Trends in Interdisciplinary Dissertation Research: An Analysis of the Survey of Earned Doctorates

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Abstract

This working paper used data from the National Science Foundation's Survey of Earned Doctorates to identify trends in the reporting of interdisciplinary dissertation research among doctoral graduates in the United States from 2001–08. These analyses were based on responses to a questionnaire item asking for respondents' field or fields of dissertation research. From 2001–08, 28.4% of doctoral graduates reported two or more fields of dissertation research, which, for the purposes of this report, indicates that their research is interdisciplinary. There were no dramatic fluctuations in the rate of interdisciplinary dissertations across each of the eight years in this analysis; the annual rates ranged from 27.7% to 30.0%. However, the data indicated that the rate at which doctoral graduates report interdisciplinary research varies across disciplines. A majority of respondents who reported two fields of research included two fields that are closely related to each other. However, when the wording of the question changed in 2004, the percentage of respondents reporting multiple fields that are not closely related to each other increased. This suggests that changes in the wording of the question elicited different types of responses. Furthermore, the diversity of fields contained within a given knowledge domain category also seemed to affect the rate at which respondents reported two unrelated fields of research. These analyses suggest that interdisciplinary research comprises a significant proportion of dissertation research projects, but there is need for further exploration of the meaning of the questions used to identify interdisciplinary research.

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Introduction

Interdisciplinary research is a topic of increased interest within the academic and scientific communities. Many researchers and organizations express positive regard for interdisciplinary approaches (Menand 2010) and view interdisciplinary research as a necessary approach to addressing increasingly complex problems (Klein 1990; Lattuca 2001). Numerous efforts have been made to promote interdisciplinary scholarship, but we know little about the nature of interdisciplinary research and those who practice it.

The term "interdisciplinary" has become a familiar one for most researchers, but there is actually no consensus on a precise definition of the term. There are multiple definitions of interdisciplinary research, and much ambiguity surrounds these definitions (Jacobs and Frickel 2009). This ambiguity and diversity of ideas makes it difficult to measure and identify interdisciplinary research, which presents a challenge to researchers wishing to study this movement that appears to be transforming the way scientific research is done. Indeed, there is no widely accepted indicator of interdisciplinary research (Wagner, Roessner, and Bobb 2009).

The National Science Foundation's Survey of Earned Doctorates offers us a valuable opportunity to address some of the unanswered questions about interdisciplinary research. This survey, which

is an annual census of individuals earning research doctorates in the United States, contains the first attempt to identify doctoral students who conduct interdisciplinary research. Building on the analyses of Falkenheim (2010), we examined this indicator of interdisciplinary dissertation research in order to better understand the prevalence of and trends in interdisciplinary activities among doctoral graduates.

The Survey of Earned Doctorates

The Survey of Earned Doctorates is conducted annually by the National Science Foundation to collect data on the number of individuals receiving research doctorates in the United States. All individuals who are finishing a research doctorate in any field at an accredited U.S. institution are asked to complete the survey, which collects information about individuals' degrees, academic institutions, educational finances, postgraduation plans, and demographic characteristics.

The Survey of Earned Doctorates asks respondents to report the field or fields of study that represent their dissertation research. They are asked to write in the name of the field or fields and then enter in a corresponding three-digit code from a provided list.[2] Beginning in 2001, respondents were given the option of reporting both a primary as well as a secondary field, if applicable. The question from the 2001–03 surveys read as follows:

> Using the Specialties List (page 7), please write the name and number of the primary field of your dissertation research.
>
> Name of Field [ ]
>
> Number of Field [ ] [ ] [ ]
>
> If you had a secondary field for your dissertation research, list the name and number.
>
> Name of Field [ ]
>
> Number of Field [ ] [ ] [ ]

In 2004 the wording of the question was changed. The new question explicitly incorporates the term "interdisciplinary":

Please write the name of the primary field of your dissertation research.

Name of Field

Using the list on page 7, choose the code that best describes the primary field of your dissertation research.

Number of Field

If your dissertation was interdisciplinary, list the name and number of your secondary field.

Name of Field

Number of Field

Beginning in 2004, respondents could then also indicate two additional fields (for a total of four fields, if applicable). Both forms of this question used since 2001 are possible indicators of interdisciplinary dissertation research. That is, if respondents provide two or more fields, this suggests that they may have conducted interdisciplinary research. For the purposes of the analyses in this report, we considered dissertation research for a doctoral degree to be interdisciplinary if the respondent reported more than one field of dissertation research.[3] In this report, we examined data from the 2001–08 Surveys of Earned Doctorates to assess the trends in the reporting of interdisciplinary doctoral research. This analysis used the best available source of data on interdisciplinary researchers to provide us with a comprehensive view of the prevalence of interdisciplinary activities at the doctoral level.

Prevalence of Interdisciplinary Doctoral Research

The 2001–08 waves of the Survey of Earned Doctorates contain 310,470 cases with valid codes for dissertation research fields.[4] Of these, 88,293 reported more than one doctoral research field. This means that 28.4% of those earning doctorates from 2001–08 conducted interdisciplinary dissertation research. Table 1 documents the number of respondents who reported multiple dissertation fields each year from 2001 to 2008. The percentage of respondents who reported two or more fields was relatively similar across years. It ranged from a low of 27.7% in 2003 to a high of 30.0% in 2005. Therefore, there is no clear trend of increases or decreases in the rate of interdisciplinary dissertation research across this time period. Also, it does not appear that the change in question wording had much of an effect on the overall percentage of respondents reporting two or more fields.

TABLE 1. Doctoral graduates reporting multiple dissertation research fields, by year: 2001–08

Year	Reporting any dissertation field (number)	Reporting two or more fields	
		Number	Percent
Total	310,470	88,293	28.4
2001	31,521	8,969	28.5
2002	36,005	10,234	28.4
2003	37,040	10,274	27.7
2004	38,227	10,650	27.9
2005	39,192	11,758	30.0
2006	41,173	11,498	27.9
2007	43,299	12,270	28.3
2008	44,013	12,640	28.7

SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Trends in Multiple Fields by Knowledge Domain

The Survey of Earned Doctorates includes a list of fields of study from which individuals can select codes corresponding to the fields of their dissertation research. This list groups the different fields of study codes into 12 knowledge domains, which are listed in the first column of table 2. Table 2 indicates the prevalence of each of these field categories among individuals who conducted both single-discipline and interdisciplinary doctoral research. This table thus allows us to compare the prevalence of each knowledge domain among doctorate earners who reported only one field and those who reported multiple fields. Table 2 illustrates that fields in the life sciences were the most commonly reported dissertation research fields, followed by engineering fields, then education fields. Relatively few doctorate earners reported dissertation research in communications, miscellaneous fields not elsewhere classified, business management and administration, mathematics, and computer and information sciences.

Table 2 shows that there is similarity in the frequencies in which each of these field categories was reported as a primary research field for both single-discipline and multidiscipline doctorate earners. The percentage of doctorate earners who reported primary fields of interdisciplinary dissertations in each knowledge domain is somewhat similar to the percentage of single-discipline doctorate earners who reported a dissertation in each of these knowledge domain categories. This suggests that interdisciplinary doctorate earners are distributed among each of the knowledge domains in a similar fashion as single-discipline doctorates. The most notable difference is in the life sciences: the percentage of interdisciplinary doctorates who reported a primary field in the life science was 7.0% higher than the percentage of single-discipline doctorates who reported life science fields.

Table 2 also indicates that doctorate earners in the life sciences were the most likely to report conducting an interdisciplinary dissertation. Given this, we explored this category of fields in more detail to get a better sense of which fields are most likely to be reported in conjunction with other fields. The taxonomy of fields used in the Survey of Earned Doctorates further divides the general life sciences category into three subcategories: agricultural and natural resource sciences, biological and biomedical sciences, and health sciences. This supplemental analysis of the subcategories of the life sciences indicates that a majority of the interdisciplinary dissertations in

TABLE 2. Fields reported as sole field of a single-discipline dissertation or a primary field of an interdisciplinary dissertation: 2001–08

Field	Non-interdisciplinary dissertations: sole field		Interdisciplinary dissertations: primary field	
	Number	Percent	Number	Percent
Total	222,177	100.0	88,293	100.0
Business management and administration	5,979	2.7	2,437	2.8
Communications	2,122	1.0	1,227	1.4
Computer and information sciences	6,958	3.1	1,646	1.9
Education	31,616	14.2	11,890	13.5
Engineering	33,354	15.0	11,866	13.4
Humanities	25,799	11.6	11,018	12.5
Life sciences	44,560	20.0	23,826	27.0
Mathematics	6,714	3.0	1,823	2.1
Miscellaneous fields not elsewhere classified	4,113	1.9	2,051	2.3
Physical sciences	23,606	10.6	7,975	9.0
Psychology	17,326	7.8	5,086	5.8
Social sciences	20,030	9.0	7,448	8.4

NOTE: Percentages may not sum to 100% due to rounding.

SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

life sciences had a primary field within the biological and biomedical sciences (19.4% of all interdisciplinary dissertations, based on primary field reported). Dissertations in agricultural and natural resource sciences made up 3.4% of all interdisciplinary dissertations, and dissertations in health sciences constituted 4.2% of the interdisciplinary dissertations. These percentages are similar to the percentages of respondents with a dissertation in a single discipline who reported dissertation research in these fields. Thus the high numbers of interdisciplinary dissertations in life science (seen in table 2) is to some extent driven by the fact that there are simply many individuals who earn doctorates in the fields of biological and biomedical sciences.

We next calculated which percentage of each knowledge domain's dissertations were interdisciplinary in order to determine which fields are most likely to produce interdisciplinary dissertations, regardless of the overall number of individuals who earn doctorates in those discipline areas. Table 3 documents the total number of dissertations and the number of interdisciplinary dissertations, broken down by the knowledge domain of the primary research field. This table also indicates the percentage of dissertations in a particular knowledge domain that are interdisciplinary. In this table, several of the knowledge domain categories have been broken down into subcategories that are listed in the survey's list of codes. These components help to provide additional detail about the distribution of individuals within each of these categories.

The overall rate of interdisciplinary doctoral research for all fields was 28.4%. The table shows the incidence of interdisciplinary dissertations as a percentage of all dissertations within a specific knowledge domain. Three domains had a percentage of interdisciplinary research above 36.0%: the agricultural and natural resource sciences fields (a subcategory of life sciences) had 36.8% interdisciplinary dissertations, the communications fields had 36.6% interdisciplinary dissertations, and the biological and biomedical sciences (another subcategory of the life sciences) had 36.2% interdisciplinary dissertations. Several other areas had rates of interdisciplinary research above 30%. The lowest incidence of interdisciplinary research was for the computer and information sciences fields (19.1%). Persons earning mathematics doctorates were also relatively less likely to report interdisciplinary dissertations (21.4%). The third lowest rate of interdisciplinary research was in psychology (22.7%).

TABLE 3. Interdisciplinary dissertations, by knowledge domain of primary field: 2001–08

Primary dissertation research field categories	Dissertations in category (number)	Interdisciplinary dissertations	
		Number	Percent
Total	310,470	88,293	28.4
Business management and administration	8,416	2,437	29.0
Communications	3,349	1,227	36.6
Computer and information sciences	8,604	1,646	19.1
Education	43,506	11,890	27.3
Education research and administration	33,451	8,573	25.6
Teacher education and teaching fields	10,055	3,317	33.0
Engineering	45,220	11,866	26.2
Humanities	36,817	11,018	29.9
Foreign languages and literature and letters	14,485	4,916	33.9
History	7,275	2,053	28.2
Other humanities	15,057	4,049	26.9
Life sciences	68,386	23,826	34.8
Agricultural and natural resource sciences	8,176	3,010	36.8
Biological and biomedical sciences	47,312	17,140	36.2
Health sciences	12,898	3,676	28.5
Mathematics	8,537	1,823	21.4
Miscellaneous fields not elsewhere classified	6,164	2,051	33.3
Physical sciences	31,581	7,975	25.3
Earth, ocean, and atmospheric sciences	6,984	2,181	31.2
Physics and chemistry	24,597	5,794	23.6
Psychology	22,412	5,086	22.7
Social sciences	27,478	7,448	27.1

SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

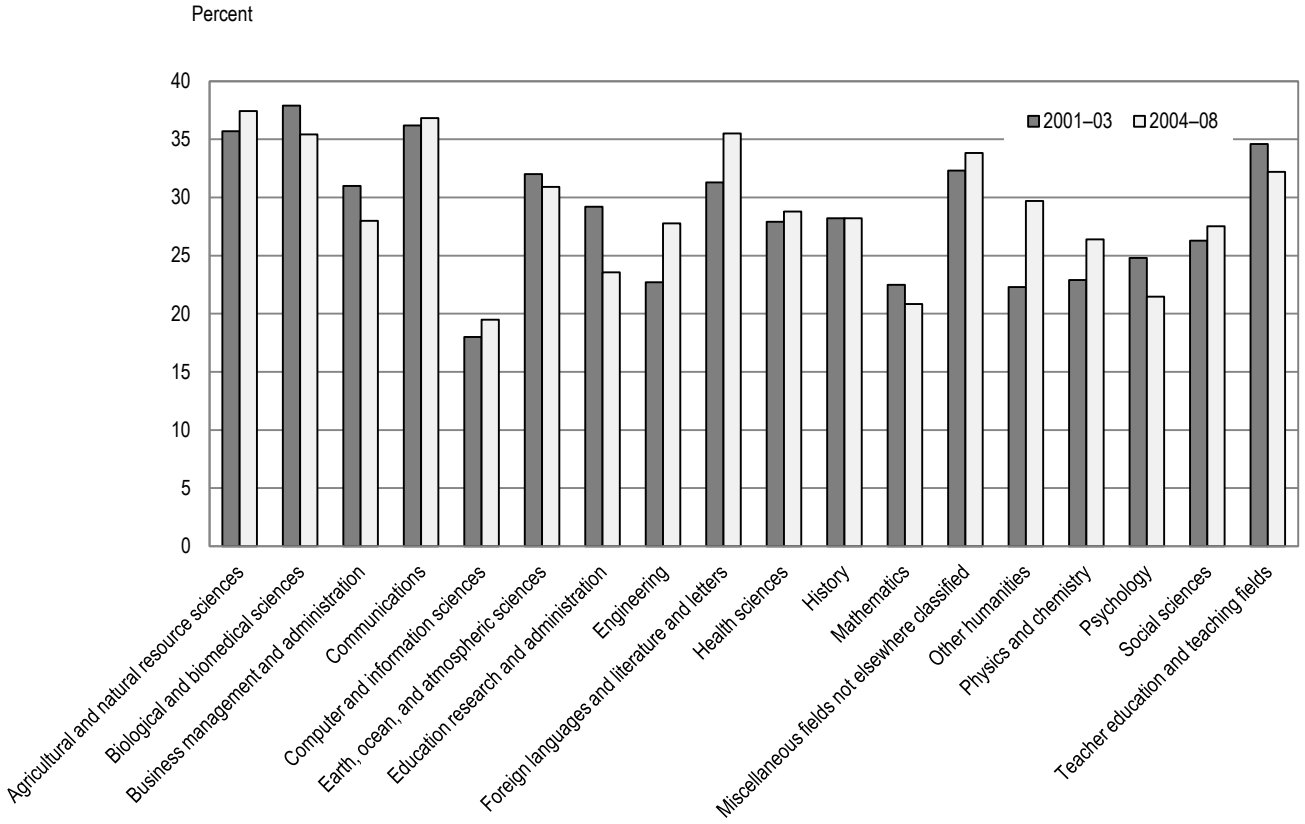
Figure 1 illustrates the changes in rates of interdisciplinary dissertations over time for each knowledge domain. Because the wording of the question about respondents' fields of research was changed in 2004, we compared the average rates of reporting interdisciplinary doctoral research from before and after this methodological change (2001–03 versus 2004–08). This figure shows the rate changes for subcategories of the education, humanities, life sciences, and physical sciences knowledge domains, rather than aggregate numbers.

The comparisons in figure 1 show that 10 of the 18 field areas had higher rates of interdisciplinary research in the later years of the survey than in 2001–03. One field had no increase, and the remaining seven showed decreases over time in the rate of interdisciplinary dissertation research. The largest decrease in the rate of interdisciplinary dissertations was within the education research and administration fields, wherein they decreased in prevalence by 5.6%. Interdisciplinary dissertations in psychology, the field category with the second-greatest decrease in interdisciplinary dissertations, decreased by 3.3%. History showed no increase or decrease in the rate of interdisciplinary dissertations over time.

The "other humanities" category, which is a diverse category that consists of a variety of fields—including American studies, music, drama, art history, religious studies, and philosophy—experienced the largest increase in the rate of interdisciplinary dissertations (7.4%). Interdisciplinary doctoral research also increased substantially in the engineering fields (5.1%) and the humanities category consisting of foreign languages and literature and letters (4.2%).

Figure 1 demonstrates that some fields spanning both the sciences and humanities have experienced increased rates of interdisciplinary doctoral research and others have experienced decreases. It is unclear from these data alone what has inspired the varied outcomes—for example, relatively large increases were seen over time in some of the humanities, engineering, and physics and chemistry, but the decreased rates of interdisciplinary doctoral research were seen within categories such as education research and administration and psychology. Also, the figure illustrates that fields that initially had high rates of interdisciplinary dissertations are not necessarily fields that experienced the greatest increases over time. In fact, several of the highest

FIGURE 1. Doctoral graduates reporting interdisciplinary dissertation research over time, by knowledge domain



SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

rates of increase are in field areas that had relatively low rates of interdisciplinary research to begin with (i.e., other humanities, physics and chemistry, and engineering).

Combinations of Fields Reported in Interdisciplinary Dissertations

Next we examined which types of fields tend to be associated with each other in the reporting of interdisciplinary dissertations. We used the classifications provided with the Survey of Earned Doctorates as a guide to classify each secondary field of research by how closely related it is to the primary field of dissertation research. If the secondary field is in the same knowledge domain as the primary field (e.g., cellular biology combined with molecular biology), then the two disciplines are considered to be "closely" related. Alternatively, if the two fields are from two different knowledge domains (e.g., biology combined with sociology) they are considered to be "distantly" related.[5]

Sixty-four percent of interdisciplinary doctorate recipients from 2001–08 reported a secondary field that was closely related to their primary dissertation field. This means that only about 36% reported a distantly related secondary field. Thus a majority of respondents who conducted interdisciplinary dissertation research reported two similar fields of research. Table 4 presents the percentage of dissertations with two distantly related fields or two closely related fields, broken down by year.

This table shows that the percentage of dissertations in which the secondary field was distantly related to the primary field increased in 2004. From 2001–03 the rate was approximately 31%–32%, but from 2004 onward the rate was 38%–39%. This is notable because the question wording changed in 2004 to include the term "interdisciplinary." Earlier in this report (see table 1), we noted that the overall rate of interdisciplinary dissertations did not seem to be affected by the question wording change. But in this case the question wording may have made a difference; the percentages in table 4 suggest that this methodological change might explain, at least in part, the sudden increase in respondents who reported distantly related fields. It seems as though the inclusion of the term "interdisciplinary" in the question after 2004 incited more people to report distantly related fields of dissertation research.

TABLE 4. Interdisciplinary dissertations, by year and whether the secondary field is closely or distantly related: 2001–08
(Percent)

Year	Closely related secondary field	Distantly related secondary field
Total	63.6	36.4
2001	68.8	31.2
2002	68.1	31.9
2003	68.8	31.2
2004	61.6	38.4
2005	60.9	39.1
2006	60.6	39.4
2007	61.1	38.9
2008	61.8	38.2

SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Next we examined whether the proportion who reported a closely or distantly related secondary dissertation field varied by primary dissertation research area. Table 5 demonstrates that the rate at which respondents reported a distantly related secondary research field varied dramatically by the knowledge domain of the primary research field. Figure 2 further illustrates this variation; it graphs the proportion of interdisciplinary dissertations using distantly related secondary fields by knowledge domain, ordered from highest to lowest. The values range from 18.7% (life sciences) to 87.7% (computer and information sciences).

The meaning of these numbers should be interpreted with caution, however, because they appear to be highly negatively correlated with the number of fields within each of these knowledge domains.[6] For example, the high proportion of distantly related fields for computer and information sciences is partially due to the fact that this field category contains only three fields, so there is less likelihood of a person being able to list two fields within this category than among the other categories. Similarly, the communications category, which has the second highest rate of 81.7%, contains only six fields, which may also limit the likelihood of an individual reporting two fields within this category. The life sciences category, which has the lowest rate of cross-category combinations (18.7%), is the category with the largest number of fields to select ($n = 70$), thereby increasing the likelihood that a person's secondary field is within the same category as their first. Figure 3 illustrates the negative relationship between field category size and the percentage of distantly related secondary research fields. There is almost a perfect, negative relationship between the number of fields in a knowledge category and the percentage of dissertations within that category which list a secondary field in another knowledge category.

Over the years, all of the field categories exhibited some increase in the percentage of secondary fields that are distantly related. Thus, as discussed earlier, over time there was a slightly greater tendency for individuals to combine two seemingly unrelated fields in their dissertation research. However, the knowledge domains with the highest increase in divergent fields were not necessarily the fields that displayed the greatest increases in interdisciplinary research in general.

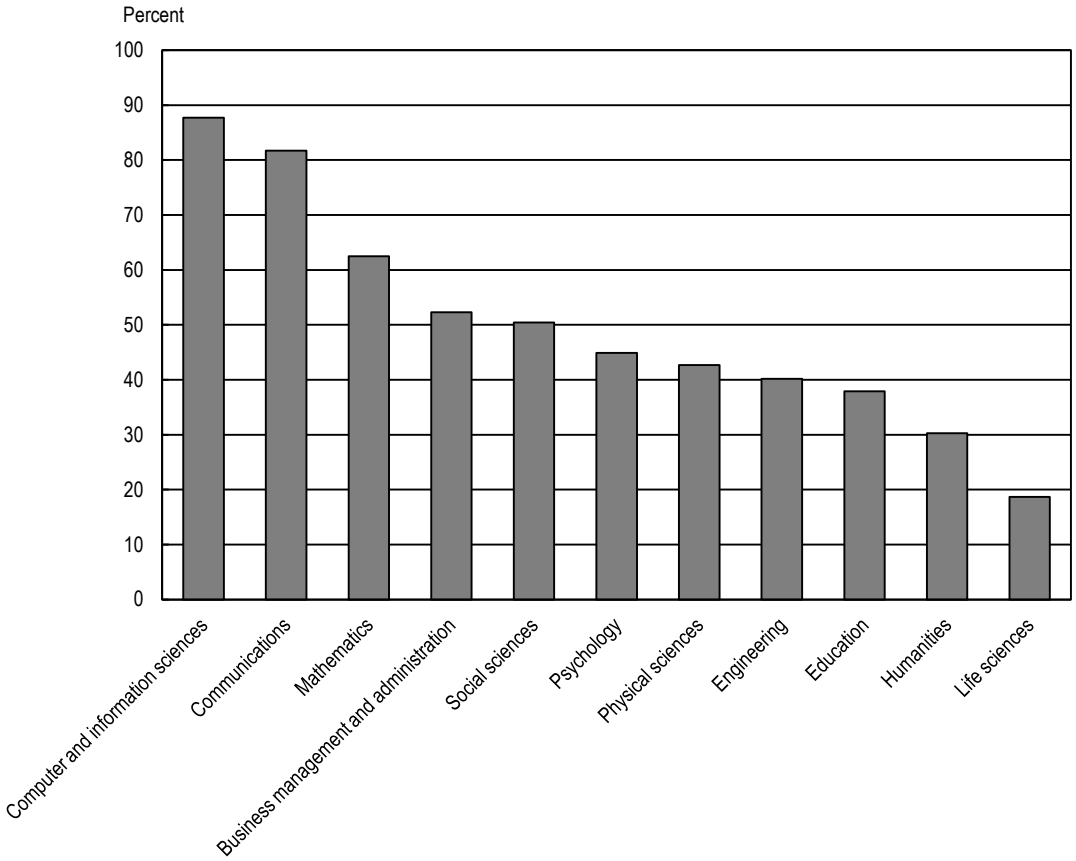
TABLE 5. Closely and distantly related secondary research fields, by knowledge domain of primary field: 2001–08

(Percent)

Primary field	Closely related secondary field	Distantly related secondary field
Total	63.6	36.4
Business management and administration	47.7	52.3
Communications	18.3	81.7
Computer and information sciences	12.3	87.7
Education	62.2	37.9
Engineering	59.8	40.2
Humanities	69.7	30.3
Life sciences	81.3	18.7
Mathematics	37.5	62.5
Physical sciences	57.3	42.7
Psychology	55.1	44.9
Social sciences	49.6	50.4

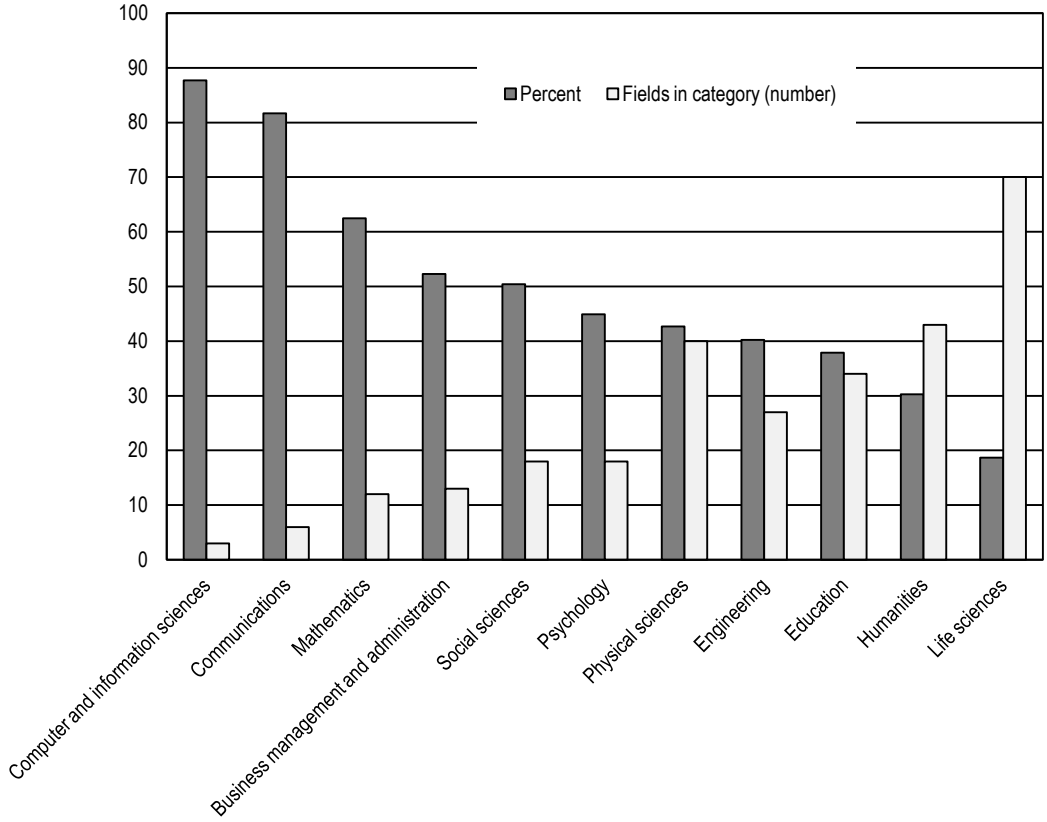
SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

FIGURE 2. Interdisciplinary dissertations with two distantly related research fields, by knowledge domain of primary field: 2001–08



SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

FIGURE 3. Negative relationship between the percentage of interdisciplinary dissertations with distantly related fields and the size of field categories: 2001–08



SOURCE: National Science Foundation/National Center for Science and Engineering Statistics, Survey of Earned Doctorates.

Summary and Conclusions

This working paper summarizes the trends in the reporting of interdisciplinary dissertation research, as measured by an indicator contained in the Survey of Earned Doctorates. This survey provides us with the best opportunity to examine the prevalence of interdisciplinary research among individuals earning doctoral degrees in the United States. No other existing data source provides such a comprehensive representation of doctoral graduates, making this examination of trends from the Survey of Earned Doctorates a valuable insight into the current status of interdisciplinary research.

The analyses contained in this report indicate that interdisciplinary research may be involved in a substantial proportion of doctoral dissertations. Twenty-eight percent of doctorate earners from 2001–08 reported using multiple fields of study in their dissertation research. This attests to the growing popularity and impact of the interdisciplinary movement.

The rate at which interdisciplinary dissertation research is conducted varied by field of study. That is, some fields of study were more likely than others to have individuals who report secondary fields of dissertation research. This suggests that certain disciplines are more encouraging of interdisciplinary research than others. Further examination of why researchers in some disciplines are more prone to conduct interdisciplinary research than in others would be useful in determining the contexts in which interdisciplinary research develops.

A majority of respondents who reported multiple research fields indicated two fields that are closely related to each other. Conversely, only about a third of interdisciplinary doctoral graduates reported using two fields that are more disparate. This is intriguing because some might argue that two fields must be unrelated in order for the research to be considered interdisciplinary. This trend suggests the need to further develop our understanding of the meaning of the term “interdisciplinary” and how these questions are interpreted by respondents.

We analyzed trends related to the change in question wording used in the Survey of Earned Doctorates. The wording change that occurred in the 2004 questionnaire did not result in any noticeable change in the overall rate at which doctoral recipients reported interdisciplinary

research. However, when we looked at the rates by knowledge domain of respondents' primary field of study, we saw that the rate of interdisciplinary dissertations increased in many areas of study when the question wording changed. Furthermore, the rate at which individuals reported distantly related fields of study used in interdisciplinary dissertations increased dramatically with the change in the question wording. All of this suggests there is value in further examination of the meanings and interpretations given to these two questions. Millar and Dillman (2010) and Millar (2011) report the results of cognitive interviews that were designed to explore the meaning of the term "interdisciplinary" as used in the context of these questions and to evaluate the accuracy of these questions as indicators of interdisciplinary research.

Nevertheless, this introductory analysis of the data contained in the Survey of Earned Doctorates provides a useful starting point from which to further explore the development of interdisciplinary research from the perspective of individual researchers. These questions that we have analyzed as indicators of interdisciplinary research may be some of the only available indicators of this type of research available in existing data. This fact makes the Survey of Earned Doctorates and its follow-up, the Survey of Doctorate Recipients, valuable sources for analyzing the individual-level correlates and consequences of interdisciplinary research. Millar (2011) reports the results of the first analyses to use these data to examine the early career impacts of interdisciplinary research.

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Notes

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2. In this report, we relied upon only the numerical codes reported by respondents for each field. All of the following analyses are limited to respondents who reported a valid dissertation field code for at least their primary field of dissertation research. Respondents were excluded if they did not write a dissertation, were missing information about their dissertation, or did not indicate field codes for their dissertation.

3. In a separate question, the Survey of Earned Doctorates also asks respondents to indicate the field in which their doctoral degree was awarded. The field of their degree does not necessarily match the primary field of their dissertation research. However, these two indicators are very highly correlated ($p = 0.97$). For the sake of simplicity, we refer to respondents' primary fields of dissertation research as their doctoral fields, although it is noted that there are some cases where these two codes do not coincide.

4. Although the Survey of Earned Doctorates first began allowing multiple responses to the dissertation research fields question in 2001, some individuals who were awarded doctorates in 2001 or later years filled out older versions of the questionnaire that did not allow for multiple responses. There are a total of 316,645 cases with valid data for a primary field of research in the 2001–08 data, but 6,175 of these respondents (just about two percent) completed a 2000 or earlier questionnaire. Most of the respondents who submitted an earlier version of questionnaire were 2001 graduates, but there were also small numbers of 2002–08 graduates who utilized a pre-2001 version as well. Due to the nature of the questions addressed in this working paper, theses analyses are limited to only those 2001–08 graduates who completed a 2001 or later version of the questionnaire. Therefore, they are not completely representative of *all* 2001–2008 graduates.

5. The doctorate earners were not included in these analyses if they reported a primary field that is classified in the "other fields not elsewhere classified" (miscellaneous) category. This miscellaneous category contains a variety of fields that are not related to each other in any meaningful way, so it does not make sense to compare them, as a group, to other fields.

6. Logistic regression analyses confirm that controlling for the size of the field category reduces the strength of the relationship between field category and percentage of secondary fields that are distantly related to the first field.