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Perceptions and Practices of Replication by Social and Behavioral Scientists: Making Replications a Mandatory Element of Curricula Would Be Useful

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ABSTRACT

Perceptions and Practices of Replication by Social and Behavioral Scientists: Making Replications a Mandatory Element of Curricula Would Be Useful

We live in a time of increasing publication rates and specialization of scientific disciplines. More and more, the research community is facing the challenge of assuring the quality of research and maintaining trust in the scientific enterprise. Replication studies are necessary to detect erroneous research. Thus, the replicability of research is considered a hallmark of good scientific practice and it has lately become a key concern for research communities and science policy makers alike. In this case study we analyze perceptions and practices regarding replication studies in the social and behavioral sciences. Our analyses are based on a survey of almost 300 researchers that use data from the German Socio-Economic Panel Study (SOEP), a multidisciplinary longitudinal multi-cohort study. We find that more than two thirds of respondents disagree with the statement that replications are not worthwhile, because major mistakes will be found at some point anyway. Nevertheless, most respondents are not willing to spend their time to conduct replication studies. This situation can be characterized as a "tragedy of the commons": everybody knows that replications are useful, but almost everybody counts on others to conduct them. Our most important finding concerning practical consequences is that among the few replications that are reported, a large majority is conducted in the context of teaching. In our view, this is a promising detail: in order to foster replicability, one avenue may be to make replication studies a mandatory part of curricula as well as of doctoral theses. Furthermore, we argue that replication studies need to be more attractive for researchers. For example, successful replications could be listed in the publication lists of replicated authors. Vice versa, data sharing needs to receive more recognition, for example by considering data production and subsequent data sharing as scientific output.

JEL Classification: A14, C80, Z13

Keywords: theory of science, replication, survey, SOEP

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Introduction

The Importance of Replication Studies

In recent years, the scientific community has repeatedly experienced prominent instances of fraudulent and erroneous research. An example of the latter in the fields of social sciences and economics is Reinhart and Rogoff's study "Growth in a Time of Debt" [1] on the effectiveness of austerity-based fiscal policies for highly indebted economies. The results of the study clearly translated into politics. It was influential on the United States Republican Party's budget proposal "The Path to Prosperity" as well as the EU Commissioner for Economic Affairs Olli Rehn's address to the International Labour Organisation in 2013. The questionable weighting methods and coding errors were only discovered after economists from the University of Massachusetts Amherst conducted a replication study [2].

The Reinhart-Rogoff-case is of relevance for this article for three reasons. Firstly, it shows that erroneous research can have an impact on political and economic decision-making. As Lacetera and Zirulia [3] state: "Even a handful of fraudulently produced results, if not detected promptly, can [...] endanger whole scientific fields as well as society at large". Secondly, the Reinhart-Rogoff-case shows the importance of data availability for the replicability of scientific research. Herndon and his colleagues [2] could only conduct a replication study and discover statistical errors because the authors of the study provided Herndon with the original dataset. And thirdly, the Reinhart-Rogoff-case shows the great potential of replication studies in teaching. Herndon, a PhD student, conducted the replication study [2] as part of a semester project.

Replication studies have an important internal value because they contribute to the self-correction abilities of the self-referential scientific ecosystem [4,5]. Additionally, replication studies enrich any curriculum in the empirical social sciences by showing how time-consuming and difficult research can actually be [6,7]. Moreover, replication studies have an external impact because they build and ensure civil society's trust in science.

The Replication Crisis

In a massive study published in *Science* that aimed at replicating the effects from 100 psychological studies, only 39% of the main effects in the original articles could be replicated [8]. The state of replicability in psychology even leads some to speak of a "replication crisis" [9].

It seems, however, that issues with the replicability of scientific research are not necessarily limited to a single discipline. In fact, replicability of research is an issue across disciplines ([10–13]A recent paper in *Nature* reported a failure to replicate significant experiments in the domain of cancer research in 47 out of 53 cases [14]. Empirical economics also faces problems with replication. In a study that aimed to replicate 18 studies published in two top journals (*American Economic Review* and the *Quarterly Journal of Economics)* between 2011 and 2014, the researchers were able to find a significant effect in the same direction as the original study for 11 of their replications (61%) [15]. In an attempt to replicate 67 papers published in 13 well-regarded economics journals, Chang and Li [16] were only able to replicate 22 (33%) of the results using data and material the authors had provided to the respective journals. Excluding six papers that used confidential data and two papers that used proprietary software, Chang and Li then explicitly asked

the authors of the original articles for assistance and were able to successfully replicate 29 of 59 papers (49%).

It is important to bear in mind that all the above-mentioned studies targeted results published in top journals in their domain. They show quite plainly that there is a quality challenge in science today, namely how to ensure the integrity of scientific research while fields and methods become more and more specialized. Furthermore the studies show that the traditional peer review may be insufficient to ensure the integrity of empirical scientific research. Because replicability of research is a core of the scientific paradigm, the scientific community has to increase the replicability of published research as well as the number of replications of published results.

Barriers to replication

On the one hand, practical attempts to replicate results often fail. On the other hand, replication studies are either rarely conducted or are not feasible in the first place. Duvendack et al. [17] differentiate between four types of replication studies: (a) narrow replications using the same data and methods as the replicated article, (b) wide replications using the same methods but different data, (c) reproductions using the same data but different methods, and (d) replications that use new data and new methods. In times of increasingly data-intensive research [18] and initiatives towards openness and transparency, replication studies using the same data as the primary investigator (types a and c) should be growing in importance because of the lower costs for the replicator Theoretically, a researcher does not have to repeat a whole study but can use the underlying data to verify or falsify published results (as a “minimal standard”).

There are a number of reasons why replication studies are currently not being conducted. Often results cannot be replicated because data from published research is not made available [19–26] or has not been sufficiently documented [26,27][26]. Even archived data is rarely actually used [28] (Peters et al. 2016). The most important reason why a researcher might be reluctant to conduct a replication study is "*because it is difficult to successfully accomplish and it carries more risk than potential reward for both the replicator and the originator of the research*" [29]. Hamermesh [30] consequently considers the replicability of (economic) research as an "ideal professed but not necessarily practiced". The underdeveloped replication culture can thus be attributed to low data sharing rates, issues with data documentation and the limited attractiveness of conducting replication studies. Furthermore, in more subjective disciplines, for example the arts and humanities and to a certain degree social sciences and economics, the objective measure of replicability might be difficult to apply.

This article focuses on the researchers' stance towards data sharing (as a prerequisite for replication studies), their perspective on the replicability of research, and their own replication practices. The results are based on a survey among 300 social and behavioral scientists, who use an easily obtained, well-documented and frequently analyzed data set. We show that researchers value data sharing and replication highly, but at best, they engage in both practices modestly. Based on our results, we furthermore conclude science policy measures to strengthen an academic replication culture.

Materials and Methods

Our empirical study is based on a standardized survey among researchers who analyze data from the German Socio-Economic Panel Study (SOEP). The SOEP is a widely analyzed multi-cohort study of the German population (Wagner et al 2007). In total, there are more than 7000 documented publications based on SOEP data in a wide range of journals (e.g., [31–36]). The SOEP survey is administered under the umbrella of the Leibniz Society at the German Institute for Economic Research (DIW Berlin). The data of the SOEP is available at no direct costs to researchers via a research data center. This is particularly interesting in the context of data-driven replication studies, since the SOEP data is easily available; this can thus be considered a lower cost situation for the replicator compared to replicate results from the scratch.

Since 2004, user surveys have been conducted in order to identify the practices and needs of the secondary data users [37]. The survey that we analyze in the following sections was open for responses from November 12th, 2015 to January 4th, 2016. It contained 18 questions on data sharing and replication studies.

Of a total of 5,149 addresses that were registered in the “user data base” of SOEP, 4519 (88%) addresses were valid and were reached. Out of these 936 (21%) respondents used the link to the online questionnaire. During the course of the first part of the questionnaire, which was not related to data sharing or replication, a total number of 303 respondents took the opportunity to leave the questionnaire. Of the remaining 633 participants (14% of reached addresses), 321 answered the second part related to data sharing and replication. 300 respondents (32% of initial respondents, 7% of contacted addresses) had at least one valid answer in the second part.

Results

This findings section begins by providing an overview of respondent characteristics. It then provides a detailed look at researchers' perceptions on data sharing and replication and several key replication practices. The final section of the findings looks at influences on conducting replication studies.

Demographics of respondents

The respondents to the additional module on data sharing and replications are mainly male (61%) and on average slightly over 38 years old (median 35). 37% are post docs or equivalent, 28% are professors, 26% are doctoral students, while a minority of 8% are students (most of them student who work in assistant roles). The two main research fields are sociology (47%) and economics (39%), while the remaining 14% come mostly from psychology, and demography, statistics or political science. The majority of respondents (78%) work in Germany, 18% is based within the EU; 4% of the responding SOEP data users come from North America, Australia, or Asia. These five demographic variables (sex, age, status, field, location) are control variables in the multivariate analyses.

Data Sharing

The questions on data sharing could be answered on a five-point scale from "does not apply at all" (value 1) to "fully applies" (value 5). We combine values "1" and "2" to create the category "does not apply", and values "4" and "5" to create the category "does apply".

Using this transformation, Figure 1 shows that 76% of respondents think that researchers should share their data for further analyses, and 89% even believe that data sharing furthers scientific progress. In addition, 73% disagree with the statement that they would rather not publish in journals with data policies that mandate data publication, and only 23% agree with the statement that they experience negative effects from sharing their data. Despite all these rather positive statements regarding data sharing, only 24% of respondents state that it is common in their discipline to share data. Figure 2 depicts how those who have already produced data – these represent 64% (187) of our respondents – engage in data sharing: only 8% have shared their data publicly, while 26% have shared within the scientific community, 32% have shared with people they knew, and 34% have never shared their data.

Figure 1. Researcher's opinion about data sharing

Figure 2. Researcher's experience in sharing research data with others

Perceptions on Replication

Asked about replications in general (again using a 5 point scale adjusted as described in the previous section), 84% agree that replications are necessary for improving scientific output. 50% agree that the effort needed to produce a replication study is too high, and 43% agree with the statement, that the success of a replication study cannot be suffi-

ciently measured. Lastly, 71% of respondents disagree with the statement that replications are not worthwhile, because major mistakes will be found at some point anyway (see Figure 3).[1]

Figure 3. Researcher's opinion about replication studies

Replications of research articles based on the SOEP do not happen often – Figure 4 shows the distribution. 58% of our respondents never attempted any replication study of an article based on SOEP data. Of those respondents who had conducted a replication study more than half of them are conducted during regular coursework – either while teaching a class (13% of all respondents) or while being taught as a student (9%). 20% of the respondents used a replication of a SOEP article for their own research. Of those who never conducted a replication study, 76% never saw a need to do so, while the rest thought it would be too time consuming (15%) or did not have enough information (9%)—either about the data, the software or the way results in the original article were produced, i.e., the scripts—were not available.

Figure 4. Researcher's experience in conducting replication studies

[1] When considering differences in this statement by field, we find—controlling for sex, status, and location of workplace—economists tend to be less likely to strongly disagree with this statement. This implies that economists are more likely than other researchers to believe that major mistakes will be found at some point anyway. When looking at age-field combinations—controlling for sex and location of workplace—economists between 30 and 45 are the one who believe most in the academic market place (see table 2).

As for those who did replicate a SOEP article, 84% were able to reproduce the results of the original article (although the results were not always exactly identical to those found by the original authors), while only 16% were not able to do so. When asked about the reason why the results could not be completely replicated, 69% of the respondents stated that the information in the original article was insufficient to allow for replication (of those, 85% needed more information on the data analyses in the original article, 15% did not have enough information about the data), while 27% thought that the effort would have been too much. Only 4% stated that the original article contained mistakes.

Regression Analyses

For exploratory reasons, we conducted a linear regression, considering the above-mentioned demographic variables, i.e. gender, age, status, field, and work location. For this, we define three dependent variables, which are all based on the question of whether the respondent has already conducted replications of an article based on SOEP data. From the possible answers “no”, “yes, for my own research”, “yes, for my coursework (as a teacher)”, and “yes, for my coursework (as a student)” we were able to construct the following three dichotomous variables: (1) *any replication*, which is “1” if the respondent conducted a replication study for his or her research or as a part of the coursework, “0” otherwise; (2) *scientific replication*, which is “1” when replication was reported “for own research”, “0” otherwise; and (3) “educational replication”, which is “1” if replications were conducted for coursework, “0” otherwise. Since professional status highly correlates with age, we only include the status variable (i.e. doctoral student, post-doc or professor).

The estimated coefficients show the shift of the probability to replicate due to a right hand variable. In the regression analysis, none of the status and field variables are significantly related to any of the three types of replication. Female researchers are more likely to conduct educational replications, an effect which translates into the overall replication analysis. Additionally, in this sample the respondents from Germany turn out to be more likely to conduct replications for educational reasons, which also then is a significant influence regarding all replications.

Discussion

Although our sample is not representative of the German Social and Behavioral science community, the results provide a general idea on the perception of replication studies as well as the barriers to conducting them. Data sharing as well as replication studies are practices that are generally perceived positively among researchers and in line with good scientific practice. As our results show, however, both are ideals professed but not practiced. For example: 71% of respondents disagree with the statement that replications are not worthwhile, because major mistakes will be found at some point anyway, but most respondents are not willing to spend their own time conducting replication studies. This can be regarded as a “tragedy of the commons”: everybody knows that replications are useful, but almost everybody counts on others to conduct them. A possible explanation for this is that conducting replication studies is not worthwhile in the context of the academic reward system since they are often time-consuming and rarely published [29].

We show that in the case of the well documented and openly available SOEP data, replication studies find few results to be erroneous. This could mean that researchers are

more careful when using openly available data, because their results can easily be replicated. What is surprising, however, is the result that few replication studies based on the SOEP data are conducted despite the fact that the data is available for every researcher and well documented and thus easy to replicate. One reason might be that currently careful documentation and sharing of the code that is used for analyzing data is not common. The availability of syntax files could increase the replicability of research results and hence the number of data-driven replications. Thus for repositories it is worthy of consideration not only to implement the citation of data as well as the citation of code and syntax files.

Our results show that most of the replication studies are done in the context of teaching. In our view, this is a promising detail: in order to increase the number of replication studies, it may be feasible to make replications a mandatory part of curricula and an obligatory chapter of (cumulative) doctoral theses. In that way, students could ‘learn from the best’ while at the same time contributing to the overall integrity of scientific research.

On a general note, we propose that the research community should strive towards establishing a market and a culture of data sharing and re-use. Besides the aforementioned implementation in teaching, instruments seem suitable that take the academic reward system into account [4,5,38]. For instance, the attractiveness for replication studies would increase if more replication studies were published; especially in times of mega journals there is no limited space argument. An additional option could be increased funding explicitly for replication studies and meta analyses. Furthermore, positive replications could serve as a proof of research and therefore successful replications could be listed in

the publication lists of replicated authors. Vice versa, data sharing needs to receive more recognition, for example by considering data production and subsequent data sharing as scientific output. In other words: the scientific community must treat the scientific paradigm more seriously and give credit in all cases where credit is due [37,38].

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Appendix

Table 1. Regression results, linear probability model (0,1 coding of the left hand variables "any replication done", "replication for scientific purposes", "replication for educational purposes").

	Type of Replication		
	Any	**Scientific**	**Educational**
Sex			
(Male)			
Female	**0.155**	0.040	**0.115**
	(0.067)	(0.054)	**(0.057)**
Status			
(Undergraduate)			
Doctoral Student	-0.151	-0.018	-0.133
	(0.129)	(0.104)	(0.109)
Post-Doc	-0.074	-0.033	-0.040
	(0.134)	(0.108)	(0.114)
Professor	-0.088	-0.104	0.015
	(0.132)	(0.107)	(0.113)
Field			
(Economics)			
Sociology	-0.069	-0.068	-0.001
	(0.071)	(0.058)	(0.061)
Other	-0.075	0.020	-0.095
	(0.098)	(0.080)	(0.084)
Location of Work			
(Other countries)			
Germany	**0.197**	0.035	**0.161**
	(0.077)	(0.062)	**(0.066)**
Constant	0.319	0.211	0.108
	(0.142)	(0.115)	(0.121)
Observations	241	241	241
R-squared	0.0678	0.021	0.0783

Notes:

Standard errors in parentheses. Coefficients significant on a 5% level are in bold. Reference categories are marked in parentheses in the left hand column. Analyses using probit and logit models did not yield different results.

Source: SOEP User Survey 2015

Table 2. Regression results, linear probability model (0,1 coding of the left hand variable).

Statement: "Using replication to check findings is not worth the effort since important mistakes will eventually come to light anyway."	
	Disagrees strongly with statment
Sex	
(Male)	
Female	-0.006
	(0.072)
Status	
(Undergraduate)	
Doctoral Student	0.067
	(0.125)
Post-Doc	-0.055
	(0.131)
Professor	0.121
	(0.129)
Field	
(Economics)	
Sociology	0.125
	(0.073)
Other	0.184
	(0.101)
Location of Work	
Germany	**0.265**
	(0.079)
(Other countries)	
Constant	0.143
	(0.139)
Observations	227
R-squared	0.100

Notes:

Standard errors in parentheses. Coefficients significant on a 5% level are in bold. Reference categories are marked in parentheses in the left hand column. Analyses using probit and logit models did not yield different results.

Source: SOEP User Survey 2015

Figure 1

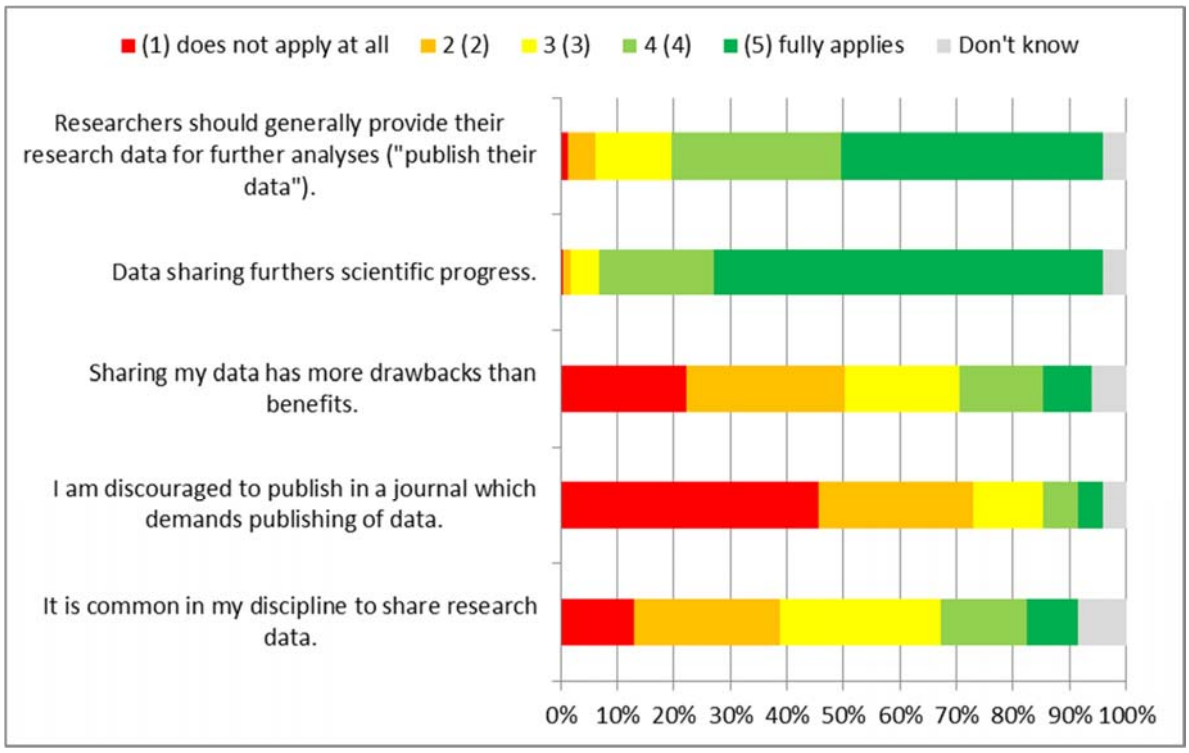
(1) does not apply at all
2 (2)
3 (3)
4 (4)
(5) fully applies
Don't know
Researchers should generally provide their research data for further analyses ("publish their data").
Data sharing furthers scientific progress.
Sharing my data has more drawbacks than benefits.
I am discouraged to publish in a journal which demands publishing of data.
It is common in my discipline to share research data.
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Figure 2

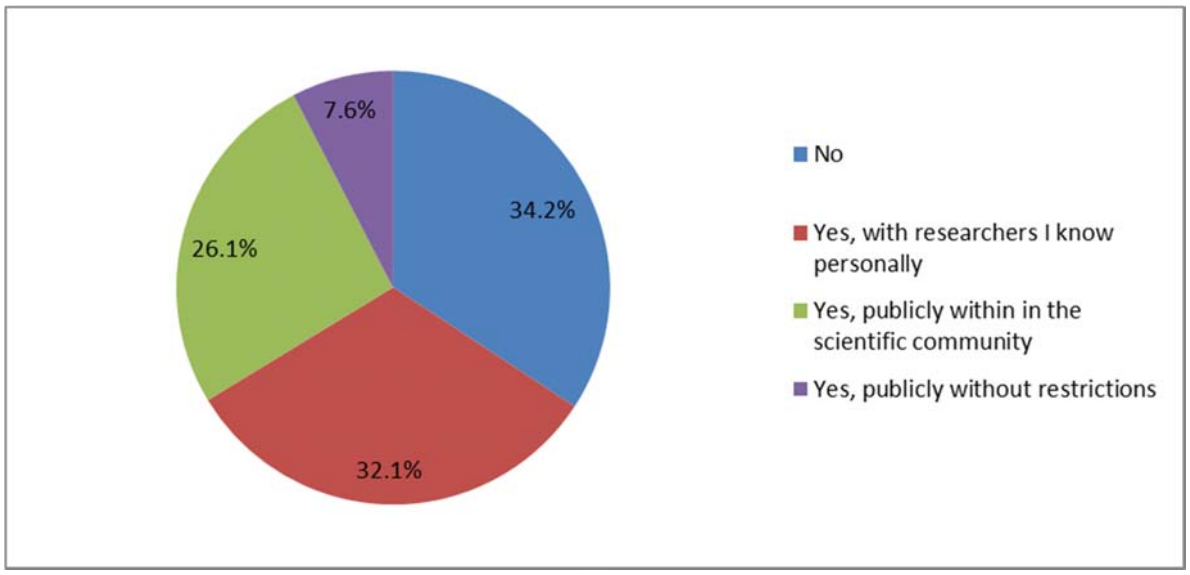
7.6%
34.2%
26.1%
32.1%
No
Yes, with researchers I know personally
Yes, publicly within in the scientific community
Yes, publicly without restrictions

Figure 3

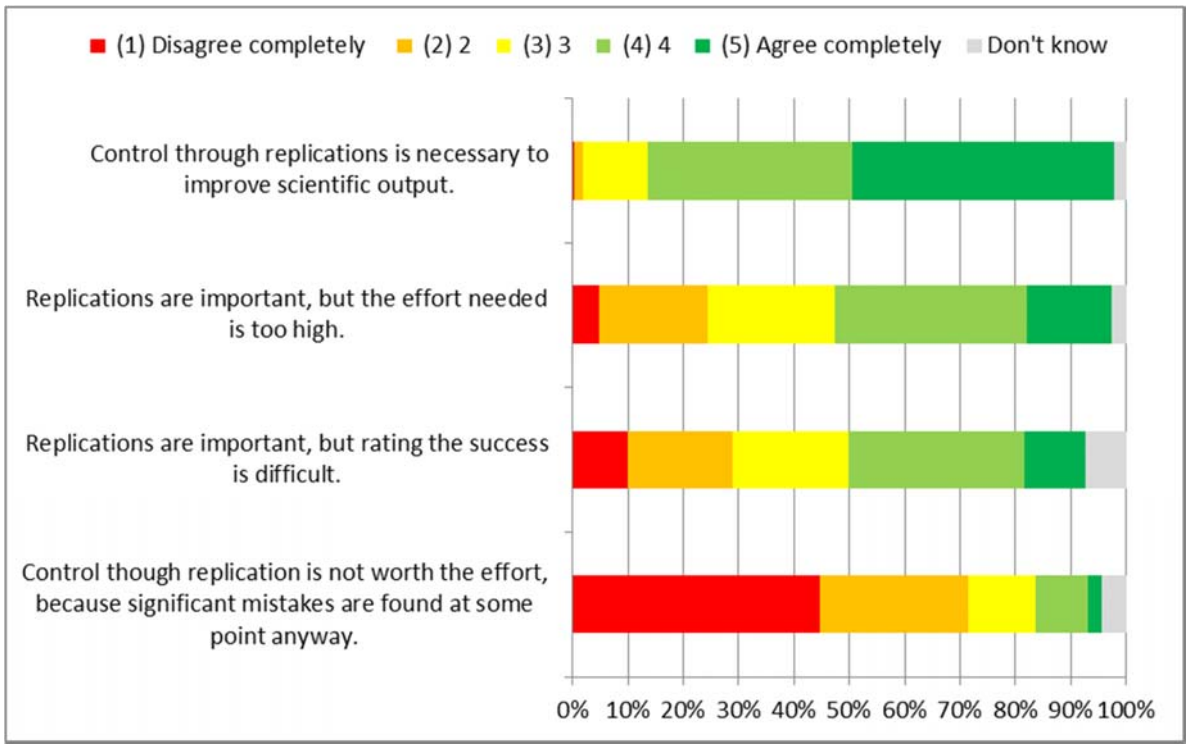
(1) Disagree completely
(2) 2
(3) 3
(4) 4
(5) Agree completely
Don't know
Control through replications is necessary to improve scientific output.
Replications are important, but the effort needed is too high.
Replications are important, but rating the success is difficult.
Control though replication is not worth the effort, because significant mistakes are found at some point anyway.
0%
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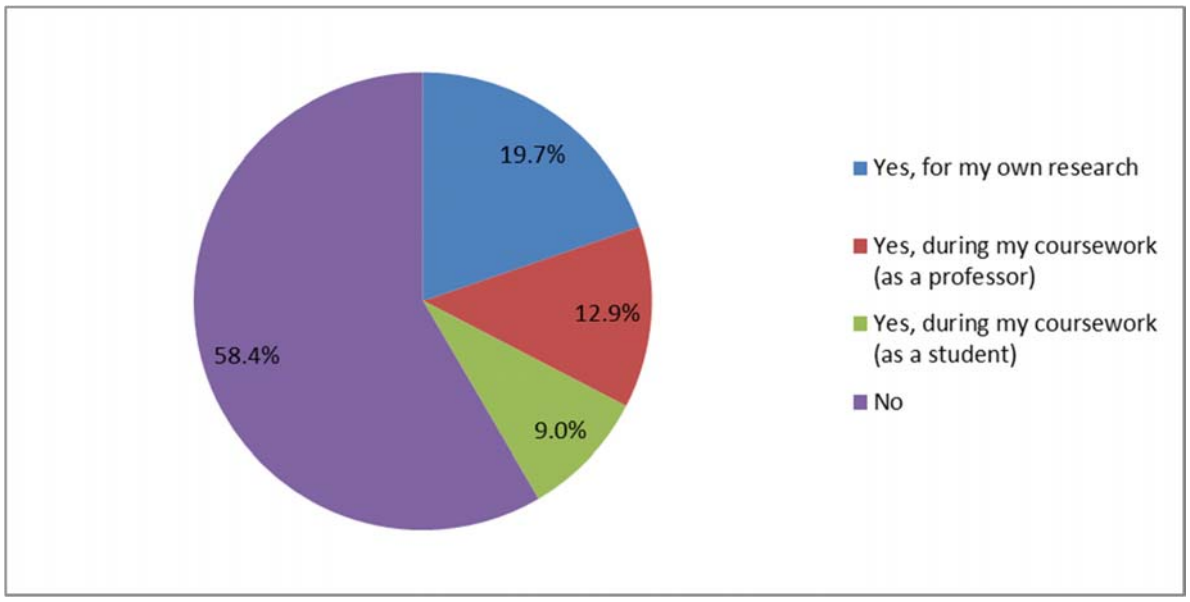
Figure 4


19.7%
12.9%
9.0%
58.4%
Yes, for my own research
Yes, during my coursework (as a professor)
Yes, during my coursework (as a student)
No