

Article

Students' Perception of Doctoral Defense Formats

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Abstract: The doctoral defense is an important step in the doctoral journey and an essential requirement for obtaining the doctoral degree. Past research on the doctoral defense has focused solely on national practices. In this work, I investigate the potential link between the doctoral defense format based on its major and minor elements and the perception of the defense by the student. For this purpose, I first reviewed the different defense formats used internationally to extract the different elements of the doctoral defense, as well as the literature on students' perceptions of the doctoral defense. Then, I carried out an international survey which received 297 responses, of which 204 completed surveys which I used for the analysis in this article. I first analyzed the outcomes of the survey using qualitative and quantitative methods, and then cross-correlated the outcomes of defense format to the outcomes of student perception. From this analysis, I observe that the defense elements that positively impact the students' perception are: publication of the thesis before the defense, receiving committee feedback before the defense, knowing the recommendation of one or more committee members in advance, having the supervisor present in the audience or as part of the committee, using a dress code, and including a laudatio. The final conclusion of this work is threefold. The first conclusion is that the details of the defense format impact most the students' perception. The second conclusion is that doctoral students on average value the defense as a positive experience. The third conclusion is that the defense format cannot influence two important aspects of how a student perceives the defense: the student's inner life and lived experience during the defense, and the behavior of the committee members.

Keywords: assessment; best practices; defense formats; doctoral defense; doctoral students; PhD thesis; quantitative research; student perception; viva; viva voce

1. Introduction

The PhD defense is considered a part of the PhD examination process and an essential part of the requirements for obtaining the doctoral degree [1]. Since the defense is a form of an oral exam, and crucial in obtaining the doctoral degree, it is important for candidates and committee members to understand the requirements. This preparation is important so that students can know what to expect during the doctoral defense, as this knowledge will help them prepare properly for the defense [2]. In terms of what students want from their defense, Wellington [3] observed that they want a "quality experience": a challenging experience that allows for deep discussion with experts in the field, and a process that allows feedback and the opportunity to improve. Other terms that are used for the defense are viva voce or viva (in the UK), disputation (in Sweden [4]), or disputas (in Norway [4]). The committee members also play an important role in the defense. Other terms that are sometimes used for the committee members are examiners (in the UK), and opponent (in Sweden and Norway [4]). For consistency, I'll solely use the terms "defense" and "committee member(s)" in this paper, even when referring to defenses from regions and countries where different terms are used.

The requirements for the PhD defense tend to be largely consistent among universities that use the same defense format. Even though there is a multitude of defense formats, 'students across all

disciplines can expect to defend their thesis through a process involving questioning, clarification and discussion of key elements' [2]. An analysis of the guidelines from 20 British universities showed that that the key criteria are the same [5], but that at the same time there are also differences in procedures and practices across universities. Key criteria for receiving the doctoral title included providing an original contribution to knowledge [6], being able to locate the research in the broader context, and displaying knowledge of the contents of the written thesis. At the same time, it is not always clear whether [2] it is the thesis (as a complete and comprehensive document) or the student (as an apprentice researcher) that is being examined during the defense, with some differences discernible across disciplines. As such, getting students ready for the defense has been compared to preparing in the dark. This observation is also reflected by the research of Wellington [3], who found that students are often confused about the procedures of the defense, the role of the supervisor, and the possible outcomes. The main source of information for students is from friends who already passed. Much of the students' prior knowledge of the defense is "*shaky and ill-founded*".

If the PhD defense is an integral part of the PhD examination, it would follow that one could fail the PhD after an unsuccessful defense. Jackson and Tinkler [7] found that failing is indeed possible in 60% of 20 British institutions. On the other hand, Mežek and Swales [4] indicated that, since the thesis is printed and distributed prior to the defense, failing a defense is uncommon in Sweden and Belgium. The same unwritten rule holds true for the Netherlands. From an international point of view, there is no consensus on the purpose of the defense [8].

Even though there are written requirements for the PhD defense, the actual defense itself and how it is carried out often depends on the committee members, their style of interaction and their style of examination [5]. Power struggles between a committee member and the supervisor can happen [9], and negatively affect the student [10]. Power abuses also manifest themselves [11] when a committee member requires the candidate to add significant work related to the committee member's "pet field", or when they require changes to a thesis that is complete, simply because the committee member wants to leave a mark on the work. Additional concerns with regard to the behavior of committee members are that '*feminist scholarship can be ridiculed by unsympathetic examiners, interdisciplinary work can be inappropriately examined, and international students can be treated as second class citizens*' [10, 12]. It has been suggested [10] that when there is a larger committee (four to eight people as in the United States), the voice of the committee will be more balanced than when one, all-powerful committee member (i.e. the external examiner in the UK) drives the outcome of the defense, and the outcome of the assessment of the doctoral thesis.

Understanding the defense, the requirements associated with the defense, and the defense format is increasingly important in the context of internationalization [7]: when a committee member participates in a defense using a different format, it is not possible to rely upon the committee member's own experiences and his/her/their tacit knowledge about the defense resulting from experience, as this experience is a function of the defense format.

When a defense is carried out according to all university rules and in all fairness, it can still go wrong because of a wrong interpretation of the expectations. Remenyi [13] describes a defense where the candidate almost failed as a result of him dropping his intellectual guard during the defense, acting as if he was having a jolly conversation with the committee members, and the committee members focusing mostly on what was not in the dissertation (i.e. its weaknesses).

While the defense is such an important step for doctoral candidates, research on the topic is often limited to national practices, mostly in Anglophone contexts ([4]), and only a few articles have explored the relation between the defense and student perception. Research on this topic is necessary, because "*... if we are using vivas to assess students, then we should also assess the vivas we are using*" [10]. This article addresses the relation between the defense format and student perception, using an international perspective. This relation is explored through the use of a survey, and the data give unique insights in the impact of different elements of a defense format on student perception. This study is necessary, as most research has focused on the UK *viva voce* defense. In the light of continued internationalization, and in particular the wish to unify European PhDs and the development of new PhD programs in emerging countries, it is important to study defense practices

internationally. Kyvik [14] remarks that there is virtually no research from an international comparative perspective. His study focused on four countries (US, UK, Sweden, and Norway). This study aims at broadening the scope of this work. Just as Kyvik [14] raised the question on 'best practices' among various procedures, and how a mix of defense formats could be the basis for a future PhD assessment system, this paper aims to study the international state of the practice, and link the defense elements to the perception of the students, before proposing the selection of the best elements. Indeed, the goal of this study is not to formulate policy recommendations, but to shed a light on the different defense formats that are used worldwide, and the students' perception of these defense formats. As such, this work can be considered a first step towards critically analyzing defense formats in the light of the perception of the students that go through the defense, and these insights can then be used by universities internationally to evaluate the defense format they use.

2. Literature review

2.1. Students' perception of the defense

In this section, I give an overview of the existing research on students' perception of the defense. The cited studies all look at one particular defense format.

Jackson and Tinkler [7] studied the perception of the purpose of the doctoral defense of students ($n = 88$) at two British universities. The perceived purpose of the defense was the authentication of the thesis and a range of assessment activities. One in six candidates that responded to the questionnaire considered that the defense serves a negative function. Another survey of recent doctors in psychology confirmed this finding, since it was found that while 85% of candidates passed the defense, 40% found it to be a negative experience [15]. These disillusioned candidates were equally divided between those who passed their defense and those who were referred. A survey of recent graduates from social sciences PhD programs ($n = 87$) in Ireland [16] found that the mean score for defense satisfaction was 4.09 on a 1 (low) to 5 (high) Likert scale. In this study, there was however a relation between defense satisfaction and the outcome of the defense: students with referral or major revisions reported a mean defense satisfaction of 1.85 as compared to minor (4.21) and no (4.80) corrections.

Jackson and Tinkler [7] also studied the perceptions of academics ($n = 142$) regarding the role of the defense. The most commonly identified purpose (36% of respondents) was to check the candidate's understanding and ability to produce and present research to PhD standard. While committee members identified one of the purposes of the defense to provide an opportunity to offer guidance and advice to the students, this purpose was not identified by the students who responded to the questionnaire. Indeed, there seems to be a mismatch in expectations and understanding of the purposes of the doctoral defense in the UK between committee members and students.

To further explore why students who successfully passed their defense may consider it as an unsatisfactory process, Crossouard [17] conducted semi-structured interviews ($n = 20$, 14 female and 6 male) of recently graduated doctors from eight universities in England. Some respondents focused on the defense's function of becoming accustomed to 'tough' academic judgments, reflecting a gendered dimension. Some interpreted the examining practices as aggressive, and some respondents experienced the defense itself as an aggression. The experience of the respondents during the defense sometimes resulted in an unexpected outcome. Where students had a difficult defense, even though they passed or passed with minor corrections, the perception of the defense influenced their future work, with one respondent being so shaken by the events that she has not been able to publish from her dissertation afterwards. For such cases, the defense completely loses its celebratory function.

Students' perception of their doctoral defense is related to the behavior of the committee members during the defense. The choice of committee members, and their impact on all levels of the defense is highlighted in [18]. This study looked at candidates' perception of the defense through semi-structured interviews ($n = 18$). Based on these interviews, it was found that committee members impact various levels of the defense: 1) the actual defense (i.e. whether the candidate felt

that he/she/they had the chance to properly defend the thesis, or if power struggles of the committee members dominated the defense), 2) in the emotions of the candidate (i.e. committee members either induce anxiety and stress, or make the candidate feel more at ease), 3) in the perceived fairness of the assessment, especially when the candidate had no voice in the selection of the committee, and 4) in the practical aspects of the defense, such as scheduling of the defense. In addition, the way in which committee members evaluate students causes uncertainty, and a survey [19] of students in education ($n = 84$) found that a quarter of the students were very uncertain about what criteria might be used by the committee members.

Students for whom English is their second language may face additional challenges during the defense. The perception on the defense of non-native English students at a university in New Zealand was studied through interviews about students' fears prior to the defense with 11 students after their defense [20]. The fears prior to the defense were related to the defense format: "*In institutions where the examinations are public, doctoral students may attend several oral examinations to observe the protocol; fear of their own then includes the public performance of the event. Fear under the British system is, ironically, of the lack of scrutiny: the unknown.*" All participants in the study agreed that the oral defense is valuable and a positive experience. This observation is important, since it represents the voice of non-native English speakers on the usefulness of the doctoral defense.

2.2. Review of defense formats

From an analysis of 49 testimonies of the doctoral defense that I collected on my blog [21], as well as a review of the literature on the doctoral defense [22], I have identified five key elements of the doctoral defense format. The first key element of the defense is whether the thesis is published before or after the defense. If the thesis is published before the defense, it is already approved by the committee, and the committee cannot require changes to the thesis anymore. On the other hand, when the thesis is published after the defense, a variety of outcomes of the defense are possible, and these outcomes are related to the level of changes that are necessary on the thesis [11]. The timeline to graduation and award of the doctoral title is less uncertain for the case when the thesis is published after the defense.

The second key element of the doctoral defense is whether the defense is oral or written. The written defense (examination report) is often used in Australia [23] and South Africa [11, 24, 25], where the assessment then fully lies in the evaluation of the thesis [26] and the subsequent rebuttal of the comments of the committee members as well as the revised version(s) of the thesis. While in these countries, the written defense format has been the format of choice because of their geographical isolation, there is a movement towards using an oral defense through videoconferencing tools. The main difference between a written and oral defense lies in the way the candidate interacts with the committee members, with more formal replies in the written format, and a session of answering a variety of questions in the oral format.

The third key element of the doctoral defense is whether the defense is a one-step or two-step defense. A two-step defense is when the format consists of two defenses, often a closed defense with only the committee and a public defense where friends, family, colleagues, and other interested people are welcome. These two steps can take place on the same day, as is common in the United States [4, 27], where a part of the defense is private so that the committee members can ask more in-depth questions. The two steps can also be separated out into two events, as common in Belgium [28], where the private defense is followed by publication of the thesis, and ultimately the public defense. In a one-step defense, all aspects of the defense take place on the same day and with the same constellation of audience and committee members.

A fourth key element of the defense is whether it is public or private. In the strictest sense, a private defense is only between the committee and the candidate, and the public defense is open to all the public. Studying different defense formats, I learned that there are different gradations of each. For example, the private defense can be with or without the supervisor, and with or without a Chair. Conversely, at some universities defenses are technically public but never advertised [29], so that they are practically private defenses. In a private defense, the committee members sometimes

ask questions by going through the thesis on a page by page basis. This approach is very uncommon for a public defense, where the committee members typically focus on broader questions. The divide between public and private defenses is hotly debated in the light of European standardization of the PhD defense [14].

The fifth and final main difference in defense format is whether the defense format follows a fixed time schedule, or whether the schedule and total time of the defense is at the hands of the committee. In a fixed time schedule, there are strict rules about the total time the defense can take, the order in which committee members will ask their questions, as well as how much time each committee member receives for asking one or more questions [30]. Candidates who defend in a fixed schedule know better in advance what their defense will look like, whereas those who defend on a schedule that is fully determined by the committee, may not know how long the defense will last. An extreme case of such an unpredictable schedule is a defense that “...has run into a second day” [11].

In addition, I have identified seven less important elements of the doctoral defense format. The first element is related to committee feedback on the thesis before the defense. Here, I make a distinction between the candidates who received committee feedback before the defense and those who didn't. In addition, I make a distinction between those who implemented the committee feedback they had received before the defense into their thesis, and those who did not or only partially included this feedback. Along the same lines, I distinguish between those who had an idea of the committee recommendation for the thesis before the defense, and those who didn't, which is an element that is of course closely related to whether the candidate received feedback in advance or not. Receiving feedback before the defense or not, and acting upon it, is closely related to whether the thesis is published before or after the defense, but there are subtle differences between defense formats. For example, in Norway [14] the thesis is published before the defense, without committee input, and a resubmission with minor corrections after the defense can be required. On the other hand, in the Netherlands, the thesis is published and printed before the defense, and the thesis will have received multiple rounds of comments from the committee members before it is accepted for defense [31].

A second less important element of the doctoral defense format is the presence or lack thereof of the doctoral supervisor during the defense. Watts [2] states that it is her experience that the *'supportive presence of a supervisors has both psychological and practical elements and can help moderate the mood of what some students will perceive as a 'gladiatorial' contest'*.

A third minor element of the doctoral defense is whether the defense included a presentation, and who made up the audience of this presentation. Some defense formats are fully centered around a candidate's presentation [27], whereas in other defense formats, the candidate only presents to the audience, not including the committee, before the official start of the defense [31]. In other defense formats [8], the committee member who takes the lead in asking questions presents a summary of the research instead of the doctoral candidate. As such, it is important not only to explore if the defense contains a presentation, but also to chart who formed the audience of this presentation.

A fourth minor element is how the committee members participated in the defense: virtually or in person. The option for committee members to connect remotely has become more widely available over the past few years. In such a format, often part of the committee and the candidate are together in a room, and one or more committee members connect virtually [32]. During the COVID-19 pandemic, the fully virtual defense became more common, as distancing measures required committee members and the candidate to remain at home and all connect remotely to participate in the defense.

A fifth minor element is related to the dress code during the defense. Here, I distinguish between the defense formats that require a dress code, and those that do not require a dress code. For the defense formats that require a dress code, I distinguish between those that require academic togas for some or all of the participants, and those that required other formal wear.

A sixth minor element is whether the defense focused on the research only, or if it included other elements. Some defense formats include additional elements outside of the doctoral thesis research. For example, in Norway [8] candidates are also required to give a trial lecture on a different

topic in their field of expertise, and in the Netherlands [33] candidates defend a set of propositions that they developed to show their general ability to argument on different topics in public.

A final seventh minor element of the defense is whether the defense included a laudatio at the end or not. The laudatio is a congratulatory speech at the end of the defense. When a laudatio is included, it typically forms part of the final steps of the defense.

2.3. Research gap

Based on the literature review, I found that research on students' perception of the doctoral defense has only been done within national contexts. This research looks at students' perceptions of the doctoral defense in an international context. Moreover, no research has been done in the past to correlate elements of the defense format to the perception of the doctoral students about the defense. In order to do so, an international comparison of defense formats is necessary, to distill the elements of that make up the different defense formats, and from there, these elements can be studied in correlation to the students' perceptions of the doctoral defense. In addition, the combination of quantitative methods with qualitative analysis of open-ended questions gives a deeper insight in the lived experiences of doctoral candidates.

3. Materials and Methods

3.1. Survey design

To study the relation between the doctoral defense (and the format of the doctoral defense) and the perception of the doctoral candidates about the defense, I carried out a survey. For this study, I obtained IRB approval nr 2019-139IN through Universidad San Francisco de Quito. The survey received responses from participants between July 13th 2020 and October 3rd 2020.

The survey, which is provided in its entirety in the supplementary material of this article, consists of three main blocks after the opening section which contained the informed consent. The first block of questions aimed at gathering socio-demographic data of the participants of the survey. The second block of questions addressed the defense and the different elements of the defense format. The third and final block of questions addressed the experience of the candidates during and after the defense. The survey contained closed multiple choice questions, 0-10 sliding scale (Likert scale) type of questions, and open-ended questions. The choice for the 11-point Likert scale was made because the results from an 11-point Likert scale tend to have the smallest kurtosis and have a distribution closest to normal [34]. The total number of questions in the survey was 54, and some questions were displayed only based on the answer of a previous question.

To cover an array of defense formats that is as large as possible, the study was open to all who have defended their doctoral thesis, regardless of the outcome of the defense, with the aim to include geographically diverse former doctoral candidates from all possible fields of study. The survey had no limitation on how recently the defense took place. For the question regarding the current position of the respondent, I used the ranking system of academics from the United States, using post-doctoral researcher, assistant professor, associate professor, full professor, and other academic appointment as the categories of academic employment.

The questions regarding the defense format were based on the elements of the defense format I had identified previously [22], and which I discussed in section 2.2. I added a set of questions regarding the student's nativeness of the language in which the defense was held, based on the previous research that looked at the experience of non-native English speaking students in New Zealand [20].

The questions on student perception were constructed based on a number of sources. First of all, questions regarding emotions were included because the emotional level of the defense was identified in the literature as an important element [16, 18]. The studied emotions include nervousness before, during, and after the defense. Other scales of student perception that were included are: enjoyment of the defense, perceived importance of the defense, perceived difficulty, perceived formality, perceived seriousness of the defense [4], and ultimately the overall value of the

PhD defense as part of the doctoral experience. Based on the literature review and the difficulties students have in identifying the purpose of the defense [7], I included a multiple choice question on the perceived function of the defense as well as an open-ended questions where respondents could add their perceived functions of the defense. Given the importance of the committee on the experience of the doctoral candidates, I included a question about the perceived fairness of the committee based on [18] and added a question on the perceived suitability of the committee to make a well-balanced assessment of the doctoral candidate's work [35].

The set of questions that look at the students' perceptions and emotions also contained a set of questions that look at the long-term impact of the doctoral defense. The long-term affective level of the defense and how it influences the subsequent career of the candidate was identified as important in the literature [17]. To include this dimension, I looked at the four aspects of long-term influence of the defense from [7]: perception of academic competence, desire to continue work in the sphere of the PhD, desire to work within academia, and perception of publishability of PhD research. I included these four aspects in the survey.

I recruited survey participants from my personal and professional network through social media and email. I am aware of the inaccuracies associated with self-reporting data and understand that the respondents represent a self-selecting convenience sample [36]. However, for the purpose of this study, which is to explore potential links between the candidates' perception and the defense format, to make a first step towards evidence-based best practices for the doctoral defense, and to identify routes for further research, this approach appears to be sufficient.

As the data analysis stage of this research coincided with the COVID-19 pandemic, using an online survey was a suitable method to collect data while meeting people in person was not possible. Using the online platform also allowed me to reach a wide international sample of participants, and allowed participants to fill out the survey at a time that was convenient for them.

3.3. Analysis methods

In the literature, I encountered two approaches for methodology. Studies are either purely quantitative, looking at the quantitative analysis of survey results. Such studies typically focus on characteristics of the defense and the PhD such as percentage of students passing [37], or time to completion of the PhD [38]. The majority of studies on student perception and the doctoral defense are qualitative studies, based on interviews with a select number of recently graduated doctoral candidates. Since I wanted to cover the international breadth of doctoral defense formats, I opted for a mixed methodology. The focus of my work is on the quantitative aspects and the statistical correlation between the defense format and the perception of the students, but I also included open-ended questions in the survey, which I analyzed using inductive thematic analysis, so that I could learn more from the lived experiences of the doctoral candidates. The open-ended questions also helped to identify particularly worrying situations in some defenses.

The methods in this work are combined qualitative and quantitative methods, with a focus on quantitative methods. On the survey platform, I first reviewed each individual's response to the survey (vertical walkthrough of the data), as well as the separate answers per question (horizontal walkthrough of the data) to familiarize myself with the information. Next, I developed a report of the responses on the survey platform, to see the first trends in the data.

I started the quantitative analysis by filtering out empty and incomplete surveys. Then, I developed a report of the responses of this filtered dataset on the survey platform. I exported the data from the survey platform in .csv format to open the dataset and converted it to a MS Excel worksheet. I analyzed the data in separate spreadsheets by breaking down survey responses per different categories of the socio-demographic category and cross-checked these results with the tables of the report and breakdowns per category developed on the survey platform. To get an initial idea of the different relationships between the categories of defense format elements and the categories of student perception, I used the cross-tabulation feature on the Qualtrics survey platform. Since the survey platform only provides the p value of a chi-squared test and an ANOVA test, I used a Wilcoxon rank sum test for the analysis of two categories and a Kruskal-Wallis test for

analysis of more than two categories [39]. To apply these statistical tests to the data, I first recoded text responses of the multiple-choice questions to numerical values and then I used Matlab R2019a to carry out the statistical tests. I selected a p -value of < 0.05 to indicate a strong correlation.

The responses of the open-ended questionnaire were analyzed for thematic content [40] using the methods of inductive thematic analysis [41, 42]. First, I read all responses in detail and used the text analysis tool on the Qualtrics survey platform to tag emerging codes to these responses. To ensure consistency of the themes and avoid repetition, I wrote memos of the codes by hand. I then went through all codes again on the platform to doublecheck and merge some codes of similar meaning based on the memo. Then, I exported the codes and number of mentions to MS Excel, in which I identified the overarching themes of the various codes, and calculated the mentions of the overarching themes. In a next step, I sorted the overarching themes from most to least mentioned. The overarching themes resulted from the data analysis, and I did not have predetermined ideas or categories for the data.

4. Results and analysis

4.1. Participants

Through the survey, I obtained a total of 296 responses with consent. These responses are anonymized and available in the public domain [43]. Of these responses, 204 respondents completed the survey, and this dataset is used for the analysis in this work. Respondents took between 2.5 minutes and 81 hours (median = 10.6 minutes for $n = 204$) to complete the survey. As respondents could return to the survey at their convenience when using the same IP address, the longer survey times indicate that respondents returned to an unfinished survey at a later stage.

Table 1 shows the socio-demographic characteristics of the respondents of the survey, as well as the breakdown per field. The majority of respondents self-identified as white (72%) and women (64%), of 35-44 years old at the time of the survey (41%), currently employed in academia (76%), who defended between 1-5 years ago (52%). Only for STEM fields, the majority (71%) of respondents self-identified as men. The respondents of STEM fields are also more diverse than the other fields, although the majority are still white (56%), and have the lowest percentage (although still more than half) of respondents currently employed in academia (58%). None of the respondents self-identified as "other" or "prefer not to say" for gender. The respondents defended their doctorate in 31 different countries around the world, representing all continents (except Antarctica). The countries with the largest representation of the respondents were the United States (33%), the Netherlands (16%), the United Kingdom (12%), Canada (9%), France (3%), and Spain (3%). The respondent's location at the time of the survey was also geographically diverse, representing 34 countries from all continents (except Antarctica). Most respondents resided in the United States (30%), Ecuador (13%), the Netherlands (13%), the United Kingdom (9%), or Canada (8%).

Table 1. Socio-demographic aspects of survey respondents, including time since defense of the doctorate.

	Total	Life sciences	Humanities and Arts	Social Sciences	STEM	Multidisciplinary
	$n = 204$	$n = 46$	$n = 29$	$n = 60$	$n = 57$	$n = 9$
Gender						
Male	36%	24%	24%	22%	71%	11%
Female	64%	76%	76%	78%	29%	89%
Age						
25-34	34%	48%	36%	22%	36%	22%
35-44	41%	39%	46%	44%	38%	33%
45-54	13%	7%	7%	17%	13%	44%
55+	12%	7%	11%	17%	14%	0%
Time since						

defense						
< 1 year	14%	11%	11%	18%	16%	0%
1 – 5 years	52%	59%	56%	50%	45%	75%
6 - 10 years	17%	17%	15%	17%	18%	0%
> 11 years	17%	13%	19%	15%	21%	25%
Ethnicity						
White	72%	70%	82%	85%	56%	67%
Black or African American	4%	4%	0%	2%	4%	22%
Asian	8%	7%	4%	3%	18%	0%
Latino/Hispanic	7%	7%	0%	7%	9%	11%
First Nations	1%	0%	0%	2%	0%	0%
Mixed	2%	0%	4%	2%	4%	0%
Other	7%	13%	11%	0%	9%	0%
Current employment						
Academia	76%	85%	75%	87%	58%	78%
Industry & Business	14%	13%	11%	7%	25%	11%
Government	4%	2%	4%	5%	4%	11%
Unemployed	3%	0%	4%	2%	9%	0%
Other	2%	0%	7%	0%	5%	0%

Note: *n* total of completed surveys is 204, but only 200 respondents filled out the field in which they obtained their doctorate.

4.2. Results of questionnaire and analysis

4.2.1. Defense format

In this section, I have provided a summary of the results of the survey. The majority of all respondents passed their defense (68.5%) or had minor corrections (28%). Only a small part of the respondents received major corrections (3.5%). None of the respondents switched fields or dropped out of their program. The most commonly used term is the defense (75%), followed by viva (18%). In some instances, other terms are used: final presentation (2%), disputation (1%), as well as nationally used terms: dissertation (German), promotie (Dutch), soutenance (French), or discussione (Italian). In most cases, the thesis is finalized after the defense (62%), but over one-third (37%) published their thesis before the defense. In addition, two participants (1%) indicated that they had not finished their thesis at the time of the survey.

When it comes to defense format, a one-step defense is most common (80%), but two-step defenses are used as well (18%), and in some cases more than two steps take place (2%). Typical two-step defenses contain a private defense, followed by thesis publication, and a final, public defense. The vast majority (99%) of the respondents had an oral defense, but two respondents had their defense in written format (one in Mexico and one in South Africa). Over half of the respondents (57%) had a public defense, over a quarter (28%) had a private defense, and the remaining group (15%) had both in a two-or-more-step defense.

Over half of the respondents (55%) indicated that the time spent during the defense was driven by the committee and their questions, over a third (38%) of the participants had a defense format with a fixed schedule, and the remaining respondents selected 'Other, please explain'. These explanations include "It was semi committee driven. It was expected to not last much longer than an hour but no fixed end time.", "Presentation was fixed, then discussion with the committee was time free", "40-50 minutes showing my results followed by approximately 4 hours of questioning.", and variations of these explanations. The overall time of the defense was 1.5 hours – 2 hours for over a third (34%) of the respondents, 1 hour – 1.5 hours for over a quarter (27%) of respondents, and 2 – 3 hours for over a

fifth (21%) of respondents. A minority of respondents finished their defense in less than an hour (12%) or in more than three hours (5%).

A slight majority (54%) of respondents received committee feedback before the defense. Of those who received feedback, more than half of them (52%) implemented this feedback in their thesis before the defense, and over a quarter (28%) implemented the feedback partially. Over half of the respondents (53%) did not have an idea before the defense of the recommendation the committee members would give, whereas a quarter (25%) had an idea of the recommendation of all committee members, and the remaining respondents (22%) had an idea of the recommendation of one or more committee members.

The majority (79%) of respondents had a defense that included a presentation. For those who gave a presentation, the majority (68%) presented to their guests and committee. Other formats included presenting only to the committee (16%) or only to the guests (2%). In the comments to this question, respondents indicated that their public defense was open to the public, including colleagues, students, and anybody who is interested who may not have been a direct guest of the candidate. The impact of defending during COVID-19 on the format was also described by a respondent as: *“typically the committee would not join, but because it was streamed and everyone was at home, they were able to see it. Usually, they’re separated in a room in the building, waiting for the presentation to be over.”*

Committees ranged in size from two to ten committee members, with the median number of committee members five (30% of respondents). In most cases (73%), the supervisor was present as part of the committee, but in some cases the supervisor was part of the audience (20%) or not present (8%). Table 2 shows the breakdown of committee composition per field, where we can see that it is slightly more common in STEM fields to have committee members from industry or government, but of the $n = 444$ logged committee members (respondents were able to select all that apply), only 17 committee members are from industry and only five from the government.

Table 2. Breakdown of committee composition per field. Note that respondents were able to select all that applied, so $n = 444$ refers to the total number of selections here, provided by 204 respondents.

	Total	Life sciences	Humanities and Arts	Social Sciences	STEM	Multidisciplinary
	$n = 444$	$n = 107$	$n = 54$	$n = 128$	$n = 130$	$n = 18$
Internal to my university	33%	33%	26%	32%	24%	33%
Internal to my department	29%	26%	43%	37%	30%	33%
External to my university, from other university	33%	36%	30%	30%	37%	28%
External to my university, from industry	4%	4%	2%	1%	8%	6%
External to my university, from government	1%	2%	0%	0%	2%	0%

Note: the respondents total of completed surveys is 204 resulting in $n = 444$ selections, but only 200 respondents filled out the field in which they obtained their doctorate, resulting in $n = 437$ selections of committee members in part of the table with the breakdown per field.

In the majority of cases (73.5%), all committee members were physically present in the room. In recent years, it has become more common for committee members to connect through video- or phone conferencing software. One possible format is to have some committee members present and some connected remotely (17.5%). The earliest registered defense of this format was in 2007 in Canada, and the majority of responses of this format are from the period 2015-2019. The option of

having fully remote defenses (9%) only became common during the COVID-19 pandemic. Generally (64%), all committee members ask questions. In some cases only some committee members (10%) and/or the audience (21%) asked questions. Four respondents clarified in the textbox that all committee members except for the supervisor(s) asked questions. Other clarifications included “Audience holding a doctoral degree” and “During the oral presentation, the audience asked questions, then on closed quarters, all the members asked questions”.

In most cases (87%), the defense focused on the research only. For the remaining respondents (13%), other elements were included: questions about the general field of research, the candidate’s experience with multidisciplinary research, interpretation of the results in a wider context, the propositions, science philosophy, defense of a societal project, and a discussion on supervisory issues experienced by the candidate. The majority (57%) of respondents had a defense format without *laudatio* (congratulatory speech of the supervisor after receiving the outcome of the defense), and the remaining part (43%) did have a *laudatio*.

The majority (78%) of defenses were held in English, with the remaining defenses (22%) in the language of the country where the university is located. The language of the defense was their native language for the majority (62%) of respondents. Over a quarter (27%) indicated that the language was not their native language, with the remaining portion (10%) indicating they considered themselves near-native speakers of the language.

Most respondents (62%) and their committee members were not required to follow a dress code, whereas over a quarter (26%) were required to use formal wear, and only a minority (13%) were required to dress in academic togas.

4.2.2. Student perception

The first aspect of student perception addressed in the survey is how nervous the student felt before the defense, during the defense, and after the defense but before receiving the outcome. Figure 1 shows that on average, students feel most nervous before the defense (median value 7 on an 11-point Likert scale from 0 to 10, average = 6.79), and then gradually less nervous during the defense (median value 5, average = 4.84), and after the defense and before receiving the outcome (median value 3, average = 4.01). The latter category, however has the largest distribution of results.

The second set of elements of student perception contains how much the student enjoyed their defense, the perceived importance, difficulty, formality, and seriousness of the defense, as well as the overall value of the defense as part of the PhD experience, as expressed on an 11-point Likert scale from 0 to 10, see Figure 2. We can see in Figure 2 that PhD candidates on average quite enjoy their defense (median value 7, average = 6.63), find their defense moderately difficult (median value 6, average = 5.90), consider it quite important (median value 8, average = 7.48), perceive the defense as formal (median value 7, average = 6.40) and serious (median value 6, average = 6.36), and overall find the PhD defense a valuable part of the PhD experience (median value 8, average = 7.46).

The next element of student perception that I explored is how fair and how suitable for making a well-balanced assessment the candidates perceived their committee. Table 3 gives an overview of the responses, as well as a breakdown per field. In the Humanities & Arts as well as the Multidisciplinary fields, the lowest perceived fairness of the committee (64% and 67%, resp.) and the lowest perceived suitability of the committee (68% and 44%, resp.) are observed. The suitability of a committee in the multidisciplinary field could potentially be a result of not all aspects of the multidisciplinary work being reflected by the committee composition.

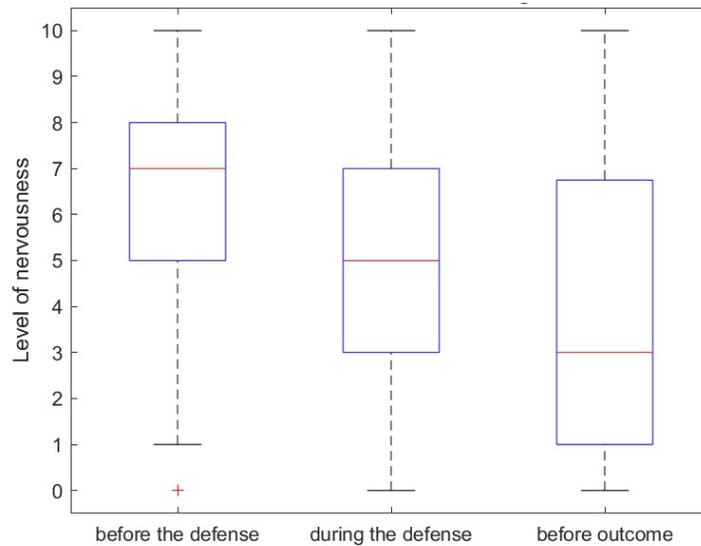


Figure 1. Boxplot of self-reported nervousness before the defense ($n = 200$), during the defense ($n = 197$), and after the defense but before receiving the outcome ($n = 175$).

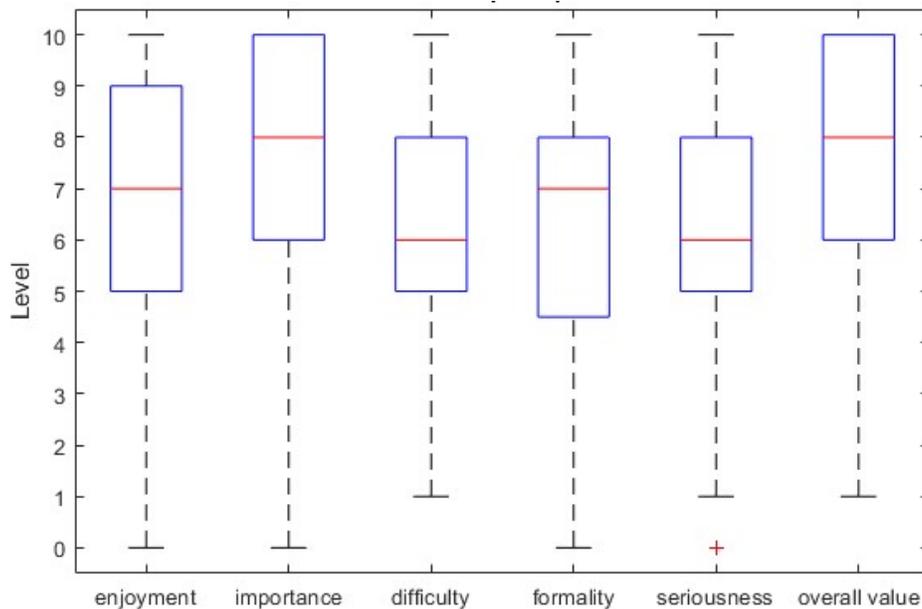


Figure 2. Boxplot of student perception of the defense: enjoyment of defense ($n = 198$), perceived importance of the defense ($n = 200$), difficulty of the defense ($n = 201$), formality of defense ($n = 200$), seriousness of defense ($n = 199$), and overall value of the oral defense as a part of the doctoral experience ($n = 201$).

The perception of the purpose of the defense is shown in Table 4, including a breakdown per field. The largest number of selections were for the function of examination, followed by confirmation and rite of passage. In the category "other", some worrying signs were given, such as "a chance for senior academics to eat their young", "confrontation", "payback for personal reasons" and "organizational nightmare". The survey also included an open-ended question on how the participants would describe the purpose of the defense in their own words. I used inductive thematic analysis on these 164 responses, which resulted in the following overarching themes, ordered from most to least

often mentioned: evaluating the ability of the researcher, receiving input from the committee, a formality, confirming authorship, evaluating the impact of the work, defending the research, a presentation, a positive experience, a graduation requirement, closure, reflection on the research, a scholarly discussion, a celebration, a confirmation, an examination, a moment to share with friends, family, and colleagues, a negative experience, a ceremony, important for the grading of the PhD, evaluating the ambassador role of the candidate, discussion of future work, a rite of passage, a time when the chair is crucial, a review, a show piece, a moment when you want to do well, an event that requires effort, an event that requires proper preparation, a time to link back to the coursework, an obligation, and a serious event. Again, in the category of negative experiences, worrying signals are given: “academic hazing”, “For me, a defense is the culmination of years of research and work. The committee treated me like some kind of an amateur or imposter, rather than an expert in my field.”, and

“Well, the purpose of what my defense was supposed to be and what it ended up being are two different things. I had attended someone else’s defense before mine and based on that experience, and the information from my advisor, I was under the assumption that the defense was a way to explain my research and to provide clarity on anything that my committee had questions about. Also, to explain any limitations. Unfortunately, 2 of my committee members did not really provide me with the opportunity to do either of these things. The first committee member lectured me for his 20 minute time limit about how he didn’t like how I interpreted one of the films I mentioned (not the ones I actually analyzed -- the film in question was just foundational). The other committee member, also male, lectured me about feminism (my dissertation’s sub-title partially includes 20th/21st century Post-modern Feminism) and went over his time soooo much that my advisor was only able to ask 1 question, since she went last. Additionally, both the male committee members wanted extensive edits that had not be mentioned previously and were not possible given the time until I had to submit my final draft, so my advisor told me to do what I could and what I felt was most useful.”

Table 3. Perception of committee by respondents. $n = 200$ for the question “Did you consider your committee fair?” and $n = 202$ for the question “Did you consider your committee suitable for making a well-balanced assessment of your work?”, and breakdown of responses per field.

	Total	Life sciences	Humanities and Arts	Social Sciences	STEM	Multidisciplinary
<i>Did you consider your committee fair?</i>						
	$n = 200$	$n = 45$	$n = 28$	$n = 60$	$n = 56$	$n = 9$
Yes	84%	89%	64%	87%	89%	67%
To some extent	15%	11%	32%	12%	11%	33%
No	1%	0%	4%	2%	0%	0%
<i>Did you consider your committee suitable for making a well-balanced assessment of your work?</i>						
	$n = 202$	$n = 46$	$n = 28$	$n = 60$	$n = 57$	$n = 9$
Yes	80%	83%	68%	83%	84%	44%
To some extent	19%	15%	32%	13%	16%	56%
No	1%	2%	0%	3%	0%	0%

Note: the total number of respondents for the first question is 200, but only 198 of these filled out the field in which they obtained their doctorate. Similarly, for the second question, the total number is 202 and 200 of these filled out their field.

To evaluate the long-term perception of the impact of the PhD defense on the students and their careers, the respondents answered four questions [7]: “How did your defense influence your perception of your academic competence”, “How did your defense influence your desire to continue to work in the sphere of your PhD research”, “How did your defense influence your desire to work in academia?”, and “How did your defense influence the perception on the publishability of your research?”. The three options for these statements were ‘XXX increased after my defense’, ‘XXX decreased after my defense’, or ‘XXX was not affected by my defense’, where XXX refers to one of

the four dimensions explored in these questions. Figure 3 gives an overview of the results. We can observe here that the majority of candidates (57%) perceived an increase in their perception of their academic competence after their defense. The desire to continue to work in the sphere of the PhD research and in academia was unaffected by the defense for most respondents (60% and 62%, resp.), and the majority of respondents (52%) also did not see an impact of the defense on their perception of the publishability of their work. We can observe as well that almost a tenth of respondents (8-9%) report long-lasting negative perceptions and career impacts after the defense.

Table 4. Breakdown of perceived purpose of the defense. Note that respondents were able to select all that applied, so $n = 536$ refers to the total number of selections here, provided by 204 respondents.

	Total	Life sciences	Humanities and Arts	Social Sciences	STEM	Multidisciplinary
	$n = 536$	$n = 122$	$n = 80$	$n = 150$	$n = 152$	$n = 25$
Examination	29%	30%	29%	29%	30%	32%
Ceremony	16%	20%	15%	9%	20%	16%
Celebration	13%	15%	14%	10%	13%	12%
Confirmation	20%	19%	18%	21%	20%	20%
Rite of passage	20%	16%	23%	26%	14%	20%
Other	3%	2%	3%	5%	2%	0%

Note: the respondents total of completed surveys is 204 resulting in $n = 536$ selections, but only 200 respondents filled out the field in which they obtained their doctorate, resulting in $n = 529$ selections of functions for the defense in the part of the table with the breakdown per field.

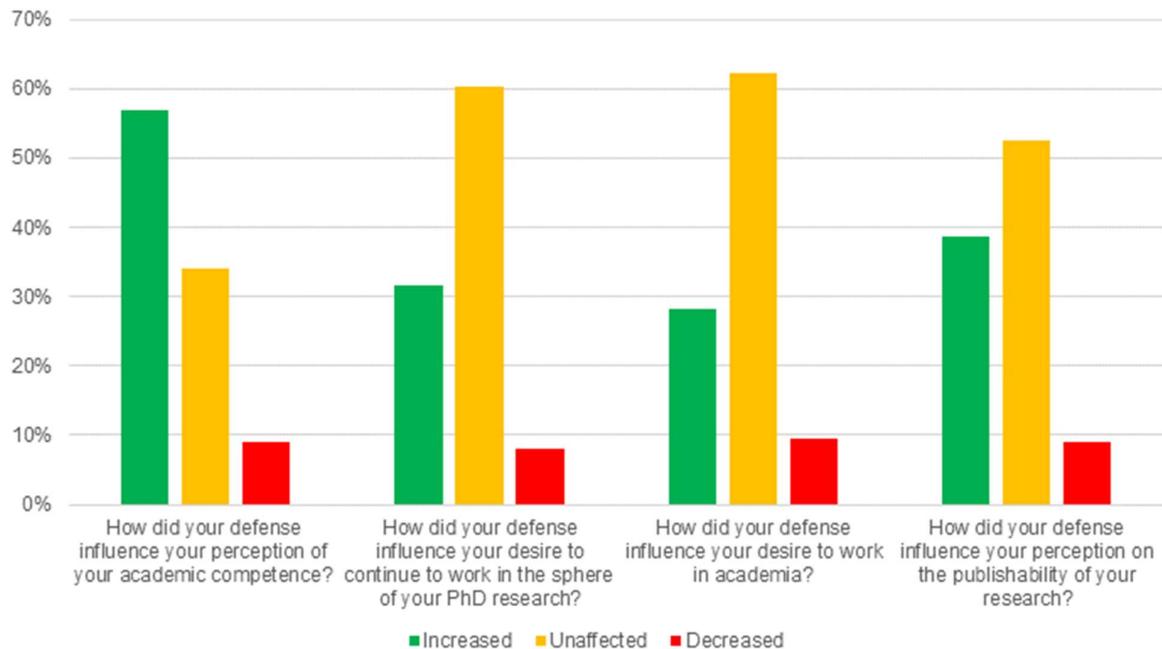


Figure 3: Long-term impact of the PhD defense on student perception, $n = 202$ for all four questions.

The survey ended with an open-ended question: 'In hindsight, would you have prepared differently for the defense? Describe what you would have done differently.' I used inductive thematic analysis on these 139 responses, which resulted in the following overarching themes, ordered from most to least often mentioned: nothing different, different preparation, different mindset, lack of support, positive experience, present contents differently, research and writing issues, different committee interaction, negative experience, defense would be different nowadays,

different clothes, tech issues, the defense is unpredictable, and use different products at the defense. In the category of different presentation are comments of those who felt they spent too much time preparing as well as those who wanted to prepare by reading different material. In the lack of support category are those who reported to have received not enough support from their supervisor, their chair, or their university in the preparation towards the defense. In the category of different committee interaction, there are issues with the composition and behavior of the committee members, such as:

"I would have jettisoned at least one member of the defense committee who had little to no understanding of the topic and clearly did not read my work. Their presence was a hindrance to the entire proceeding and they were also late, which put the defense in jeopardy of being cancelled."

"I don't think I would have prepared differently, but I think that if my committee members had actually done in the defense what was supposed to happen (asking me to clarify, etc.), I think it would have been a very valuable experience. I had prepared to clarify my arguments. I was not prepared to explain a very knick-picky element of an introduction to a chapter. I was also not prepared to listen to someone who is not an expert in feminism explain how I should have approached it. These were not things that a) should have happened, and b) that anyone could have been prepared to defend against or explain."

"My committee members almost uniformly asked me questions that were not central to my dissertation, for example, about footnotes or asides, and on the whole, I didn't feel like I was asked to defend my dissertation because I didn't feel their questions were actually very serious. It was very disappointing. Now, I always tell people to prepare by reviewing their footnotes."

The unpredictability of the committee and the defense is also reflected by:

"No, in the UK is very much driven by the examiners so the experience can vary quite a lot depending on whom you get as examiner, whether is from the supervisor's academic circle, etc so it is difficult to anticipate."

In the negative experiences category, I also sorted these worrying comments: *"I don't think I could have - I had had no reason to believe I would be asked to revise and resubmit until I was actually there."*, *"Everything from the beginning"*, and *"I wouldn't have prepared differently. I wish the oral presentation were eliminated. It is over-emphasized in the US and doesn't serve a real purpose."* For those who had a positive experience and would not have prepared differently, the following comments are representative:

"I believe that practicing my presentation and reading "how to" guides for preparing for my defense helped me to prepare. Also, knowing myself and how I react under performance pressure (public speaking) helped me to know how to prepare for my defense. I don't think I would have done it differently."

"No. I was well-advised, knew what was expected and it went exactly as planned. I was not surprised by anything, was confident in my work, and felt it went well."

4.3. Association between defense format and student perception

4.3.1. Matrix of analyses

To analyze the association between defense format and student perception, I first set up the analysis matrix shown in Table 5. This matrix identifies 16 elements of the defense format of which the correlation to the 14 aspects of the student's perception of the defense should be evaluated, resulting in 224 analyses. These 16 elements are the four of the five major elements and the seven minor elements identified in Section 2.2, expanded with the following three elements: committee composition, language nativeness, and who asked the questions during the defense. Given the small

number of respondents with a written defense, this variable is not correlated with student perception. The minor element of committee feedback and prior recommendation is separated into two elements: whether the student received committee feedback before the defense or not, and whether they had an idea of the recommendation prior to the defense or not. Moreover, from the comments in the “Other, please explain” textbox to the question if the defense followed a fixed time schedule or if the timeline was committee-driven, I could derive that this question was not clear for all participants. Therefore, I analyzed the relation with the duration of the defense to the students’ perception. The assumption here is that shorter defenses are those with a fixed time schedule, whereas longer defenses are at the discretion of the committee members.

Preliminary analyses consisted of setting up cross-tabulations on the survey platform, which included percentages per categories, stats tests of these percentages, the chi-squared test p -value, the averages per category, and the ANOVA p -value. While I did not use these crude stat tests for the final analysis, I evaluated these stats tests and the percentages and averages per categories to identify which entries of the analysis matrix are suitable for an in-depth analysis in Matlab, which required recoding the text values into numerical categories for processing in Matlab. I wrote a separate code for the different characteristics of the defense format and included programmed loops to remove “NaN” results.

Table 5. Matrix of analysis between categories of defense format and categories of student perception.

	Characteristics of defense format	Student’s perception of defense
1	Thesis publication before or after defense	Nervousness
2	One- or two-step defense	Enjoyment
3	Public or private defense	Perceived fairness of committee
4	Duration of defense	Perceived committee balance
5	Committee feedback before defense or not	Perceived importance
6	Prior idea of recommendation	Difficulty of defense
7	Defense with or without presentation	Formality of defense
8	Number of committee members	Seriousness of defense proceedings
9	Presence of supervisor	Purpose of defense
10	Committee composition	Perceived academic competence after defense
11	In-person or remote defense	Desire to continue in field after defense
12	Language nativeness	Desire to remain in academia after defense
13	Defense dress code	Perceived publishability of research after defense
14	Source of questions	Overall perception of defense as valuable experience
15	Defense about research only or including other elements	
16	<i>Laudatio</i> or not	

4.3.2. Major elements of the defense format

The analyses indicate that students’ perception is improved for those who published their thesis before the defense as compared to those who published the thesis after the defense. I carried out a Wilcoxon rank sum test for the categories of publishing the thesis before and after the defense ($n = 195$ respondents) in correlation to various dimensions of student perception. In the analysis, I left out the $n = 2$ respondents who indicated that they had not yet submitted their thesis. Those who published their thesis before the defense enjoyed the defense more (average = 7.714) than those who published afterwards (average = 6.112). The p -value is 1.97×10^{-5} and $h = 1$, indicating that the null hypothesis can be rejected. In the following analyses, I will only report the p -value for the cases with $h = 1$. Those who published their thesis before the defense perceived their defense as less important

(average = 7.041) that those who had not yet published their thesis (average = 7.854) ($p = 0.025$). These observations can be explained by understanding that the defense is an important step of feedback for those who submit their thesis after the defense, and since the uncertainty on the outcome is higher, they may also enjoy their defense a bit less. Those who published their thesis before the defense perceived it as more formal (average = 7.466) than those who published after the defense (average = 5.758), with a p -value of 2.7×10^{-6} and $h = 1$. This observation can be explained because when the thesis is already approved by the committee and published, the defense proceedings can be perceived as more of a formality. Of those who published their thesis before the defense, 66% perceive it as a ceremony versus 27% of those who published afterwards, and more of a celebration (43% versus 29%). 67% of those who published their thesis before the defense reported a perceived increase in their academic competence after the defense, versus 52% of those who published their thesis after the defense ($p = 0.044$). Reversely, more (46%) of those who published the thesis after the defense report an increase in their perception of the publishability of the work than those who published before the defense (27%, $p = 0.005$), which can be explained because a defense with a positive outcome will then be followed by the publication of the thesis. Finally, those who publish their thesis before the defense find it a more valuable experience than those who published after the defense (average values of 8.096 versus 7.176 resp, $p = 0.0053$).

Overall, having a one- or two-step defense did not impact the students' perception much. The only difference is that those with a two-step defense perceived it as more of a ceremony than those with a one-step defense (56% and 39%, resp.). This observation can be explained by the fact that the second step in the two-step defense is indeed more ceremonial in nature, as the student has already passed the internal defense.

Those with a private defense perceived the defense to be more important than those with a public defense (average of 8.018 and 7.08, resp., $p = 0.042$). Those with a public defense perceive their defense to be more formal than those with a private defense (average of 6.722 and 5.407, resp., $p = 0.0018$). Of those who have a public defense, almost half (48.7%) perceive it as a ceremony, compared to only 21.1% of those with a private defense. The perception of academic competence of the students decreased for more cases of those who had a private defense (17.9%) than for those with a public defense (2.6%), but there is no statistically relevant relation between private or public defense and perceived academic competence after the defense. While the literature points towards more potential power abuse in the case of a private defense, the data from this survey do not show a clear improved perception of the defense for the students who had a public defense as compared to those who had a private defense.

The impact of the duration of the defense on the student perception is limited, and only few dimensions of student perception seem to correlate to the length of the defense. Figure 4 shows that the perceived formality of the defense decreases as the defense duration increases ($p = 0.007$ with a Kruskal-Wallis test). There is however no influence of the duration of the defense on the perceived difficulty. Shorter defenses can be more formal in nature and serve as confirmations, while longer defenses may feature more in-depth questioning by the committee. This explanation is also supported by the results of the purpose of the defense: of those who had a defense of less than an hour, 54.2% perceived the defense as an examination, versus 90% of those with a defense of over three hours. Conversely, 75% of the respondents who had a defense of less than an hour described its purpose as a ceremony, versus 33.3% of those with a defense between 1.5 and 2 hours, 20.9% of those with a defense between 2 and 3 hours, and 60% of those with a defense of more than 3 hours.

4.3.3. Minor elements of the defense format

Receiving committee feedback before the defense improves the students' perception. Those who received committee feedback before the defense enjoyed the defense more than those who did not (average of 7.19 versus 6.00, $p = 0.0019$ using a Wilcoxon rank sum test). Those who received committee feedback before the defense consider it more of a ceremony (48.6%) than those who didn't (34.0%) and more of a celebration (41.3%) than those who didn't (25.5%). When a student has

already received feedback, and potentially also already incorporated this feedback, the student experiences less uncertainty before and during the defense.

Similarly, the candidates who had an idea of the recommendation of some or all committee members prior to the defense had a more positive perception that those who didn't. Those who did not have an idea of the recommendation for their thesis and defense were more nervous after the defense but before hearing the outcome (average = 4.68 on a 0-10 Likert scale) than those who knew from all (average = 2.86) or some (average = 3.65) of their committee members ($p = 0.0028$ using a Kruskal-Wallis test). Those who knew the recommendation of all committee members enjoyed themselves more (average = 7.45) than those who knew of some (average = 6.84) or none (average = 6.16) of the committee members ($p = 0.0246$). Similarly, those who did not know the recommendation experienced the defense as more important (average = 8.047) than those who knew of some (average = 7.372) or all (average = 6.306) committee members ($p = 0.0008$). On the other hand, those who knew the recommendation of all committee members perceived the defense as more formal (average = 7.245) than those who knew of some (average = 6.045) or none (average = 6.159) of the committee members ($p = 0.0301$). The observations of the sentiments are in line with the result that those who already knew the recommendation of all committee members perceived the defense as more of a ceremony (66.7%) than those who knew of some (47.7%) or none (28.0%) of the committee members. Those who knew the recommendation of all committee members also perceive the defense as more of a celebration (51%) than those who knew from none of the committee members (18.7%). The result of those who knew from some of the committee members is similar (52.3%) as for those who knew of all committee members (51%). These observations can be explained because a student who knows some or all of the recommendations of the committee members is faced with less uncertainties and potential surprises during the defense.

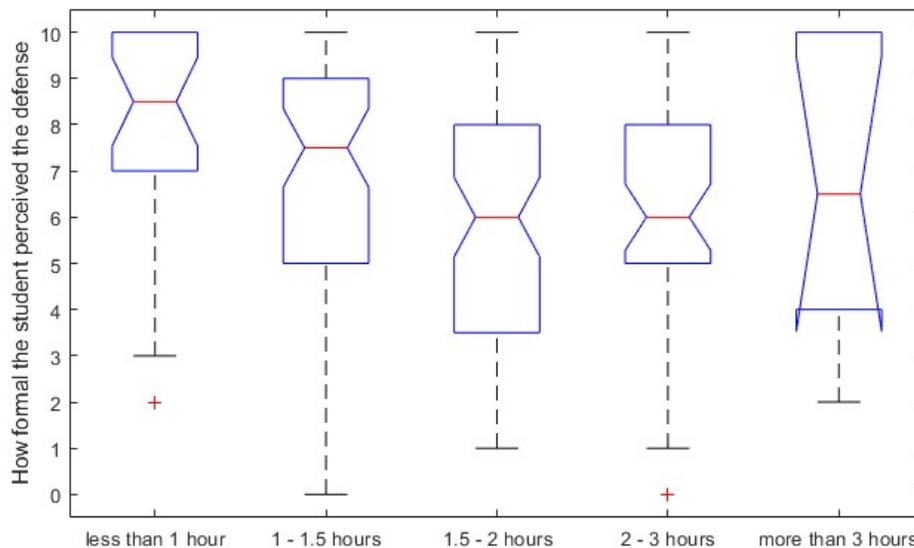


Figure 4. Relation between how formal the student perceived the defense and defense duration.

The committee composition seems not to have an influence on most aspects of student perception. Figure 5 shows the boxplot of the overall value of the defense broken down by the presence of different categories of committee members. While the trend is the same for all categories, the marked lower value is associated with the presence of a committee member internal to the department. Potentially, a committee member who is internal to the department has worked too closely together with the candidate to provide quality feedback. However, more research on committee composition is necessary, and more defenses in which members from the government and industry participated should be studied and correlated to student perception.

Student perception is not correlated to who asked the questions during the defense: all the committee members, some committee members, or any combination in which the audience was also allowed to ask questions. This observation may be explained by the fact that it is not the person who asks the question that matters, but the question in itself.

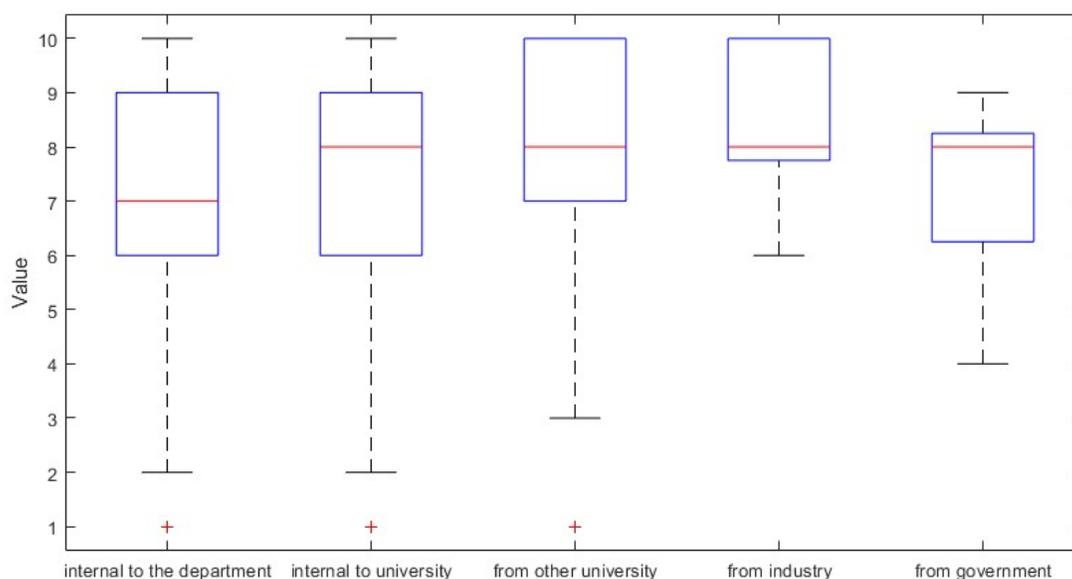


Figure 5. Value of defense as a function of committee composition.

Having a supervisor present during the defense (as committee member or as member of the audience) has a positive impact on the perception of the student. When the supervisor was present as part of the committee (average = 6.671) or audience (average = 6.676), the student felt less nervous before the defense than when the supervisor was not present (average = 8.00), see also Figure 6a ($p = 0.0699$ using a Kruskal-Wallis test, indicating only a weak correlation). During the defense, the presence of the supervisor seems not to matter so much, see Figure 6b. After the defense, not having the supervisor present gives higher nervousness (average = 5.00) than having the supervisor as part of the audience (average = 4.813) or committee (average = 3.698), ($p = 0.053$, indicating only a weak correlation), see Figure 6c. It seems that those whose supervisor is not present during the defense, enjoy the defense less (average = 6.707 for when the supervisor was present as committee member or audience versus 5.706 when the supervisor was not present), but a statistical correlation was not found. When the supervisor is not present, the defense is perceived as more important (average = 8.941) than when the supervisor is part of the committee (average = 7.194) or part of the audience (average = 7.868) ($p = 0.0075$). The defense is perceived as more formal when the supervisor is present (average = 6.322 when the supervisor is part of the committee and average = 7.316 when the supervisor is part of the audience) than when the supervisor is not present (average = 4.938) ($p = 0.0051$). The students perceive the defense more as a ceremony when the supervisor is part of the committee (44.90%) or audience (44.74%) than when the supervisor is not present (11.77%), and more as a celebration when the supervisor is present (38.10% when the supervisor is part of the committee, 26.32% when the supervisor is part of the audience, 17.65% when the supervisor is not present). These sentiments can be explained by the emotional support that the presence of a supervisor gives to a student, regardless of the active participation in the defense.

Having a presentation as part of the defense format seems to have a positive impact on the students' perception, but significant correlations could not be found. Those who had a defense format with a presentation perceived the defense as less important (average = 7.323 on a 0-10 Likert scale) than those who did not have a presentation (average = 8.071), but the Wilcoxon rank sum test p -value equals 0.0787 and $h = 0$, so that a correlation between perception of importance and

presentation cannot be inferred. The defenses that included a presentation were perceived more as a ceremony (45.96%) than those that didn't (26.19%). The defenses that did not have a presentation had more negative impact on the perception of academic competence (19.51%) than those that didn't (6.21%), but a statistical correlation could not be confirmed ($p = 0.6846$, $h = 0$). Similarly, the defenses that included a presentation increased more the desire to work in the sphere of the PhD research (35.4%) than those that didn't include a presentation (17.07%), but a statistical correlation could not be confirmed ($p = 0.2868$, $h = 0$). While these results show no statistical significance, having a presentation as part of the defense format may be positive because it allows the student to prepare for the presentation in advance, as a certain element of the defense, and, when the discussions center around the presentation and the projected material, the student may also feel that they have a better grip on the contents of the defense. These explanations are speculations and require further in-depth research on the function of a presentation during the defense and how a presentation potentially steers discussions during a defense.

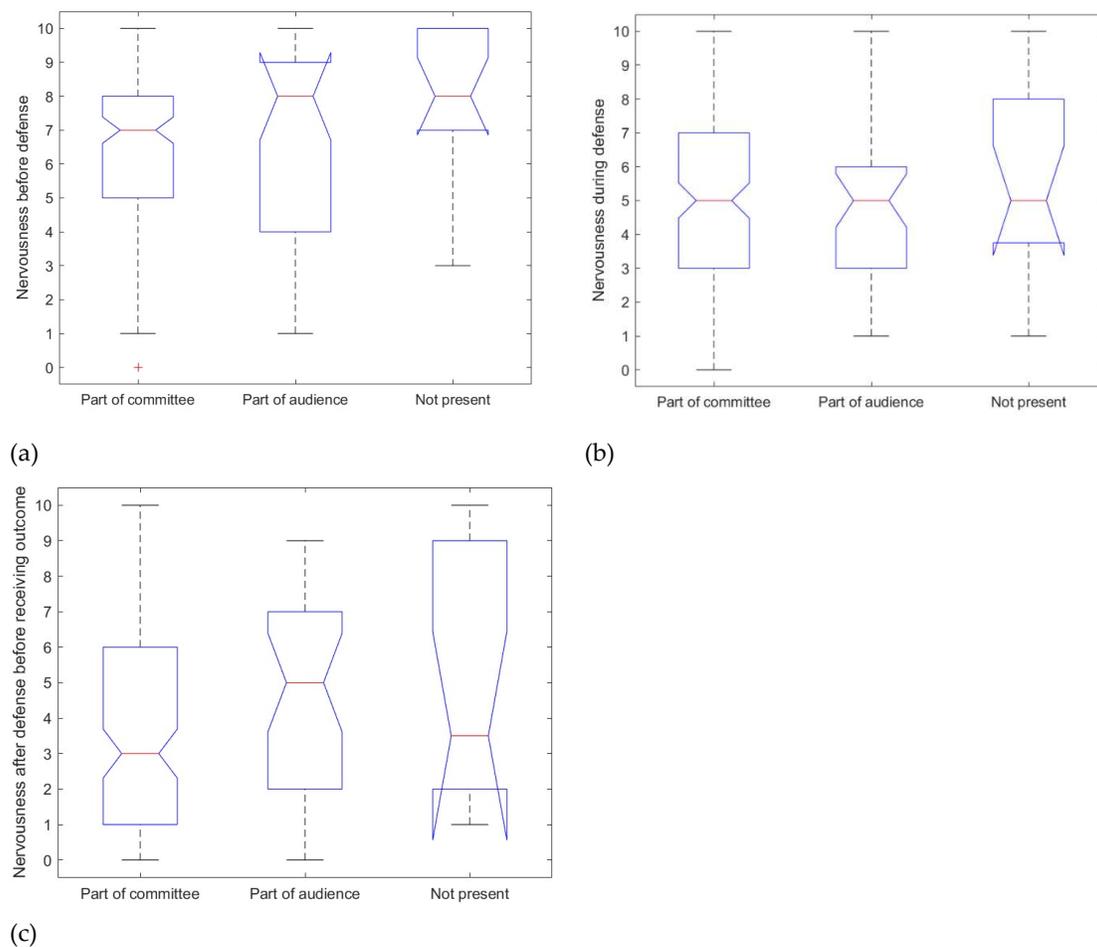


Figure 6. Relation to nervousness (on a 0-10 Likert scale) and supervisor presence: (a) before the defense, (b) during the defense, and (c) after the defense and before receiving the outcome.

Overall, there seems to be no correlation between virtual or in-person defense and student perception. When all committee members were present, the defense was perceived as more formal (average = 6.678) than when some (average = 5.714) or all (average = 5.500) were connected remotely, see Figure 7 ($p = 0.0547$). The overall value of the defense was rated slightly lower for those who had a fully remote defense (average = 6.889) as compared to those who had some committee members connecting remotely (average = 7.324) or all members present (average = 7.605), but the statistical test showed no significance. Other dimensions of student perception did not correlate to whether the

defense was in-person or remote. This observation may indicate that in the COVID-19 pandemic, all parties involved managed to deliver a more or less similar experience to the students defending their doctoral thesis as before distancing measures were in place.

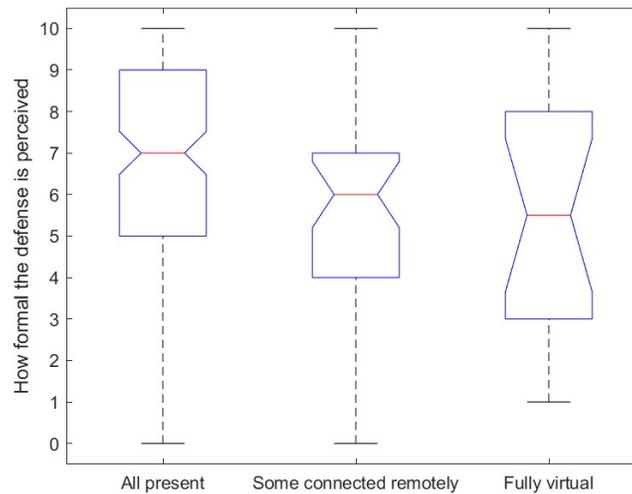


Figure 7. Perceived formality of defense as a function of in-person or (fully) remote committee.

A more formal dress code seems to positively impact the students' perception. Both the students' enjoyment ($p = 0.0018$) and the overall perceived value (Figure 8, $p = 0.0008$) of the defense are correlated to the dress code of the defense. Recoding the data into the group with a dress code and without a dress code, I find that the average perceived value for the defenses with a dress code (avg = 8.2985) is higher than those without (avg = 7.0379), $p = 3.7 \times 10^{-4}$ and that the average enjoyment (avg = 7.4615) is higher for those with than for those without (avg = 6.2061) a dress code, $p = 0.0018$. Using a more formal dress code could be seen as a way to clearly mark the defense event, and may make the experience more memorable for the student.

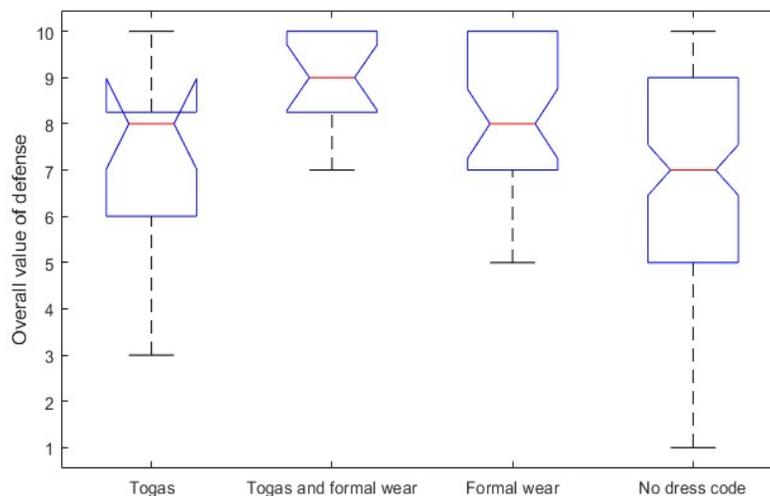
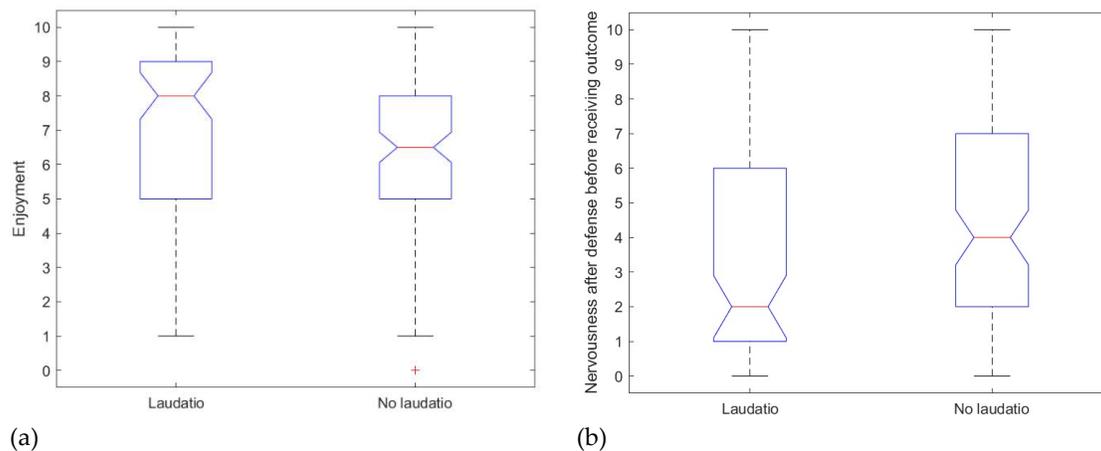


Figure 8. Overall value of the defense as a function of the dresscode.

When the defense contains other elements than only the research, students tend to rate the overall value of the defense higher (avg = 8.222) than when the defense is based on the research only (avg = 7.345), $p = 0.0548$ with a Wilcoxon rank sum test, but $h = 0$, indicating that the null hypothesis cannot be rejected. Other aspects of the emotional dimension of the student perception show no

correlation to whether the defense contains other elements or not. In terms of the function of the defense, I observed that a defense that contains other elements is perceived more as a celebration (55.6%) than a defense that doesn't (30.9%). A potential explanation is that students for whom the defense format includes other elements can showcase their knowledge over a broader range of topics or skills, and enjoy this opportunity. However, only 13% of the respondents had a defense format that included other elements than only the research in the thesis, and these additional elements varied widely. Further research is necessary to study the different additional elements that can make up the defense, and how each of these elements separately is rated and perceived by the students.

Generally, a laudatio has a positive impact on student perception of the defense. Students whose defense format contained a laudatio enjoyed their defense more (average = 7.405) than those who didn't (average = 6.061) ($p = 0.0003$), see Figure 9a. There is no relation between defense formats with or without a laudatio and nervousness before and during the defense. However, those who have a defense format with a laudatio are less nervous after the defense (average = 3.421), while waiting for the outcome, than those who do not have a laudatio (average = 4.455) ($p = 0.0121$), see Figure 9b. A defense with a laudatio is perceived as more formal (average = 7.60) than a defense without (average = 5.513) ($p = 7.49 \times 10^{-9}$), see Figure 9c. A defense with a laudatio is also perceived as more difficult (avg = 6.318) than a defense without (avg = 5.586) ($p = 0.0111$), see Figure 9d. In terms of perception of the function of a defense, the results show that a defense with a laudatio is perceived less (72.09%) as an exam than a defense without a laudatio (82.76%), more of a ceremony (63.95% for a defense with a laudatio and 25.86% for a defense without) and more of a celebration (47.67% for a defense with a laudatio and 24.14% for a defense without). Finally, in terms of overall value of the defense, the perceived value of a defense with a laudatio is higher (avg = 8.168) than a defense without (avg = 6.922) ($p = 0.0002$), see Figure 9e. A laudatio marks the formal appreciation of the supervisor for the newly graduated doctor, and as such makes the defense a more memorable event, which is more positively evaluated by students than a defense without a laudatio.



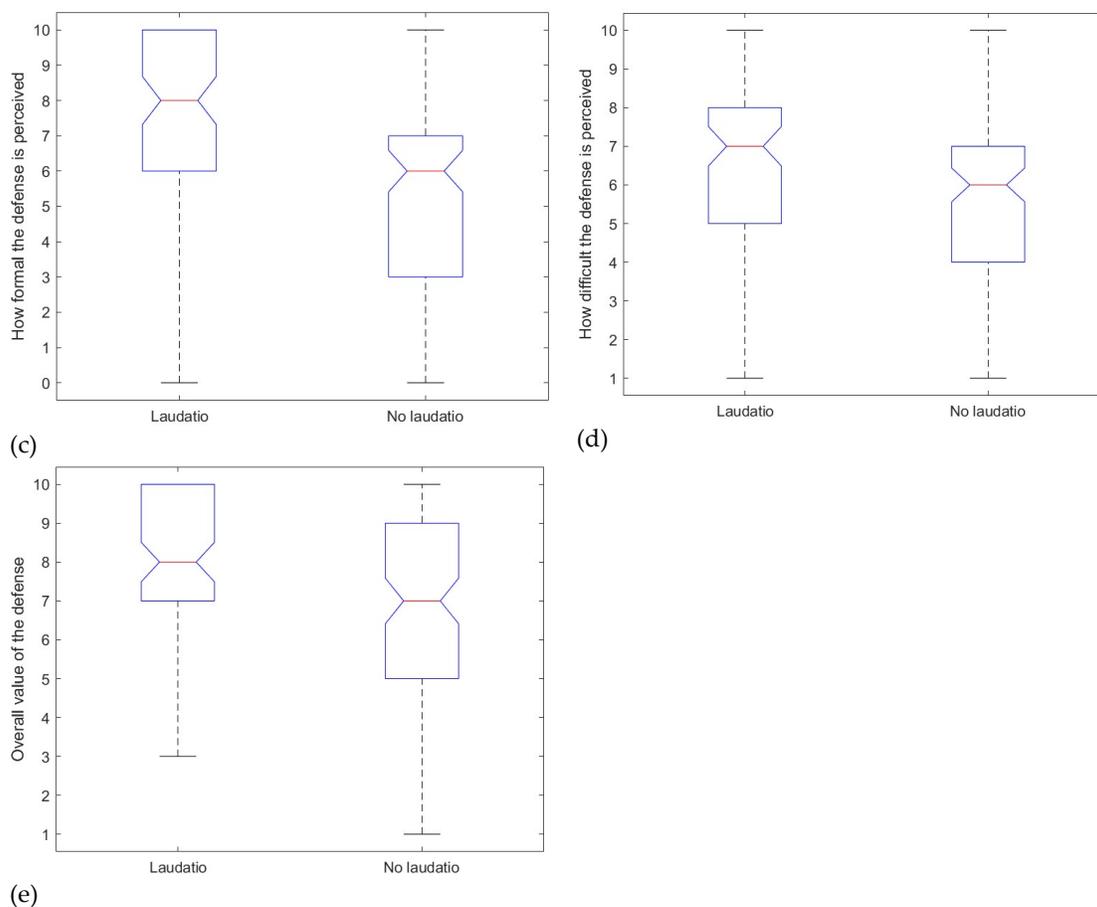


Figure 9. Relation between student perception and a laudatio: (a) enjoyment, (b) nervousness after defense and before receiving outcome, (c) formality, (d) difficulty, (e) overall value of defense experience.

There is a limited influence of language nativeness on student perception. Language nativeness does not influence nervousness, enjoyment, perceived importance, and overall value of the defense, but it does influence the perceived formality of the defense ($p = 0.0076$), see Figure 10. Non-native speakers got the largest boost in their perception of academic competence. A large majority (70.1%) of those who defended as non-native speakers and 76.2% of the near-natives to the language of the defense reported that the defense increased their perception of academic competence. These values are in contrast to 47.6% of the native speakers reporting a perceived increase in academic competence. These results may be explained by the hypothesis that in hindsight non-native speakers feel prouder of obtaining their doctorate in a language that is not their native language than for those who achieved the doctorate in their native language. The non-native speakers have to both master the research topic and the language to a high level. However, how being a native language speaker impacts students' perception and perceived competence is a large and complex topic [20] that is outside the scope of the current study.

5. Discussion

Since this work represents the first study that attempts to link elements of the defense format to students' perception of the defense, a direct comparison with previous work is not possible. However, several aspects of this work allow for comparisons to findings from the literature.

The first aspect to discuss is the influence of the major elements of the defense format on students' perception. Those major elements of the defense formats are those elements that I identified in previous work [22] as those elements that have the largest impact on how the defense is

carried out, and on the function of the defense in a student's trajectory towards obtaining the doctorate and graduating from the PhD program. From these five major elements, I found that the only element that had an influence on students' perception is whether the thesis is published before the defense or after the defense. I did not have sufficient data to make conclusions about the difference between a written and oral defense format.

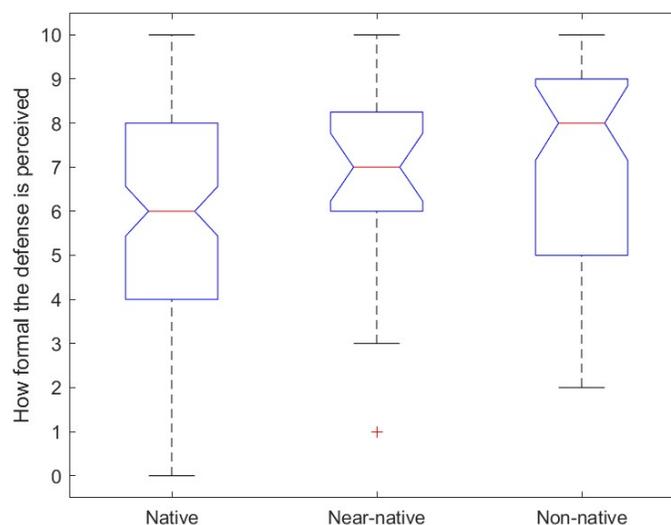


Figure 10. Perceived formality of defense as a function of language nativeness.

Defending the thesis in one or two steps does not have a significant impact on the students' perception. Similarly, I found from the data that the influence of having a public or private defense on students' perception is limited. It has been suggested that private defenses more often lead to abuse of committee members [10] as the committee members may feel less scruples about their misbehavior behind closed doors. However, I did not find evidence for this suggestion in this set of data. The results seem to indicate that what matters is how the committee members behave during the defense, regardless of them being in closed quarters or not. The fifth and final main difference in defense formats is whether the defense format follows a fixed time schedule or can be driven by the committee. I replaced this element with the duration of the defense, as answers in the "other, please explain" textbox indicated that this question allowed for multiple interpretations. The impact of the duration of the defense on the student perception is, again, limited. Students do not seem to perceive defenses that take more time as more difficult defenses.

The second overall aspect to discuss here is the overall influence of the minor elements of the defense format on students' perception. These minor elements of the defense formats are elements that I identified in previous work [22] as differences that have only a limited impact on the overall timeline of the defense. Some of these could be considered just cosmetic differences in the look and feel of the defense. The first element is related to the level of input a student has from the committee on the thesis before the defense. Receiving committee feedback before the defense improves the students' perception. Similarly, knowing the recommendation before the defense improves students' perception, as these two dimensions take away uncertainties about the defense and the opinion of the committee. In the open-ended questions, respondents indicated in a few cases misbehavior of committee members. These difficulties have been addressed previously in the literature as well [9]. Moreover, one respondent also reported a male committee member displaying negative behavior against feminist scholarship, which has also been reported in the literature previously [10, 12]. Misbehavior and unprofessionalism on the side of the committee members is not something that can be avoided by having a certain defense format, but requires careful selection of committee members within collegial networks.

Committee composition has no impact on students' perception, except that having a committee member internal to the department resulted in a slightly lower overall value. Student perception is not correlated to who asked the questions during the defense: all the committee members, some committee members, or any combination in which the audience was also allowed to ask questions resulted in similar levels of students' perception.

A second less important element of the doctoral defense format is the presence or lack thereof of the supervisor. Having a supervisor present during the defense (as committee member or as member of the audience) has a positive impact on the perception of the student. This observation is in line with what Watts [2] called the psychological and practical elements of support the presence of the supervisor can bring. This observation is also in line with what Jacobs [35] mentioned: "*Knowing that you've got at least one person in the room who truly does 'have your back' is huge.*" I, however, assume here that this statement may only be true when the relation between the candidate and supervisor is based on support, trust, and mutual respect. A third minor element of the doctoral defense is whether the defense included a presentation or not. Having a presentation as part of the defense format seems to have a positive impact on the students' perception, but significant correlations could not be found. My hypothesis here is that students feel less like they are "*preparing in the dark*" [2] when they are preparing the actual presentation that they will give, and when potentially the questions are centered around the projected information. However, statistical support is lacking at the moment, and a possible explanation for this lack of statistical proof may be that a presentation can be used in various ways, which each have various impacts on the student. A presentation at the beginning of the defense for friends and family may be perceived differently as a presentation which forms the core of the discussions. A fourth minor element is how the committee members participated in the defense: virtually or in person. Overall, there seems to be no correlation between virtual or in-person defense and student perception.

A fifth minor element is related to the dress code during the defense. A more formal dress code seems to positively impact the students' perception. While such an element may be dismissed as only a cosmetic difference, the use of a more formal dress code does seem to correlate to more positive perceptions of the student. Similarly, including a laudatio at the end of the defense has a positive impact on the perception of students. These festive elements seem to help make the defense a more memorable and positive experience for students. A seventh and final minor element is whether the defense focused on the research only, or if it included other elements. When the defense contains other elements than only the research, students tend to rate the overall value of the defense higher. However, since the types of additional aspects that can be included in a defense vary, further research is necessary to correlate these different elements to the students' perception.

One overall finding is that the data of this study show that students find the defense a positive experience. This study highlights that the defense should not be abolished, but that we should seek to improve it. We can frame these discussions in the light of internationalization and the need for best practices. The observation that the defense is a valuable experience answers a question about the value of the defense as asked by Wellington [3].

In terms of research on perceptions of supervisors related to the defense format, Goulding and Geraghty [44] carried out a survey regarding the implementation of European standards into UK doctoral education in the field of pharmacology. The responses, as well as interviews with supervisors and sentiments expressed during a workshop on this topic, overwhelmingly showed that UK supervisors are convinced that the UK *viva* in its format is to be preferred over the continental defense, which includes iterations towards the final dissertation and defense by processing committee feedback. This perception of supervisors is in contrast to research outcomes from the literature which show the particularities and drawbacks of the closed British defense [5, 7, 17]. In this study, however, the only element of difference between the continental and British defense formats that was found to have an impact on students' perceptions is whether the thesis is published before or after the defense.

From the qualitative analysis of the open-ended questions, I also conclude that a student's perception of the defense is a very personal experience. As identified in the literature [10, 17, 45], the

affective level of the doctoral defense, and the doctoral journey at large, is as important as the scholarly and cultural levels. Yet, most of our attention focuses on the scholarly level, whereas the affective and cultural levels often are neglected. One of the insights of Sikes [9] draws on the commentary of Davies [46] that neoliberal governments want to consider everyone as having measurable and manipulative characteristics, so that any student can be considered as an object that can be categorized and made predictable. In the light of doctoral assessment, such characteristics, categorization and predictability do not reflect the messiness, subjectivity, and emotional dimensions involved with the doctoral defense. As such, it is necessary to acknowledge this, and share experiences. By focusing on the experiences of students in this work, I hope to start the discussion on how the affective level plays a role.

The limitations of this study are related to the self-selecting sample of respondents. Most of the respondents were recruited through Twitter and LinkedIn, as well as by email. While over 30 countries are represented in the survey, the regions that are most represented in the survey are also the regions where I personally know most people and/or where I have worked, lived, and studied myself. A second limitation of the current study is that the data comes only from students recalling and describing their experiences in hindsight, rather than from direct observation or written reports. This issue is often faced when researching doctoral education [10]. A third limitation is that minorities are not well-represented among the respondents.

Based on this study, I identify potential topics of further research. The first topic that requires further research is related to the inclusion or not of a presentation, as well as other elements, during the defense. To clarify these aspects, further research on the function of the presentation during the defense, and how a presentation potentially steers discussion during a defense is necessary. Similar questions remain to be answered about the other elements that can be included in a defense format. Moreover, more research on committee composition is necessary. In particular, more defenses in which members from industry and/or the government participate should be studied, and correlated to student perception.

Other topics that require further research are: exploring how minorities experience the doctoral defense, widening the geographical breadth of the analysis of defense formats, in-depth interviews with recently graduated doctoral candidates, a study on the role of committee members and supervisors on students' perception, a study on the influence of the preparation for the defense on the defense experience and outcome, and a further study on how socio-demographic factors impact students' perception.

6. Conclusions

In this article, I report on a survey that I carried out on doctoral defense formats and the perceptions of students. From the data, I studied these elements separately, and also studied which elements of the doctoral defense format and students' perception are correlated. The following elements were found to positively impact the student perception of the doctoral defense:

- Publication of the thesis before the defense.
- Receiving committee feedback before the defense.
- Knowing the recommendation of one or more members of the committee before the defense.
- Having the supervisor present in the defense as committee member or in the audience.
- Using a formal dress code and/or academic togas during the defense.
- Including a laudatio at the end of the defense.

Two elements were found to positively impact the student perception of the doctoral defense, but require further study as no statistical significance could be found. These elements are including a presentation in the defense format, as well as including other elements outside of the thesis research in the defense format.

Of the five major differences in defense formats, only the element of publishing the thesis before or after the defense was found to have an impact on the students' perception of the defense. Reversely, of the seven minor differences in defense formats, six elements impact the students'

perception of the defense. While these minor differences do not impact the overall timeline of student's trajectory towards obtaining the doctorate, they change the look and feel of the defense. Since the emotional level of the doctoral defense is important, it is actually the details that can improve how students feels during the defense, and how they reflect back on the defense afterwards.

A second major finding of this work is that the doctoral defense is, on the average, considered to be a valuable experience. As such, the data indicates that we should not seek to abolish the doctoral defense, but to improve the defense.

While we should strive to come to a defense format that can be considered a positive experience for the student, one of the conclusions of this work is that two elements that are outside the reach of the defense format have a large influence on the students' perception of the defense. The first element is the personal experience and feelings of the student before, during, and after the defense. Since a personal experience is vastly subjective, it is difficult to "control" the experience through a defense format. Supervisors and committee members should be aware of and sensitive to the emotional dimension of the defense for the student. The second element that has a large impact, and that was observed clearly from the qualitative analysis of the open-ended questions, is the behavior of committee members during the defense. Regardless of the defense format, a committee member can focus all effort on questions that are only tangentially related to the thesis, or behave poorly (by, for example, arriving late). Here, the development of guidelines and best practices for committee members could be a solution, as well as training of supervisors and committee members on how to positively participate in doctoral defenses.

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