers at three campuses in understanding and supporting students with varied non-cognitive profiles. As part of this research, we negotiated the content of a national survey, suitable for use on our own campuses as well as with other national partners, to probe more than a dozen constructs collectively describing student non-cognitive attributes. The construction of the survey itself was non-trivial, and involved significant negotiations among the researchers including initial collection of instruments with validity evidence to serve as a basis for discussion; an in-person kick-off meeting; multiple follow-up teleconferences; multiple rounds of inclusion/exclusion decisions based upon mutually-agreed upon guiding principles; pilot survey testing; pilot data evaluations such as exploratory factor analysis; and final decisions about instruments/items to include in the final version, all while considering survey length, distribution channels, and key IRB concerns. This paper details the 10-month effort to construct a survey that meets the research needs and intellectual curiosity of partners at three diverse campuses. In this process, we had to balance the different institutional contexts of the funded partner sites while also maintaining flexibility for national distribution. The deliberate processes we used may serve as a template for future survey creation, starting from constructs of interest, to selection of specific instruments (or sub-scales thereof), and factor analysis to consider further down-selection of individual items to include in the final survey. The outcomes of this paper may serve the engineering education community by highlighting previously undocumented processes in collaborative survey construction that introduce intellectual complexity or time delays into the development timeline.**

I. Introduction

Our three-institution collaboration among nearly a dozen researchers was awarded a set of linked NSF grants in Fall 2016 to build, among other important objectives, a national dataset using a survey instrument. The population composing this dataset was undergraduate engineering and computing students, and the goal for this phase of the NSF project was to enroll students from about 15 diverse institutions across the United States in the study. In addition to these 15 'national' sites, we also enrolled students from the three 'partner' (i.e., funded) institutions in the study.

This research-to-practice paper explains the processes we used to collaboratively construct the survey and deliver it to our national sites, and details the challenges and lessons learned. For the most part, the process we adopted allowed for a harmonious approach to survey construction and deployment, but institutional and researcher differences entered the process in two main places: (i) priorities for what to measure on the survey, and (ii) Institutional Review Board (IRB) activities. While the former were navigable based upon shared trust among the researchers and extended conversations about measurement priorities, the latter proved to be more complicated. The goal for this paper is to elevate our experience of negotiating and delivering a national survey, and as a result help other researchers considering similar projects to avoid some of the mis-steps and time delays we experienced.

II. Background on this project

This project focuses on the role of non-cognitive factors in undergraduate engineering and computing student success. Success is defined quite broadly to be inclusive of the usual academic measures of GPA, retention, or graduation rate, but also the feeling of belonging to a discipline and a general sense of thriving or well-being. Prior research has focused to a large extent on cognitive predictors (e.g., SAT score or high school GPA) of student academic outcomes [1]–[3]. Recent work has augmented cognitive-only models with non-cognitive predictors as well [4], [5], and typical non-cognitive constructs include identity [6], [7], personality [8], [9], self-control [10], [11], and mindset [12]–[15]. Despite

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these recent improvements in our understanding of the role of non-cognitive factors in student outcomes, many research opportunities remain.

The collaboration arose from the shared interests of the PIs at the three institutional partners, who have all previously collected anecdotal observations and/or research findings that formed the preliminary data in the original NSF proposal. The funded project contains several research questions about the role of non-cognitive factors, including the goal of creating customized interventions to support students in achieving success in the broad sense defined here. The full set of research questions for the overall project therefore includes questions about intervention design and implementation, and especially questions about how those interventions might need careful calibration for institutional context and culture. For instance, we expect that–based upon the local culture of the partner institutions–interventions on one campus might be best designed for delivery by faculty, while on another campus a similar intervention might be best delivered by student affairs personnel.

In the context of this paper, which focuses on the collaborative development of our survey, the relevant **research question** from the overall project is: *What are the NCA profiles of engineering and computing students, and to what extent do profiles vary by institution, academic program, demographics, or over time?* The first step in this project was to collect a national dataset using a validated survey to characterize, in the broadest way possible, the non-cognitive profiles of engineering and computing students. Understanding these profiles will help in the intervention design and implementation phase, because it will allow our research team to target areas that potentially have the highest impact on student success. The remainder of this paper describes four specific and important phases of our survey work, from development to deployment, and is very much in the spirit of previous related work on the Pathways of Engineering Alumni Research Survey (PEARS) survey [16].

III. Step 1. Survey development

A. An in-person summit

Even at the proposal stage, the six PIs from the three partner institutions acknowledged their different viewpoints about what might be the most important non-cognitive factors to measure on a survey. While their broad interests aligned, the specifics of what constructs actually appeared on the final 'production' version of the non-cognitive survey were up for negotiation. We therefore created a deliberate process involving an in-person, one-day summit among the PIs and graduate students on the project. Through a series of group emails and conference calls in advance of this meeting, the research team agreed to an agenda and a set of working principles for survey development. Table I summarizes the design principles agreed to by the PIs, and these principles were used to frame the conversations at the in-person meeting. (Table I is a lightly edited version of the original document we used to frame the conversations.) The summit was held at a neutral site (i.e., not at one of our home campuses) that offered relatively easy flight access from each PI's home airport. Our meeting was held in a hotel conference room in Dallas TX in February 2017.

The agenda for the one-day meeting was organized around specific discussion topics that were expected to lead to a very early version of the survey before the end of that day:

1) The local context of each partner institution: what are the factors at each institution that could drive interest in specific non-cognitive constructs?
2) Hypothesis generation: what are the most compelling research questions for each institution/PI, and what constructs must be measured to explore those research questions?
3) Survey beta version construction: based upon these discussions and design principles, what does version 0.1 of the survey look like?

Much of the discussion was framed by a very lightweight version of a Strategic Doing (SD) process [17]. This process focused on using broad framing questions about what *could* be done (the entire universe of possible actions), and then successively narrowing and focusing the discussion on what *should* be done (what would be the set of highest-impact research areas), and then finally what *will* be done (what is the near-term plan for what we will do). Strategic Doing has been successfully used in academic institutions and other settings to frame strategic conversations [18].

The end result of the one-day, in-person meeting was an initial version of the survey (version 0.1), which was both too broad and too long, as well as a plan for further refinement of the survey and down-selection to the final set of constructs to be included on version 1.0, to be tested in Summer 2017. We left the one-day meeting with a set of deadlines for subsequent decisions, as well as a time and date for the next conference call during which we would iterate further on the survey.

Despite the positive outcome of the in-person summit, there were some challenges with organizing and executing it. Planning was a challenge for both logistical reasons (getting six PIs from three institutions together during the middle of the semester), and only five of the six PIs were able to attend. In addition, planning the meeting from afar was somewhat challenging, and we were fortunate to have staff members on the lead campus who were able to organize the facilities in Dallas. Cost was also an obvious concern, and we used grant funding to support travel because we believed this in-person meeting was important enough that it required a dedicated, one-day duration and physical presence of the research team. Finally, we experienced a variety of time delays leading up to the meeting, simply due to logistics of emails and especially the conference calls leading up to the in-person meeting. The entire planning process took about 2 months, at least one month longer than anticipated.

B. Survey pilot testing

We want to be clear that survey pilot testing was not conducted until after appropriate IRB processes were completed (as described below). However, we include the pilot testing

TABLE I
SURVEY DESIGN PRINCIPLES AGREED TO BY PROJECT PIS.

1. We would like to have the survey finalized and ready for use by March 17, 2017.
   a. This will allow us to begin to collect data in Spring and Summer 2017 and start preliminary analysis during Summer 2017.
   b. This would be both a paper and electronic implementation, and each site would use the format most suitable for their students. Purdue will take the lead on developing a paper version using existing tools and expertise at the institution.

2. The survey should take approximately 20-25 minutes for a participant to complete.
   a. Any longer than this could cause students to become fatigued and lose interest.
   b. This could mean that concessions and negotiations may need to be made over what is included within the survey.
   c. English reading comprehension may affect survey completion time.

3. The instruments added to the survey should be themed around our non-cognitive and affective factors.
   a. While cognitive based survey items are interesting to study, and a case can be made supporting their relationship to non-cognitive affective factors, the overall purpose of this project lies within the non-cognitive space.
   b. Survey items supporting non-cognitive/affective factor measurement should be given priority over cognitive measures.

4. The survey should include items that researchers can use to publish.
   a. If there is a question that a researcher or group of researchers are interested in answering, we should try to include an instrument to support this within the survey.
   b. If there is something that is suggested to be included within the survey that does not support answering a research question, we should evaluate its inclusion within the survey.

5. To the extent possible, survey instruments/items should be provably valid and reliable, and have a reasonably substantial body of literature behind them. The survey can and will be altered throughout the project, based upon how the survey performs (both timing and psychometrics) and feedback from participants.
   a. As much as we will try to prevent it, some survey items may not work (psychometrically) and may need to be changed or eliminated.
   b. There may be some additional items that we are interested in observing that may need to be pushed to a later survey due to survey length constraints in v. 1.0.

description in this section of the paper because it was an explicit outcome of the survey development process.

We decided to do a limited pilot test (with just two of the three partners because of IRB limitations; see below) in Summer 2017, with the purpose of testing: (i) average completion time, and (ii) psychometrics of the constructs on the survey. We used an electronic version of the survey delivered in Qualtrics, and not surprisingly discovered that the survey was longer than our 20-25 minute objective ($n = 490$ respondents across two partner sites). We expected that psychometric analysis of construct performance would help us identify poor-performing constructs that could be removed in the final version of the survey.

Many of the constructs we attempted to measure were probed using instruments from the literature with validity evidence (principle 5 on Table I). However, the populations on which they were validated were often not the engineering- and computing-specific populations that were the interest of our study. As such, we suspected that some of the instruments might not show the same level of validity with our population as had been previously reported in the literature. We conducted a variety of psychometric tests on the pilot data (including EFA [19]) to identify poor-performing instruments as candidates for removal from the production version of the survey.

As a result of this pilot testing process, we collaboratively identified a number of constructs for removal from subsequent versions of the survey. The final version of the survey for delivery at both the partner and national sites contained a total of 185 items related to 29 constructs, and all remaining constructs probed by the survey had acceptable validity in our pilot study [19].

However, even within this successful pilot period, we encountered challenges mostly related to access to student populations on our campuses. We experienced time delays in data collection due to local logistics of collecting approvals as necessary to sample the desired populations (from instructors, course coordinators, department heads, etc.), in-person recruiting, and finally electronic delivery of the survey. While the outcome was positive from a data collection standpoint, it look more effort to organize than had been originally anticipated.

IV. STEP 2. IRB APPROVAL

The IRB processes in place were non-trivial and, more importantly, different at each of the partner institutions. The challenge was to write a single IRB protocol that accommodated participants from the funded partner sites as well as participants from 'national' sites. Partner sites and national sites required two different consent processes and data col-

lection procedures, so the IRB protocol had to allow for the following:

- each partner institution's participants would consent to accessing their academic records (i.e., transcript and admission data), as well as their 'personal' record as held by the Office of the Dean of Students (ODOS)
- all partner institution researchers would have access to *de-identified* data from each of the other partners, including partner institution participant survey data and academic records
- identified participant records from each partner institution would only be accessible by researchers from that institution
- national site participants would self-disclose personal, demographic, and academic data on the survey itself, at their discretion, supportive of our goal of minimizing the potential need to engage with IRB offices at each of the national sites (see below for how this played into recruiting national sites)

To be more specific about a participant's 'personal' record, we mean non-medical, non-academic interactions with ODOS that help us understand the personal context of each participant at the partner sites. The related research question has to do with the relationship between personal challenges or obstacles, non-cognitive profiles, and outcomes achieved. We expect this personal data to be a crucial element of our understanding of the lived experience of students at our institutions, and the deeply important context within which their non-cognitive attributes were expressed.

These goals seemed achievable, but we encountered differences in the IRB offices at the partner institutions in two regards: (i) interest in/willingness to defer oversight to other institutions, and (ii) view of the trade-offs between participant protection and access to participant data (in particular, personal data from ODOS).

Federal guidelines allow for a deferral process to facilitate multi-institution research projects. Under this arrangement, one institution's IRB office defers to a second institution's, trusting the processes in place at the second institution to be robust and consistent with the standards and interpretations of the first. In the case of this collaboration, a preference was expressed by one IRB office to not defer oversight to any other IRB, and instead have its own IRB approval on its own campus. This in turn resulted in each of the three partners on this project having their own IRB protocol and approval on their campus, with collaborators named on each protocol.

The second issue was more significant and more difficult to navigate. Research involving student academic records is very common, and most institutions are experienced in handling FERPA and other concerns for these kinds of data. Our request to obtain personal records from participants was new for the lead institution on this project, and the local PI worked closely with ODOS and other compliance personnel on the lead campus to generate a Memorandum of Understanding (MOU) about who would access the data, how it would be used, and how participant privacy would be secured. Although the principles in play for personal data are the same as for academic data, our request for this data was nonetheless new on our campus. As a result, the IRB process took quite a long time (about 5 months) to navigate all the subtle elements of this issue. The outcome, however, was that the lead institution had a template for this process that could be exported to the other partners to help secure IRB approval for these data on their campuses.

The final issue on the list, related to national sites, was also crucial to the project. Our goal for the first round of data collection was to collaborate with about 15 national sites. This project simply does not have the funding or personnel to individually negotiate with 15 separate IRB offices, so we had to write the national site survey delivery protocol to meet certain criteria that would eliminate the need for consultation with national site IRB offices:

- data collection must be anonymous at the national sites
- demographic, academic, and personal data must be self-disclosed at the discretion of the participant
- local personnel at the national sites must be furnished aggregated data only, not raw response data, so that they have no potential to identify students at their institution based upon (for instance) respondent demographics

A final subtle issue that our team had to tackle was the incentives for participation, particularly at national sites. We offered $50 gift cards in a random raffle of respondents at each institution who fully completed the survey within the survey administration period. In order to execute the raffle, we obviously needed to know the identity of the respondent– despite our goal of making the survey anonymous. Our process to handle this situation was to offer, as the last item on the survey, respondents to opt in to the raffle by providing their email address so that we could contact them if they won the raffle. Upon collection of the data and verification of completion of the survey, these email addresses were immediately stripped from the data file and placed into a separate file used only for purposes of executing the raffle, leaving only the anonymous survey responses as the raw data file.

We expect that up-coming changes to the Federal Common Rule may allow for more flexibility in the deferral process, in which case we will pursue that route for continuing reviews or new amendments and protocols as appropriate. This notwithstanding, the entire IRB process across all campuses took longer than anticipated, especially considering the negotiations around access to ODOS records. While the processes were collaborative and productive, they were nonetheless time consuming. This time delay pushed data collection on the three partner campuses into the early spring semester 2018 (it was originally planned for mid-fall 2017). Data collection from national sites occurred in Fall 2017 and Spring 2018.

V. Step 3. National site recruitment

National site recruiting was pursued using a combination of purposeful and opportunistic sampling. We set out with the goal of recruiting partner sites with different institutional

or student characteristics, including institution size, funding model (public/private), geographic location, admissions profile (local, regional, or national/international recruiting footprint for undergraduate programs), and population served (2 year/4 year). We also sought institutions whose student demographics were diverse in terms of gender, race and ethnicity, and socio-economic status.

With this recruiting aspiration in place, we networked at the 2017 ASEE Annual Conference in Columbus OH and sought out individual people at potential national sites. We used face-to-face contact as a primary recruiting mechanism, often using our own professional networks to target candidate national sites. We printed 100s of two-sided postcards that described the research and what national site participation would entail, and handed them out widely throughout the conference. We also leveraged on-campus partners from the lead institution (Associate Deans and Deans of Students from ODOS), who publicized the effort widely through their professional networks (which, at least in the case of ODOS, are nearly orthogonal to the ASEE network). As a result of this in-person recruiting effort, we developed an initial list of about 60 potential national partners who expressed interest in learning more.

Each initial conversation was followed up with a formal email invitation to learn more and potentially participate, which itself was followed up with a 30-minute webinar about the expected impact of the research and specific details about what national site participants could expect. Throughout this process, the number of potential partners decreased from the original list of about 60 to a much smaller list of less than 20. The benefits of participation as a national site were:

- a customized report illustrating the aggregate non-cognitive profile of respondents from that national site as compared to the entire dataset, along with summaries of each measured construct.
- $50 gift cards as an incentive for participation raffled off to participants who fully completed the survey in the specified time frame.
- periodic updates from our team to the national sites about the research, especially when we enter into the intervention phase.

In each of the webinars and subsequent conversations, IRB was specifically mentioned. Our team sent our IRB approval letter and relevant protocol documents to prospective national sites, and we encouraged them to connect with their IRB office to ensure that their IRB was comfortable with the approvals we had obtained and the data collection processes we had in place. In each case, we attempted to navigate to the person(s) at the potential national site who had the authority to approve distribution of a survey to their students, and often this was an Assistant or Associate Dean, a Department Head, or other faculty member with a role that gave them this authority. This point of contact (POC) was tasked with distributing the survey to their students and receiving the customized school report from us.

This recruiting process was extraordinarily time-intensive, and PIs and others from each institution collaborated to create the initial list of potential national sites. As the relationships progressed, they were owned by a single person; this was a deliberate choice because bookkeeping of who would talk to whom became, very early on, a difficult proposition. For instance, we learned at ASEE that across the entire research team, our professional networks substantially overlapped, and several of us worked to recruit the same person. While in the beginning, the ownership of relationships was distributed across the research team, once it became apparent that an institution would be willing to talk seriously about being a national site, the relationship was handed off to the single person who built the relationship to the point of their participation in the research. In the end, our sampling of institutions was based largely on existing personal relationships.

In all, we handed out over 100 advertising postcards, held about 10 webinars, sent and received 100s of emails, and collaborated with nearly 30 people at 18 different institutions as potential national sites. The final result of this recruitment effort was that we actually collected data at 15 national sites. Of those who did not opt in as a national site, one expressed IRB-related concerns, and the other relationships were not able to be advanced to a place where data collection could be approved at the institution. Recruiting and building trusted relationships with the national sites was an extremely time-intensive enterprise, requiring organization and diligence, and (perhaps not surprisingly) took longer than expected.

VI. Step 4. Data collection

In Fall 2017 and Spring 2018, data collection at 15 national sites and the 3 partner sites was executed, with all but one of the national sites using the electronic version of the survey and the partner sites using a combination of electronic and paper-based versions. Data collection was offered to the national sites using a single anonymous survey link in Qualtrics that contained embedded data to identify the school in which the participant was enrolled. This anonymous link was sent to our POC at each national site, who in turn sent the link and our IRB-approved recruitment email to the mailing list(s) they had for students in engineering and computing at their institution. Each POC was also asked to send, in addition to the first recruitment email, several follow-up reminders at specific time intervals. Because our research team had no access to the mailing lists used by the POCs, we have no way of verifying if/when reminder emails were sent.

The number of respondents at each national site varied as a function of the number of students to whom the survey was offered, which was in turn a function of who authorized delivery of the survey (i.e., who was our POC). A single faculty member could distribute the survey in her class, a Department Head could distribute to all undergraduates in the department, or an Associate Dean could distribute it to an entire college. In all, we collected about 2,300 responses from national site participants, with the low number from a single institution being 3 respondents and high number being

303. We asked each POC to report the number of students to whom they sent the survey, so that we could calculate an approximate response rate, but for many of the national sites we never received accurate information. As a result, we cannot calculate a response rate for this survey.

During this same period, we collected over 1,300 responses from the three partner sites. After cleaning of the data and removing incomplete surveys, we ended up with a dataset of over 3,000 responses useful for analysis across the partner and national sites. We also awarded several dozen gift cards through our random raffle process.

VII. Lessons Learned

Throughout this process, we made a deliberate effort to structure survey development and deployment to be as productive and efficient as it could be. Starting with a shared understanding of process and survey design principles was a crucial feature of our work, because it allowed our team to enter our one-day summit with a shared goal and set of constraints. We used a disciplined process and timeline to make decisions about constructs/instruments to include on the pilot survey, as well as an evaluation plan to examine the performance of the pilot survey from a psychometric standpoint. Taken together, we believe that this process worked well, served our needs, and allowed us to move with relative efficiency to create the survey.

Nonetheless, as detailed above, virtually every step of the process took longer than expected. This may be the result of overly-ambitious goals and slightly unrealistic expectations for timeline of execution. But more likely, this was simply an under-appreciation for how the complexity of the project (six PIs, three institutions, many graduate students, three IRB offices, dozens of potential national sites, ...) would translate into time-intensive activities. We note the time delays were only related to research deliberations in Step 1 (survey construction), while essentially all other time delays were related to communication, relationship building, collaboration, and logistics. We believe it is therefore crucial that team members on complex collaborations such as this have excellent interpersonal skills in order to reduce–to the extent possible– the amount of friction in the system.

An important lesson of this research is also the unexpected complexity of IRB processes across the three partner campuses. While it may have been possible to push harder on each IRB for a deferral arrangement, our ultimate outcome was positive from the research standpoint although it was very inefficient. Working with appropriate parties on each campus in a deliberative and collaborative way, especially regarding ODOS data, was a key element of our IRB success. We took the time to explain the research to personnel within our organizations that do not often become engaged in this kind of research, and we built trusted relationships over time that enabled us to arrive at an MOU that was satisfactory for all parties.

We also learned that recruiting for a national survey is extremely time intensive and was significantly lubricated by our collective existing professional relationships. In retrospect, we believe that the single-person-ownership model for national site relationships was effective, but for future rounds of data collection we will most likely work toward a more distributed model in which each researcher owns a small subset of all the relationships with national sites. Organizing this does not seem insurmountable, but it will require us to think carefully about how to organize the effort and, perhaps more importantly, how to keep track of these conversations and relationships. Some version of a CRM process and data system might be really valuable to manage this process.

Related to this, our experience shows how difficult it is to be intentional in sampling processes in a project like this. In the end, many of the national sites ended up being samples of convenience, based upon interest and good will from known colleagues. As such, many of our sampling aspirations have not yet been met and will be considered for future rounds of data collection.

Finally, we learned that the engineering education research community seems quite open to partnerships like this, and our experience suggests that truly national efforts can be executed because of the curiosity and goodwill of our community. We were humbled by the sincere enthusiasm expressed by many of our national site POCs, and the gratitude expressed when we shared the customized school report with them. Much of the research done in our community is confined to a single institution, and we have been impressed and gratified at the enthusiasm expressed by our colleagues across the country.

VIII. Conclusion

This paper details our experience in developing and deploying a national survey about student non-cognitive factors and their role in student success. We followed a deliberate process that attempted, with reasonable success, to anticipate the challenges of a three-institution collaboration and overcome them with both effectiveness and efficiency. Guided by several survey design principles and a framework for having strategic conversations about the research, we were able to construct a pilot version of the survey for testing over the course of several months, with full participation by researchers at all three partner sites. Survey pilot testing was an explicit part of the survey development plan, with psychometric evidence used to shape the final production version of the survey. Obtaining IRB approval across the partner sites was more challenging than expected, and in the future it may be possible to arrange for deferrals that would expedite both approval and continuing review. National site relationships were very time intensive to build, but yielded (when combined with the partner site data) a master dataset of over 3,000 respondents to the non-cognitive survey from engineering and computing majors. This is the first truly national dataset related to non-cognitive factors for this population, and the subsequent research enabled by this dataset seeks to support student success through individualized interventions and other support structures.

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