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Strengthening Knowledge Co-Production Capacity: Examining Interest in Community-University Partnerships

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Abstract**:**

Building successful, enduring research partnerships is essential for improving links between knowledge and action to address sustainability challenges. Communication research can play a critical role in fostering more effective research partnerships, especially those concerned with knowledge co-production processes. This article focuses on community-university research partnerships and factors that influence participation in the co-production process. We identify specific pathways for improving partnership development through a prospective analytical approach that examines community officials' interest in partnering with university researchers. Using survey responses from a statewide sample of Maine municipal officials, we conduct a statistical analysis of community-university partnership potential to test a conceptual model of partnership interest grounded in natural resource management theory and environmental communication. Our findings both support and advance prior research on collaborations. Results reveal that belief in the helpfulness of the collaborator to solve problems, institutional proximity, familiarity, perceived problem severity and problem type and trust influence interest in developing community-university partnerships. These findings underscore the benefits of proactively assessing partnership potential prior to forming partnerships and the important roles for communication research within sustainability science, especially with regard to strengthening partnership formation and knowledge co-production processes.

Keywords: community-university research partnerships; communication; sustainability; knowledge-action; stakeholders

Introduction

In light of the increasingly complex sustainability problems facing local and global communities and the need to improve the scientific basis for decision making [1], sustainability science elevates the role of research collaborations [2,3] and communication [4] among scientists and stakeholders in developing solutions. Clark and Dickson [5] identify collaborations as one of the core features of sustainability science initiatives: "for such knowledge to be truly useful it generally needs to be 'co-produced' through close collaboration between scholars and practitioners" (p. 8059). Numerous sustainability science programs in higher education institutions in the US emphasize university-stakeholder partnerships as a desirable form of collaboration. For example, Harvard's Sustainability Science Program emphasizes linking research and innovation with policy and management. Similarly, the vision of Portland State's Institute for Sustainable Solutions includes a statement about partnering with businesses, governments and other organizations in the development of sustainable solutions, and institutions, like Arizona State University (ASU) and the University of California, Los Angeles (UCLA), have established partnership programs, such as the Sustainable Cities Network and Corporate Partners Program, that purposefully link researchers and public and private partners in the research process and the advancement of solutions. Although many universities are heeding the calls for collaborative research and are making progress on bringing diverse groups together to address sustainability issues, disconnections between the production of knowledge and its actual use in society persist [6]. These persistent divisions indicate that we still have a great deal to learn about how to develop community-university partnerships that facilitate more robust links between the various actors in the knowledge system [7]. Communication research can play a foundational role in helping bridge this gap.

We present a model for studying place-based community-university research partnerships that seeks to deepen our understanding of knowledge co-production processes through model findings and the integration of communication theory, an underrepresented discipline in sustainability science [8]. We conducted this research within the context of a large sustainability science initiative, Maine's

Sustainability Solutions Initiative (SSI) at the University of Maine, that aims to co-produce science with project partners in Maine to help advance solutions to sustainability problems. Following Kates' and Parris' [9] recommendation to "identify the specific trends most relevant to such places and the ways in which local populations can contribute to altering the trends that affect them," (p. 8,066), we examine the potential for community-university partnerships using survey responses collected from local government officials. Through our findings, we offer an example of how to assess partnership potential, target partnership efforts and improve one's approach to and communication about prospective collaborations. We draw on communication research to interpret and apply the results of the study. Specifically, we use framing research in science communication [10] to explore how to better frame and adapt research to align with local issues. Informed framing may help demonstrate to project partners that partnerships are mutually beneficial [11] and that the research "fits" the information needs of stakeholders [12]. We also use communication research to ask certain questions of the data about partner relationships and the influence of communication on partner perceptions and behavior. Communication theory asks which communication practices influence perceptions of partner's capacities, capabilities and expertise and how do these influence work [13,14]; who gets to participate in activities to address problems [15]; how such practices (re)enforce power structures in relationships [16]; and the relationship between such practices and knowledge co-production, particularly in terms of partnership development. Our model is place-based, which means that we focus on municipal agents as key stakeholders within the context of our larger research team. Our team determined that surveying local decision-makers and attempting to strengthen relationships with them may prove valuable for identifying local and state-level social-ecological system (SES) trends. The complexity of SESs, which are composed of multiple subsystems that "are relatively separable, but interact to produce outcomes at the SES level, which… affect these subsystems and their components" [17]), demands such an integrated approach. Further, a recent survey of SSI researchers revealed that, of all external stakeholder groups identified in a set of in-depth interviews with SSI researchers, municipal officials received the highest mean involvement score in these researchers' projects [18].

This research represents a three-fold aim. First, we contribute to the growing body of research on building partnerships through our survey and the analysis of our data. We study factors, such as perceptions of partners' capacities to help solve problems, familiarity, institutional proximity, problem characteristics and trust, that we expect to influence interest in developing a partnership. Second, we present a model that proactively assesses partnership potential prior to the formation of partnerships. This second aim is particularly novel, in that it advances the need to study the communication and collaboration context in ways that assist with aligning the need for scientific research and other community-based forms of knowledge with its supply before the partnership begins [19]. Finally, we use this research as a tool to help our colleagues gain a deeper understanding about the institutions and individuals with whom they are partnering in their pursuit of advancing solutions-oriented sustainability science. We maintain that communication research can make important contributions to sustainability research, because of its deep understanding of relational dynamics and emphasis on attending to place-based perceptions and needs.

This study extends prior research on community-university partnerships focused on sustainability in three key ways. First, it offers a model to evaluate partnership potential, instead of focusing exclusively on *existing* partnerships. By exploring the beginning phase of partnership development—pre-formation—we provide insight on factors that may influence partnership development and that contribute to long-term partnership success or failure. While some of the variables evaluated and findings discussed in this manuscript may seem common sense, research on communication and social behavior documents that things that appear as common sense to some are often proven inaccurate. As a field, communication studies conceptualize communication as constitutive. This means that communication acts do not simply reflect objective reality, but rather that they constitute our sense of the world [13]. As such, what appears to be common place knowledge to one community or stakeholder group often does not resonate as common sense with other individuals or groups. For example, while a researcher interested in addressing novel, complex problems in her/his field may be motivated to participate in a partnership to study that issue, a local decision-maker facing a problem that seems intractable may be demotivated rather than motive to

spend resources to address the issue. Integrating communication into sustainability research is important, because of the particular understanding this field brings to the table about issues that appear natural or normal, but are indeed socially constructed.

Exemplary studies from the field of science communication clarify this point. Fischhoff [20], for example, discusses the complexity of science communication in terms of climate change communication and documents that assumptions about reactions to risk communication have not always played out the way one would anticipate. He writes, “Indeed, focusing attention on uncertainties may encourage people to think that nothing can be done until they are resolved… An alternative framing of climate science is that its uncertainties show the fateful gambles that we face. From that perspective, greater uncertainty can mean greater reason to act” (p. 703). In terms of community-university partnerships, we may assume that experiencing severe problems in a municipality will motivate people to participate in a partnership aimed at helping to solve the problems. However, as prior research notes, even when confronted with messages about severe problems, people may not respond as anticipated [21]. Further, even when the overall behavior of the social system follows expected patterns, rigorous testing of the phenomenon can show the “how” and “why” of the systems properties. This study advances our conceptual understanding of the relationship between certain key factors and interest in developing community-university partnerships and points to some complexities not previously identified in the literature.

Second, we extend prior research by studying community-university research partnerships, an emphasized, but understudied, relationship in the sustainability science literature. Finally, we contribute to the growing body of literature that documents the importance of paying attention to and encouraging particular kinds of communication in engaged, participatory research projects [4,8,22,23] and of improving access to technologies that promote communication [24]. Specifically, we integrate environmental and science communication research to interpret and utilize the results of the regression model developed in this manuscript. Through the survey and subsequent analysis, we identify potential opportunities for improving communication and collaboration in

community-university partnerships and directions for future research that use communication theory to interrogate relationships in partnerships.

Research Partnerships for Sustainability Research

Research documents that collaborations among interdisciplinary groups of scientists and stakeholders not only have the potential to improve understanding of the diverse facets of complex systems [25] and mobilize coordination across interconnected landscapes [22], they also have the potential to encourage social learning between groups [26], facilitate processes for transition [27] and more effectively link knowledge with action [4,28]. In a 2008 report on public participation in environmental assessment and decision making, Dietz and Stern [29] documented that "best practices in public participation can advance decision quality, legitimacy, and capacity simultaneously" or individually (p. 92), and Austin [11] asserts that partnerships are thought to address problems with "high levels of complexity, low levels of public confidence in institutions, and insufficient capacity within a single organization to go it alone" (p. 421). In addition to studying partnership outcomes for sustainability, researchers have also studied structural, interpersonal, and political or institutional factors that influence partnership success. With a long tradition of studying public participation and decision making, environmental communication contributes critical insights to our understanding of (in)effective collaborations, participatory engagement, and environmental decision making [8,30,31]. For example, studies repeatedly demonstrate that processes that employ participatory communication strategies improve stakeholder experiences [32] and decision making [33], while ineffective processes can significantly harm the quality of decision making and stakeholder trust [15,34]. Researchers in the fields of applied anthropology and political science offer insights on critical features of partnerships [11,35]. For example, Austin [11] argues that success in partnerships is recognized as related to "relationships of mutual benefit, identifying and working toward a common purpose, developing effective group process, and demonstrating effectiveness through performance" (p. 421). Finally, researchers document institutional and political elements that influence relationships in community-university partnerships and

knowledge-action linkages [35–37]. Through a series of interviews with the public, Walsh [35] discovered that participants perceived the university as "driven by political ideology" (p. 26), people on campus as lacking accountability, and the university as being largely unresponsive to the interests of the public. She also found that the context in which these discussions took place, rural vs. urban, mattered in terms of perceptions. Dilling and Lemos [36] found that institutional arrangements, such as training and incentives for hiring information brokers, and institutional capacities, such as technical capacity and leadership, impact how users and producers of knowledge are connected and, subsequently, "how science is produced and used" (p. 685). Finally, Israel, *et al.* [38] note that many of the challenges in community-based research result from, among other things, competing institutional demands, tenure and promotion guidelines, funding institution requirements and political and social dynamics.

Despite these important studies, there remains a significant gap in the literature. The majority of scholarship on public collaboration in resource management and community-university partnerships provides a retrospective rather than a prospective analytical approach by evaluating established participation events and partnerships (e.g., [29,34,39,40]; extant scholarship pays little attention to factors that constitute the foundation on which to build effective partnerships. In fact, even though some studies examining research partnerships may note in the partnership description why or how the partnership formed [11,41,42], they often do not provide an empirical evaluation of the conditions that influenced partnership development, and they rarely discuss how to start partnerships when no relationship with partners yet exists. This gap in the literature weakens collaborative capacity, as researchers and research teams often struggle with initiating partnerships. Some researchers do not know how to find project partners and, once communication is initiated, "getting off on the wrong foot" can undermine partnership success. Gauging collaboration potential in advance may help identify important issues prior to beginning conversations with potential partners and before beginning the research process. Furthermore, this pro-active approach may help partners identify resources to build stronger collaborations, such as incorporating facilitation into budgets in situ in situations that warrant increased attention to conflict management.

Although university and college researchers often contribute to the work of collaborative groups addressing sustainability and collaborative management issues [26,43,44] through research, facilitation and expertise, little research in the sustainability and environmental management literatures statistically analyzes and models the relationship among university and college researchers and other stakeholders (for exceptions, see [26,45]). Studies tend to focus on outcomes for sustainability, like those cited above, or relationships among, for example, citizen stakeholders and local, state or federal management and planning agencies [34,46]. The studies might also investigate the science-stakeholder relationship at the level of knowledge integration [47], documenting the complications of and opportunities for scientists to incorporate local knowledge into science, and stakeholders to understand scientific information and incorporate it into local decision making [29]. While it is important to understand outcomes and public-management interactions, there is a critical need for research on the development and progression of community-university research relationships. This is important given the increased interest at many universities in engaged research [48], specifically in sustainability programs (e.g., ASU‘s Global Institute of Sustainability, UCLA‘s Institute of the Environment and Sustainability and Lund University Centre for Sustainability Studies). The complexity, challenges, paradoxical and sometimes conflicting nature of these relationships is well cited (i.e., [28,38,49]. Understanding these relationships is likely to provide important insights on how stronger relationships can improve outcomes and research-informed management decisions that promote sustainability. In the following sections, we develop and test a model that assesses community-university partnership potential and factors that may influence partnership development.

Conceptual Framework and Research Questions

To develop and test a quantifiable tool for evaluating community-university partnership interest, we build on environmental communication research on public participation and collaboration and environmental sciences and natural resource management literature on environmental planning, behavior and collaboration. Drawing on this literature, we developed a conceptual model of the

relationship among a set of predictor variables and officials' interest in developing a community-university partnership and designed a survey instrument to test theoretically and empirically supported variables shown to influence partnership success and interactions (see Figure 1 and Table 1). As Holland [50] notes, researchers know what (un)successful engagement looks like, but much less is known about how to achieve those characteristics that lead to successful engagement (p. 10). Recognizing the paucity of research focused on evaluating partnership potential, two broad research questions guide our analysis:

RQ 1**:** What are municipal officials' interests in developing community-university partnerships?

RQ 2: What factors influence municipal officials' level of interest in developing community-university partnerships?

One of the survey goals was to identify potential research partners. Thus, asking respondents to report their interest in a partnership assisted us in gauging whom to approach for future partnerships. Asking empirically what factors influence their responses provides us with information on what to emphasize in conversations (e.g., how working together can help solve problems), what issues (e.g., trust) may need to be addressed during initial conversations, what resources and incentives may be needed to encourage participation (e.g., funding, flexible scheduling) and what institutional barriers may need to be overcome (e.g., public access to information, negative perceptions of science and/or the university).

Interest in Partnerships

Given the assortment of problems, contexts and diverse experiences with higher education institutions in Maine communities, we expect that municipal officials' interest in partnerships will vary across people and municipalities, in part because each municipality is likely to have different perceived transaction costs associated with forming and participating in the partnership [51]. Research on decisions to enter into collaborations (as assessed after the person joined the collaboration) indicates that participation is not preordained and that there are numerous factors

influencing participation, such as the perceived benefits of the collaboration [52], the perceived costs of the collaboration (e.g., physical distance and uncertainty) [51,53], the perceived severity of the problem being addressed [54] and participant trust in the organizing institution [55], including general and specific properties of trust [56]. Drawing from these studies, we incorporate and test similar factors in our model predicting stakeholder interest in developing a community-university partnership. These factors and their expected relationship to the dependent variable, interest in a community-university partnership, are discussed below (see Table 1).

Belief in the Partnership Helpfulness

Belief that the partnership is useful for managing issues, such as watershed resources, is shown to influence the likelihood of participation in collaborations [57]. Studying non-participation in a parental program, Pettersson, Linden-Bostrom and Eriksson [58] found that parents who did not perceive the program as beneficial were more likely to be non-participants than parents who perceived benefit. Hoppner, Frick and Buchecker [59] suggest that participants' belief that a particular process will solve problems may be measured as a form of confidence in a process or outcome. Given the extensive time and resources required of collaborations, it makes sense that people need to believe they will benefit from the collaboration and that the issue under discussion is best solved through collaboration. Thus, we expect to find a positive relationship between municipal official interest in partnering and this belief. If municipal officials believe that researchers can help them solve municipality problems, they should have higher levels of interest in developing community-university partnerships.

Perceived Costs of Collaborating

In addition to benefits, potential partners also consider the costs of collaborations [52]. After all, the expected overall (or net) return for municipal officials from partnering is a function of their perceived benefits and costs of collaboration. Direct, out-of-pocket costs may include employee time, travel expenses and monetary resources (e.g., purchasing equipment, food, mailings). El Ansari

[60] adds personal costs, such as loss of privacy, to monetary and human capital expenses of community partnerships. At least some of these costs may be correlated with the physical distance between members of the partnership. Referencing the transaction cost theory of trust, Lubell [53] measured the effects of institutional distance (physical distance and distance between centralized decision making and local action) on trust in an organization. Citing Levi's (2000) transaction cost theory of trust, Lubell writes that "the greater the institutional distance between a truster and trustee, the higher the transaction costs of developing trust-based relationships" ([53], p. 239). The proximity of the municipality to university and college campuses is particularly important to consider in this study, because of tensions that sometimes occur about the "perceived costs *versus* benefits of the town-gown relationship" [61]. Time and travel costs are likely also associated with proximity. For example, one might expect that municipal agents working 100 miles from a university or college are likely to incur higher costs than municipal agents within 25 miles. Thus, given the higher costs, we expect there to be a negative relationship between distance from a university or college and interest in developing a community-university partnership.

Similarly, if a municipality's staff is largely composed of volunteer leaders (elected or appointed), officials may perceive that there are higher time costs associated with a community-university partnership, because volunteers need to commit additional volunteer hours to participate in the partnership. In Maine, municipalities with populations fewer than 1,000 residents typically are governed by a board of elected volunteers and a manager or administrative assistant [62]. Alternatively, municipal officials from small communities that may not have the resources of large communities may also perceive high costs associated with inaction and view partnerships as one avenue for achieving desired goals at a reduced cost. Accordingly, we have ambiguous expectations about the relationship between population size and interest in partnerships; municipality size could be positively or negatively correlated to interest.

There are also costs in partnerships that are not easily calculated, such as cognitive or emotional costs. Uncertainty is documented in the literature as a risk in relationships carrying potentially

significant associated costs, such as unintentionally terminating an interaction [63]. Researchers Berger and Bradac [64] argue in their discussion of uncertainty reduction theory that a central concern of newly acquainted people is the reduction of uncertainty, and research on anxiety/uncertainty management theory documents that anxiety, an emotional cost, often accompanies uncertainty, a cognitive cost, and that both may influence communication or relationship avoidance [65]. Experience, or prior history, with a person or institution reduces uncertainty because more is known about the situation [66]. With a reduction in uncertainty, there is also a reduction in the interaction risks and associated costs. Literature in fields like economics and anthropology refer to the influence of past action or experience on future conditions as path dependence [67], although many suggest a more complex approach to understanding path dependence than one that simply states that the past influences the future (e.g., [67]). We expect that having experience with university researchers will be positively associated with interest in developing a partnership.

Perceptions of Problem Significance and Problem Type

Research demonstrates that people who perceive a problem to be severe are more likely to join a partnership that addresses the issue of concern than people who do not perceive that a problem exists [51]. Referencing environmental regulation support, Johnson and Scicchitano [54] argue, "individuals are not likely to support the imposition of stricter environmental standards unless they perceive an environmental problem exists" (p. 834). Similarly, we argue that municipal officials will be hesitant to invest in a problem-solving partnership if they do not perceive that there are problems in their municipality. We expect that problem severity, regardless of problem type, will be positively associated with interest in developing a community-university partnership.

Trust

Trust is evaluated frequently in the collaboration and participation literature and is shown to influence participation [57]. DeCremer and Tyler [68] found that participants with high levels of trust

in the authority figure in the partnership wished to contribute more than did those who had low levels of trust. While generalized or overall trust is frequently measured [53], the literature documents that trust is a nuanced and contextual variable. For example, studying community-water resource management agency relationships, Leahy and Anderson [55] discovered that five major factors comprised overall trust, including trust in the governing agency, social trust in people in general, trust in the technical competence of the governing agency, trust in shared interests among members of the partnership and trust related to feelings of being heard and having influence. In light of this complexity, studies often measure both generalized trust and "trust-warranting properties," ([53], p. 245) or "different dimensions of trust" [59], such as fairness, technical expertise and shared interests [55,69]. Based on prior research, we expect that high levels of generalized trust in university or college researchers will be positively related to interest in developing community-university partnerships. Similarly, we expect a positive relationship between officials' perceptions of "trust-warranting properties" and their interest in developing community-university partnerships.

Methods

Using survey responses of Maine municipal officials, we employ ordered logit regression analysis to test empirically the conceptual model summarized in Figure 1.

Study Area

Maine, the study area of this empirical research, is an excellent location to examine community-university research partnerships. Maine's history of strong local control, local government decision-making capacity and numerous and diverse municipalities elevates the relevancy of municipal officials to sustainability challenges. Further, the state's universities and colleges are also diverse in size and mission. The variation in both communities and universities creates an interesting setting in which to test our conceptual model. Moreover, Maine's academic

institutions generally share a common interest in establishing community-university research partnerships, creating an engaged audience for the findings of this research.

Participants

We distributed the Maine Municipal Official Survey to 2,553 municipal officials in 499 municipalities and townships throughout Maine. The sample was derived from the Maine Municipal Association's (MMA) municipal official list, which is updated daily [70]. Officials holding the following positions were surveyed: key official, community development, planning, purchasing, assessing, finance, public safety, recreation, chief elected official (e.g., selectboard), personnel, public works, welfare and code enforcement. Only a few municipalities had all 13 positions. We have multiple responses per community from officials, and the number of responses varies across municipalities. Using a modified version of Dillman's Tailored Design Method for surveys [71], we sent four solicitations for participation to municipal officials, including a pre-notification letter, first round survey and invitation letter, reminder postcard and second round survey and invitation letter. In each survey cover letter, we asked participants to complete the survey based on their work experience in their specific municipality. In cases where participants worked for multiple communities, we randomly selected the town for which they were to respond. We achieved a 46% response rate (n = 1,177), and respondents represented 86% of Maine municipalities. The ordered logit regression analysis uses responses from a subset of the sample (n = 769; 65% of total respondents) that provided complete responses to the survey questions employed to measure the dependent and independent variables in our empirical model. This study was approved by the University of Maine Institutional Review Board for the Protection of Human Subjects.

Measures

We pre-tested the survey instrument on a small group of municipal officials and sought feedback from key non-governmental organizations that work with staff from Maine municipalities. Details about how the dependent and independent variables are measured in the regression analysis are

reported in Table 2. Prior to asking participants to rate their interest in pursuing a community-university partnership (the dependent variable in this analysis), we described in the survey that the structure of community-university partnerships varies and offered examples of the various roles municipal officials and university researchers may play in the research process, such as co-defining the problem or co-conducting research. We provided a broad description of collaborating to emphasize two critical features of community-university partnerships. First, partner participation in research varies depending on the problem and partners. Second, partnerships involve sharing resources, knowledge and responsibilities at some level. This description of partnerships provides a context for understanding the responses analyzed in this study.

Interest in Developing a Partnership

Our empirical regression model explains the variation in our dependent variable, which is municipal officials‘ stated interest in developing a community-university partnership (see Table 2). Specifically, we asked municipal officials to rate on a five-point Likert scale, “Considering your current municipal position, how interested are you in pursuing a community-university partnership?” (see Table 2). To retain data, we combined responses of “not sure” with responses on “neither unlikely nor likely”. We justify this combination, because these two types of respondents are similarly positioned to engage in the next step of having a conversation about developing a partnership. The distribution of participant responses demonstrates variation in municipal officials‘ interest in partnering. The percentages of participants by level of partnership interest are as follows: “very unlikely” (4%), “unlikely” (8%), “neither unlikely nor likely” and “not sure” (35%), “likely” (33%) and “very likely” (19%). Individual municipal official‘s rating of interest in a partnership is the dependent variable in our empirical regression model.

Belief in Partnership Helpfulness

We invited participants to report their belief in partnership helpfulness by asking them to describe if they think university researchers could be of assistance in resolving municipality problems. Unlike

Lubell [57], who studied a specific partnership addressing specific issues, the municipal official survey asked officials about a series of diverse economic, social, environmental and policy problems. Thus, we chose to ask participants about their general perceptions of researchers' ability to help solve problems in their municipality (see Table 2).

Perceived Costs of Collaboration

We analyzed several potential costs to collaborating that we hypothesize would influence officials' interest in developing partnerships, including proximity to universities and colleges in Maine, municipality size and past experience with researchers. In order to calculate distance between a municipality and a university or college, we selected a set of colleges and universities in Maine based on if the institutions were listed as accredited by the New England Association of Schools and Colleges (NEASC). We selected NEASC schools because their shared accreditation ensures a level of similarity across these institutions in terms of basic standards of education, allowing us to assess perceptions of those institutions by municipal officials more evenly than allowed without a common denominator. Further, all institutions listed as accredited by NEASC

Perceptions of Problem Significance and Problem Type

We asked municipal officials to rate the severity of four sets of issues for their municipality: economic, social, environmental and policy issues. Because our survey was intended to assess a variety of economic, social, environmental and policy issues, rather than one specific issue (e.g., wind energy development, poverty, surface water quality or land-use zoning regulations), participants were presented with 10 to 13 types of issues known to be potential problems in Maine. To develop the set of problems included in the survey, we learned from the format of the National League of Cities survey of local government officials, a survey which scopes out problems of national significance. To tailor the survey to fit Maine, we drew on feedback from state policy makers, municipal organizations and media analyses. In addition, two of the survey developers are part of the University of Maine's Margaret Chase Smith Policy Center, a center focused on contributing to

policy discussions and analyses in the state. Finally, some problems evaluated in the survey aligned with ongoing or proposed research projects under the SSI research program (e.g., vernal pool regulations). We created and analyzed the reliability of composite variables for each set of questions. Alpha scores for each summated scale indicated high reliability: economic ($\alpha = 0.80$), social ($\alpha = 0.84$), environmental ($\alpha = 0.90$) and policy issues ($\alpha = 0.78$).

Trust

We measured officials' trust with multiple survey questions, including a general measure of overall trust in researchers and an agreement index representing levels of agreement on statements about specific reasons for trusting university researchers (see Table 2). Statements included in the agreement index address technical factors of trust, such as "I trust researchers (faculty/staff) from the University of Maine System, because they provide scientific information" and interpersonal factors of trust, such as "I trust researchers (faculty/staff) from the University of Maine System because they share my values." The alpha score for the agreement index indicated high reliability ($\alpha = 0.93$).

Data Analysis

We analyzed the survey response data using Statistical Analysis System (SAS) software. For all survey items, we calculated descriptive statistics, such as mean, minimum, maximum, median, mode and standard deviation. We developed a regression model to explain the variation in municipal officials' level of interest in developing community-university partnerships using variation in the set of factors we conjecture will influence these interests (see Figure 1, Tables 1 and 2). Because survey responses describing the level of interest in partnering are discrete, ordered items, we developed and estimated an ordered logit regression model [72,73]. Similar to a linear regression model, the ordered logit model explores correlative relationships among the dependent variable and the set of independent or explanatory variables. However, the discrete and ordered nature of the dependent variable changes the required assumptions of the regression model and the interpretation of

estimated parameters. The model is often motivated as a set (1 minus the number of ordered categories) of equations, where each individual equation posits the probability of a response taking on one of the potential discrete values, and one category is treated as the reference category. Our analysis explores patterns across five response categories describing the level of interest in a community-university partnership. Hence, the ordered logit model becomes a series of four equations, where the probabilities of specific responses (e.g., the probabilities of responding 1 (very unlikely), 2 (unlikely), 3 (neither unlikely nor likely and not sure), 4 (likely) or 5 (very likely)) are evaluated using functions based on the cumulative logistic distribution. The cumulative probability values are generated as a function of the product of specified independent variables and a corresponding set of parameters. The ordered logit model allows for intercept terms to vary across response categories and holds the remaining parameters constant across the response categories. For the purposes of this paper, we employ a significance threshold of 10% (0.10) when discussing specific parameter or coefficient estimates. Multicollinearity diagnostics results are normal, with tolerance scores greater than 0.20 and variance inflation factor (VIF) scores below 4 [74]. Parameters are estimated using maximum likelihood estimation methods.

Results

The results of the ordered logit regression support the model specification and provide general support for our prior expectations of the influence of factors on interest in partnering (see Table 3). Global tests of the model (parameters = 0) indicate that the empirical model fits the data (Likelihood ratio $\chi 2 = 272.26$, $p < 0.0001$). Although the nonlinear structure of the underlying likelihood function complicates direct interpretation of these parameter estimates, we can interpret the signs of the estimated coefficients as associated with the extreme response category or being “very likely” to be interested in developing a partnership. A negative coefficient implies that the probability of being interested in developing a partnership decreases if there is an increase in the corresponding explanatory variable [72,73]. We found a significant, positive relationship between the dependent variable, interest in developing a community-university partnership and the following independent

variables: belief that university researchers can help municipalities solve problems, low perceived costs of collaboration, severe economic problems, and high levels of overall and specific properties of trust. The specific relationships are described below. Parameter estimates, standard errors, and significance statistics are reported in Table 3.

Our expectation that officials' belief that university researchers can help solve municipal problems will be positively associated with interest in developing a partnership is confirmed in the model. The positive estimate value indicates that those who think researchers can help solve problems tend to have higher levels of interest in a partnership than those who answered "no." Similarly, the positive estimate value associated with responses of "not sure" indicates that those who are unsure if researchers can help tend to have higher levels of interest in a partnership than those who answered "no."

Our expectation that officials who perceive there to be high costs (as measured by municipality distance from a college or university and experience) associated with collaboration will be less likely to be interested in developing a partnership is supported overall, although population size did not reach the necessary significance level. Officials who had previously worked with university researchers were more likely to be interested in developing a partnership than those who had not previously worked with researchers. Further, the model reveals that as physical distance increases between the municipality and a college or university campus, interest in developing a partnership decreases. In other words, there is a negative association between distance and interest in a partnership. Finally, while the association between population size and interest in a partnership is negative, the association was not significant in this model.

The model revealed mixed results in relation to our expectation that ratings of severe economic, social, environmental or policy problems will be positively associated with interest in developing a partnership. The model estimates indicate interest in developing a partnership varies by type of problem and problem severity in relation to the type of problem. For example, the positive sign associated with economic problems indicates that municipal officials who rated economic problems

as moderate to severe tend to have a higher likelihood of being interested in developing a community-university partnership. However, we did not find significant associations between social, environmental and policy problems and interest in a partnership.

Our expectation that overall and specific properties of trust will be positively associated with interest in a partnership is supported. Officials reporting having “a lot” of trust in university researchers are more likely than those reporting not having any trust at all in researchers to be interested in developing a partnership. Results document that as trust increases, the influence of trust on the dependent variable increases. However, results suggest that having low levels of trust are not significantly related to interest in a partnership. In addition, results indicate that positive perceptions of trust-warranting properties are positively and significantly correlated with officials‘ interest in a developing a partnership.

Discussion

Our study reveals that there are several factors that influence interest in developing a partnership with university researchers. Findings indicate that if municipal officials do not think researchers can help solve municipality problems, have low or limited opinions of researcher trust-warranting properties, perceive high costs associated with collaborating and are not experiencing severe economic problems in the municipality, partnerships may struggle to get off the ground because of the negative effect on stakeholders‘ interest in developing a community-university partnership. These factors could be particularly problematic for researchers involved in sustainability work or a community-based management initiative [46], where stakeholder feedback and buy-in is essential. These findings support prior research on state government-citizen and citizen-based watershed partnerships, specifically that belief in the helpfulness of the collaborator [58], perceptions of transaction costs (physical distance [53]) and familiarity [66], perceived problem severity [54] and trust [57] influence interest in developing or joining partnerships. Importantly, we statistically test prior assumptions about community-university partnerships that were either qualitatively evaluated or assumed, but not studied, filling a gap in the literature. This study also provides data that can be

compared and combined with data from other studies in a meta-analysis to study patterns and relationships in partnership behavior across contexts and groups. In addition to our unique approach to studying partnership potential, this study offers several new insights into partnership formation.

One of the most significant findings is that respondents‘ likelihood of partnership interest varies by problem type. More specifically, we find a positive association between partnership interest and economic problems at the municipal scale and no associations between partnership interest and environmental, social and policy issues. Unlike Lubell *et al.*‘s [51] work, which demonstrates that the perceived problem severity of an ecosystem‘s health is positively related to watershed partnership participation, our results demonstrate no significant relationship between moderate–severe environmental problems and partnership interest. Past partnership research has not adequately addressed participation variability based on issue type, nor identified potential reasons for that variability, perhaps because most partnership literature addresses very specific issues or processes. Importantly, we demonstrate that approaches that work for addressing one type of issue may not work when addressing a different type of issue and that the relationship between problem severity and interest is complex and may not unfold as one might assume. Attempting to address complex, “wicked” sustainability problems with diverse stakeholder groups and researchers from a wide range of disciplines requires us to understand how different contexts and perspectives can influence collaboration [75].

Framing research in communication assists in applying some of these findings to the development of community-university partnerships. In complement to the model findings that municipal officials expressed a higher likelihood of interest in developing a partnership when experiencing moderate to severe economic problems, descriptive survey statistics document that officials‘ responses indicate that municipalities are experiencing severe economic problems, but small to no environmental problems, on average. Communication researchers might leverage these complementary findings to help identify ways to frame research. For example, researchers conducting research on environmental problems who are interested in working with municipal officials may want to explore

explaining the relevance of their research using an economic frame. As Nisbet [10] notes, ethical reframing is not about twisting your science; it is about making it salient to the group with whom you are communicating. An ability to reframe one's science not only helps people understand its relevance in relation to a particular set of concerns (e.g., economics), but, in terms of municipal officials with decision-making power in a community, it may help them understand how the research can help them solve complex local problems involving intersecting social-ecological issues. An emphasis on framing also reminds us that how we understand an issue, what we view as common sense and who we perceive should be involved in addressing it are socially constructed [13], partially through the ways we choose to talk about issues. Recognizing and adapting to different ways of understanding and interacting in the world are important for knowledge co-production, as they are part of the "mutual learning and fact finding" process argued by Walker [76] as an attribute of collaborative public participation processes (p. 124). As revealed in the model results, perceptions of how researchers can help solve problems significantly influences interest in a partnership. Thus, the results not only provide insight on relevant framing, but they also demonstrate that "good science" alone will not motivate involvement; people must understand how the research is relevant to them.

Model results beg the following questions: Why are severe economic problems positively correlated to interest, while environmental problems are not significantly correlated? How do university researchers improve confidence that researchers are able to help local communities solve problems? In other words, how do we improve research saliency? Finally, how do we strengthen trust in university researchers? Whereas other fields may approach answering these questions from a deficit perspective, holding the assumption that low interest in a partnership is the result of science illiteracy or a lack of appreciation for research and the benefits of science [77], a communication scholar is likely to interrogate the relationships—or the lack thereof—that undergird stakeholder perceptions. They might pose the following questions: "Are there specific communication patterns or behaviors influencing officials' perceptions of university researchers in such a way that they are disinclined to partner on environmental issues and more inclined to partner on economic issues?" or "Do municipal officials view themselves more or less capable of addressing different problem types

through a collaborative partnership?" "Do municipal officials perceive the problems as intractable at the local level and partnerships as ineffective for addressing issues caused by, for example, global situations [11]?" These questions probe communication between partners and communication networks, offering opportunities for investigating how and what communication *interactions* influence relationship perceptions that, in turn, may influence relationship potential. Such questions move the analysis toward a focus on the role of communication in building relationships and creating opportunities to generate new collaboration structures and collective capacity and away from a transmission approach to communication and knowledge-action.

As we consider these findings, we must also recognize the study limitations and opportunities for future research. First, as with any model, not all factors that influence partnership formation may be assessed. Given the survey format in which we were interacting with stakeholders, the broad nature of the survey and space limitations, certain variables were not included. For example, research documents that power differences in partnerships may impact knowledge co-production [26] and knowledge-action outcomes [6], among other important aspects of sustainability. Hoppner *et al.* [59] suggests that participants' perceived self-competence and perceived lack of influence on the process may influence their intention to participate in a participation process. In addition, research documents that town-gown relationship factors, such as community members' perceived fairness of campus decision makers, may influence support for university or college projects [61] or, in relation to this project, interest in developing relationships with researchers. Future studies should test such factors and their relationship to interest in a research partnership. Regarding the variable of prior experience, scholars like Mahoney [67] argue for a more complex approach to studying path dependence. He suggests that three features of path dependence must be acknowledged in path dependence analyses, including a study of causal processes that pay particular attention to early process events, an understanding that final outcomes cannot be predicted by initial conditions alone and a recognition of inertia, or that "once processes are set into motion and begin tracking a particular outcome, these processes tend to stay in motion and continue to track this outcome (p. 511)". Our study addresses one type of condition (experience) that may influence future partnership

interest, but future studies using path dependence analyses should take a wider view of relationship history to account for the various conditions that might influence future action. Second, while this study explored the relationship between problem severity and type and interest in a partnership, we collapsed multiple types of problems (e.g., decreasing water quality and loss of farm land) into broad categories (e.g., economic, social, environmental and policy), a move supported by scale reliability statistics. While the goal of this study was to explore these issues broadly to assess partnership potential in Maine, future studies may benefit from exploring the relationship between specific problems and interest in a partnership, as most partnerships form to address a particular problem or set of problems.

Finally, when evaluating results from any study, one must consider the context in which the results were generated. In this study, results may be influenced by the socio-economic climate, specifically an economic recession, in which participants evaluated municipal problems and potential community-university partnerships. Retesting this model under different conditions will lend insight on if and how partnership preferences vary in different socio-economic situations.

Conclusion

This research moves forward the partnership literature in sustainability science by advancing a regression model that evaluates a previously under-explored relationship, specifically, community-university partnerships. Few studies systematically and statistically analyzed the factors that influence community-university partnership formation. Rather, they provide retrospective analyses of partnerships. Our research provides a statistical basis for understanding the *development* of partnerships and the barriers and opportunities for improving engaged research. One important consideration for future research is to examine whether interest in partnerships leads to effective collaborations and if such interest influences future outcomes. In addition, this study offers insights on local government as stakeholders in partnerships. Even as we look toward regional or global solutions, many of the issues we address in sustainability demand place-based approaches [78,79]. Some of the most prominent sustainability science programs in the United States encourage

place-based, often municipally-based, research (e.g., ASU and UCLA). While the results offered in this study are specific to Maine in the sense that the specific conditions influencing partnership interest may be place-based (e.g., experience with researchers or trust) and time-specific, the approach to studying partnership development and the factors studied are generalizable to and testable in other places. Researchers exploring partnership interest need to study interest in *context*, adapting the variables under investigation accordingly. Understanding the perspectives of local government officials is not only important for addressing local sustainability issues, such as urbanization, clean water supplies and energy efficiency, engaging local stakeholders is also important because of the reciprocal benefits that may arise from partnerships between universities and local communities. Such partnerships provide students and faculty a learning space in which to work and conduct research that is external to the university, that is familiar, and that they are likely to understand the dynamics of more intimately than they would a community in a different culture and country. In addition, partnerships provide community partners with opportunities to contribute to and engage in cutting edge work that has the potential to benefit its citizens. Finally, we demonstrate the important role communication scholarship can play in designing engaged research studies and understanding and strengthening collaborative potential between stakeholder groups to improve knowledge flow between knowledge production and use [8].

Improving links between knowledge production and action for sustainability requires that scientists work across diverse disciplines [80] and in collaboration with a complex array of stakeholders in the research process [4]. Community-university partnerships are one promising means of strengthening knowledge co-production for the development of sustainable solutions. Conducting engaged, problem-centered research in community-university partnerships requires that we rethink not only *what* we study, but *how* we study it; it requires that we select new methods and theories of engagement and that we approach research design with an eye toward engagement. Our survey was designed in such a way that it contributes to the growing body of literature on collaboration in the context of sustainability science, while also helping to inform decision making about partnership formation within the context of our large, interdisciplinary research team, Maine‘s SSI. This research

has already informed research projects studying researcher perspectives on and motivations for partnerships; it has helped research teams affiliated with a large-scale sustainability science initiative to critically analyze how they discuss their research with stakeholders, in terms of solving problems, in particular, and how their research might lead to solutions; and it has encouraged teams and administration to think about distance issues and approaches to minimizing feelings of geographical distance. Finally, one of the most important results of this research is that it encourages a proactive approach to partnership development, where researchers, stakeholders and university administrators take steps (e.g., meetings, learning sessions, outreach efforts) to lay a solid foundation for partnerships prior to needing them to solve problems.

The more we understand about partnership formation, the more successful scientists will be in developing meaningful partnerships and positively impacting society. As communication researcher Carbaugh [81] reminds researchers conducting community-based research, first and foremost, researchers need to listen to the communities. Communication research with its deep understanding of relational dynamics and emphasis on attending to place-based perceptions and needs offers a rich approach to learning and co-production in community-university partnerships. Through such an approach to learning, we enhance the capacity of individual actors and institutions to work together to assess, address and adapt to the complex system in which we live. Further, the engagement of diverse viewpoints significantly impacts sustainability, “How the process is shaped, by whom and who is included are important issues . . . that will influence how sustainability comes to be defined” ([27], p. 286). Paying attention to and understanding partnership development is essential for bringing together diverse voices that can speak to and help find solutions to sustainability issues. With that said, while partnerships aim to be beneficial and perhaps even empowering, those attempting engaged research must be cognizant of the fact that even in efforts to “do good,” actors in and outside of the partnership may still be harmed by unjust—albeit often unintentional—abuses of power [82].

Increasingly, funding agencies, like the National Institutes of Health, the National Science Foundation and the National Oceanic and Atmospheric Administration, among others, are investing funding in large, interdisciplinary teams charged with producing and applying science that can lead to important changes. We hope this work can help to articulate some of the factors to consider when initiating partnerships and the important perspectives communication researchers bring to externally-funded, solutions-oriented research teams. To promote engaged scholarship in sustainability science, researchers need to evaluate partnership potential, understand which doors are open and work to open the ones that are closed through thoughtful, respectful responses and interactive communication. We believe communication research has many critical roles to play in this type of work, and understanding stakeholder perspectives and needs constitutes, but one of these roles [8].

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Figures

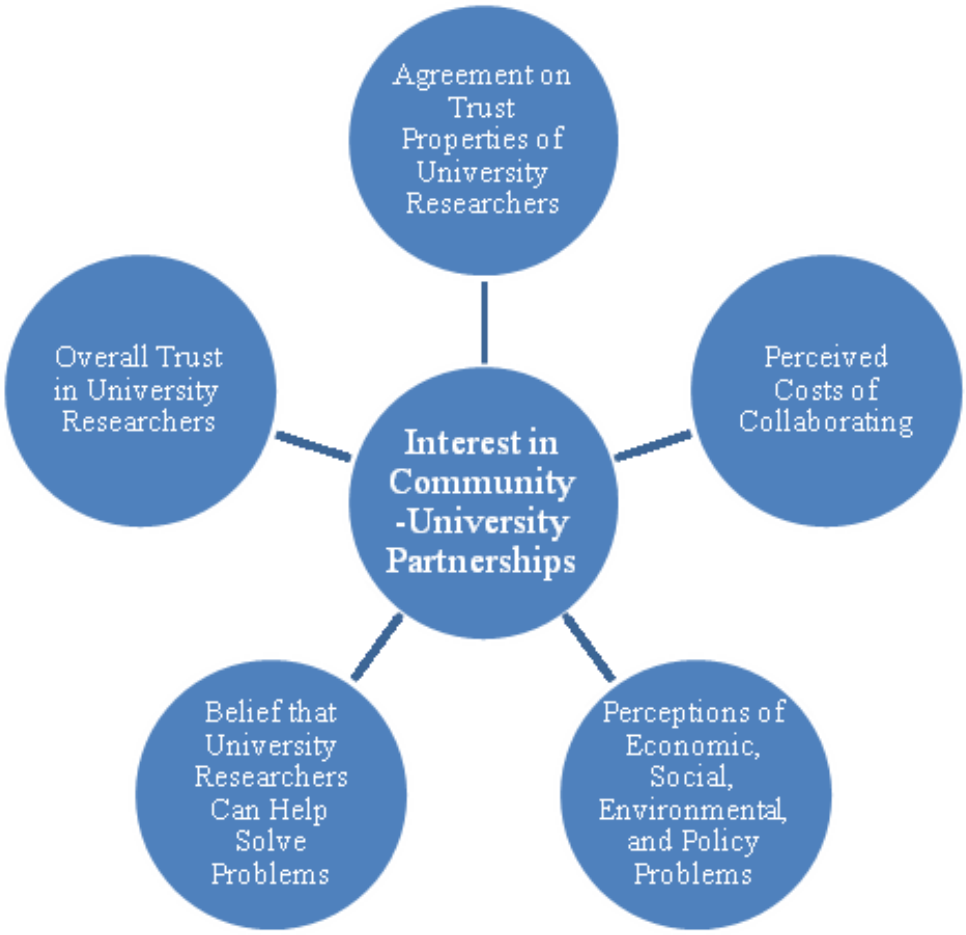

Figure 1 Municipal Officials' interest in community-university partnerships

Table 1 Developing an empirical model of municipal official interest in community-university partnerships

Factor Description Survey Measurement	Variable Name	Expected Sign
Belief in assistance of university researchers in resolving municipal issues		
	Assistance_yes	+
	Assistance_not sure	+/–
Perceived costs of collaboration		
Distance between municipality and closest university or college	Municipality Distance	-
Population size of municipality	Municipality Population	+/–
Experience with university researchers	Experience	+/–
Problem severity and type		
Severity of economic, social, environmental and policy problems	Economic, Social, Environmental and Policy	+
Trust in researchers		
General or overall trust in university researchers	Overall Trust	+
Agreement on trust properties	Specific Trust	+

Table 2 Empirical model of municipal official interest in community-university partnerships: descriptive statistics.

Variable Name	Measurement	Mean	Standard Deviation
Interest in partnership			
	Level of interest recorded using 5-point Likert scale (5 = Very likely; 4 = Likely; 3 = Neither unlikely nor likely and Not sure; 2 = Unlikely and 1 = Very unlikely); 1 serves as the reference category	3.54	1.03
Belief in assistance of university researchers in resolving municipal issues			
Assistance_yes	Set equal to 1 if "yes" response to question about potential assistance; 0, otherwise	0.31	0.46
Assistance_not sure	Set equal to 1 if "not sure" response to question about potential assistance; 0, otherwise	0.56	0.49
Assistance_no	Set equal to 1 if "no" response to question about potential assistance; 0, otherwise Assist_no serves as the reference category	0.13	0.34
Perceived costs of collaboration			
Municipality distance	Distance between municipality and closest university or college using Esri's ArcGIS software (miles)	12.9	9.4
Municipality population	Population size of municipality (full-time residents) divided by 100 (2010 US Census of Population and Housing)	50.3	78.5
Experience	Set equal to 1 if participant had experience working with university faculty, staff or student researchers; 0, otherwise	0.31	0.46
Problem severity and type			
Economic	Set equal to the mean score across economic issues (1 = not a problem; 2 = small problem; 3 = moderate problem; 4 = serious problem)	1.79	0.56
Social	Set equal to the mean score across social issues (1 = not a problem; 2 = small problem; 3 = moderate problem; 4 = serious problem)	1.24	0.57
Environmental	Set equal to the mean score across environmental issues (1 = not a problem; 2 = small problem; 3 = moderate problem; 4 = serious problem)	0.77	0.57
Policy	Set equal to the mean score across policy issues (1 = no debate; 2 = limited debate; 3 = moderate debate; 4 = extensive debate)	1.04	0.51

Table 2. *Cont.*

Variable Name	Measurement	Mean	Std. Dev.
Overall trust in researchers			
Trust not at all	Set equal to 1 if "not at all (1)" response to question about overall trust; 0, otherwise; Trust not at all serves as the reference category	0.03	0.16
Trust a little	Set equal to 1 if "a little (2)" response to question about overall trust; 0, otherwise	0.05	0.22
Trust not sure	Set equal to 1 if "not sure (3)" response to question about overall trust; 0, otherwise	0.27	0.45
Trust some	Set equal to 1 if "some (4)" response to question about overall trust; 0, otherwise	0.26	0.44
Trust a lot	Set equal to 1 if "a lot (5)" response to question about overall trust; 0, otherwise	0.39	0.49
Agreement on trust properties of researchers			
Specific trust	Mean score across trust properties (5 = Strongly agree; 4 = Somewhat agree; 3 = Neither disagree nor agree; 2 = Somewhat disagree and 1 = Strongly disagree)	3.41	0.62

Table 3 Municipal official interest in community-university partnerships: model results.

Variable	Parameter Estimate (Standard Error)	Significance Level
Researcher assistance with problems_yes	2.51 (0.26)	<0.001
Researcher assistance with problems_not sure	1.34 (0.23)	<0.001
Municipality Distance	-0.02 (0.01)	0.019
Municipality Population	-0.00 (0.00)	0.944
Experience	0.41 (0.16)	0.011
Economic Problems	0.48 (0.16)	0.002
Social Problems	-0.19 (0.16)	0.245
Environmental Problems	-0.12 (0.14)	0.396
Policy Debates	0.16 (0.14)	0.277
Overall trust_a little	0.70 (0.53)	0.187
Overall trust_not sure	0.80 (0.48)	0.096
Overall trust_ some	0.91 (0.48)	0.062
Overall trust_a lot	1.43 (0.51)	0.005
Specific trust	0.47 (0.14)	0.001
Intercept 2	-1.01 (0.59)	0.091
Intercept 3	-2.36 (0.59)	<0.001
Intercept 4	-4.67 (0.61)	<0.001
Intercept 5	-6.59 (0.63)	<0.001
Model Fit Statistics: Akaike Information Criteria (AIC) = 1,908.46, Schwarz Criterion = 1,992.07, -2 Log L = 1872.46		
Global Null Hypothesis (Parameter Estimates = 0): Likelihood Ratio (Chi-square = 272.26, p-value < 0.0001; Wald = 244.11, p-value < 0.0001).		

Notes: This table summarizes the results of an ordered logit r=regression analysis (n = 769), with a discrete dependent variable taking on five discrete levels describing partnership interest. The parameter estimates were estimated using maximum likelihood; the model was run such that it directly describes the probability of a higher interest in a community-university partnership.

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