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CRISES IN A DOCTORAL RESEARCH PROJECT: A COMPARATIVE STUDY

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ABSTRACT

Aim/Purpose: To present quantitative results of an investigation that assessed crises reported by doctoral candidates while working toward their degree.

Background: Crises that candidates encounter during their doctoral journey may lead to attrition from the doctoral program. A crisis in a doctoral project has several characteristics that must be understood in order to identify the crisis and, if possible, take corrective actions. Our study investigates various types of potential crises and the way candidates experience them.

Methodology: We conducted a survey among enrolled doctoral candidates at five universities in Israel and three technological universities in Western Europe. We compared the answers of Israeli Social Sciences and Humanities candidates with those of Israeli Science and Engineering candidates; we also compared the answers of Israeli Science and Engineering students with their Western European peers. We applied statistical analysis to identify and compare significant patterns of reported crises among these three groups of candidates. In addition, we tried to find significant relationships between the reported crises and selected parameters that characterize the candidates' background and learning habits.

Contribution: The research presents quantitative results of typical crises patterns in a comparative study. It shows that while many candidates experience crises, few seek professional assistance.

Findings: Our investigation showed that about 60% of enrolled doctoral candidates reported a crisis. Of the candidates who reported crises, about 70% did not seek professional assistance. Emotional crises were reported by a significantly higher percentage of Social Sciences and Humanities students than of Science and Engineering students. Conversely, expectation crises were reported by a significantly higher percentage of Science and Engineering students than of Social Sciences and Humanities students. Significantly, more Social Sciences and Humanities students reported economic crises than did Science and Engineering

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	students. Students who experienced a crisis reported that it caused delays in the research and affected its quality. As a result of their crisis, over 25% of Science and Engineering students seriously considered terminating their studies.
Recommendations for Practitioners	The results and discussion may be useful as a guide for advisers to better understand the formation of crises among their doctoral students.
Recommendation for Researchers	The quantitative methodology presented in the paper may be applied to investigate additional phenomena in the field of doctoral studies.
Impact on Society	The paper demonstrates that doctoral students are aware of potential crises due to the stressful environment they face. By reducing the number of crises, it may be possible to reduce the current rates of attrition, which have a significant impact on national economy.
Future Research	In future work we plan to expand the research to include the US in the comparative study.
Keywords	crisis in doctoral research, adviser-candidate relationship, doctoral education

INTRODUCTION

A crisis is defined as an emotionally significant event or radical change of status in a person's life ("Crisis," n.d.). A crisis in a doctoral project has several characteristics that must be understood in order to identify it and, if possible, take corrective actions. A severe crisis is one that leads to failure to complete the doctoral program. Many other crises may, however, be recoverable, if they are recognized at an early stage and addressed by the candidate or the adviser. Delamont, Atkinson, and Parry (1997, p. 12), who interviewed scientists and social scientists on the topic of supervising a PhD, quote Dr. Gastineau, faculty member in development studies at Gossingham University (both names being pseudonyms):

> "*DPhils are terrible things, and I don't yet know a DPhil student who didn't go through a financial crisis, a mental crisis, a supervisor crisis or an emotional crisis, that's why it's such an appalling system.*"

In this paper we use the term crisis similarly to its meaning in the above citation. Other researchers prefer to use different terms to express emotionally significant events. For example, Vekkaila, Pyhältö, and Lonka (2013) explored doctoral students' experiences of disengagement from their doctoral processes. They found that activities that trigger disengagement typically include struggles and conflicts within the scholarly community and reported that problems in the research itself were less frequently found to be the main source of disengagement. Katz (2009) classified crises that may occur during a doctoral research project: adviser crises, professional crises, expectations crises, emotional crises, survival crises, and international student crises. In the next section we will review the literature related to each of these crises.

We distributed a uniform questionnaire to doctoral candidates at five Israeli research universities and three universities in Western European countries – Italy, Portugal, and Switzerland. We first compared opinions of Israeli students from different academic disciplines, i.e., social sciences and humanities (SS&H) vs. natural sciences and engineering (S&E). Disciplinary differences in opinions within universities were previously studied by Becher (1994). He explained that academic disciplines have their own particular cultures, codes of conduct, and intellectual tasks that influence the experiences of the students. We also compared opinions of S&E doctoral students from Israel and from Western Europe. Since Israeli universities have been participating in the EU Programs for Research and Innovation (Horizon 2020), it was interesting to compare the opinions of S&E candidates from

both regions. In these collaborative European projects, teams of scientists from Europe and Israel collaborate on interdisciplinary projects, working in joint research teams.

According to Gardner and Gopaul (2012), attrition rates for full time doctoral students are in the range of 40-50%. Jones (2103) reported that attrition rates may be even higher, from 33% to 70%. Stress and isolation were found to be prime contributors to the phenomenon of attrition (Ali & Kohun, 2007). Stress and isolation, as well as economic pressure and poor relations with the adviser, are also the key factors leading to crises among doctoral students. Better understanding of crises' sources and of their patterns may assist in reducing students' dropout rate from doctoral programs. The main objective of this study was to identify patterns of crises in doctoral research projects and investigate parameters that may affect such crises. By analyzing candidates' responses to our questionnaire, we may learn whether doctoral students are aware of potential crises, whether they used professional support when needed, and how those crises affected their doctoral research. We also conducted a statistical investigation of four research questions: Do external, part time students report more crises than internal students? Is there a connection between the number of weekly hours devoted to studies and the development of crises? Does the frequency of meetings with the adviser influence crisis appearance? And finally, do students who report that they love their research and enjoy their life as candidates experience less crises?

LITERATURE REVIEW

As mentioned in the Introduction, Katz (2009) classified crises in a doctoral research into six categories: adviser crises, professional crises, expectations crises, emotional crises, survival crises, and international student crises. In the following paragraphs we will review the literature related to candidates' relations with their advisers, academic challenges, and unmet expectations from the doctoral program, emotional problems, economic survival of candidates, and challenges that face international doctoral students.

STUDENT-ADVISER RELATIONSHIP

Adviser crises may arise against the backdrop of repeated disagreements with the adviser and, at times, a lack of "chemistry" between the adviser and the advisee. Lovitts and Nelson (2000) explained that the most important factor in a student's decision to continue or withdraw from a doctoral program is their relationship with the faculty adviser. Students who complete their degree express higher satisfaction with their faculty advisers than do students who leave the program. Ranking high among the reasons for attrition during the first year of graduate school is adviser mismatch or disagreements with the adviser (Golde, 1998). A concerned faculty adviser is the best person to evaluate an individual's progress and strengthen the student's sense of self-esteem. A poor relationship between the student and his or her adviser will detrimentally affect a doctoral project regardless of any or all of the other elements that may support it (Jones, 2013). According to Protivnak and Foss (2009), many students feel that the mentoring they received was the most supportive experience of their doctoral studies and, conversely, some students had difficulty with their doctoral mentoring and felt abandoned. The supervisory relationship has been identified as one of the main factors influencing student satisfaction and their success or disappointment (Jairam & Kahl, 2012). Gardner (2010) stated that the isolation that accompanies doctoral studies must be balanced with peer or supervisor support, otherwise isolation can lead to attrition. Good relations with the adviser were found to be critical for the candidate's well-being and success. Vekkaila et al. (2013) described doctoral students' experiences of disengagement from their doctoral processes. Such problems often originate from the relationship between the doctoral student and the adviser. Mason (2012) stated that having a collegial relationship with advisers is also critical for student satisfaction and motivation, so these relationships should be encouraged. In summary, the supervisory relationship is likely to "make or break" the doctoral candidature (Jones, 2013).

Professional Concerns

The term "professional crisis" refers to a student's unsatisfying performance as a researcher and the enormous stress this situation causes. It relates to a candidate's fears of not advancing well in the doctoral research and negative feelings that arise as a result. Some doctoral candidates are concerned that they will not be able to deliver novel and valuable academic findings to write a doctoral dissertation (Katz, 2009). Juniper, Walsh, Richardson, and Morley (2012) discovered a broad range of concerns anticipated by candidates about candidature. Prominent among these was concern about the "experience of research", about the ability to make the transition from being a good course-taker to a researcher, as unmet research expectations may hinder progress and cause distress. Kiley (2009) found that many doctoral candidates go through at least one stage during their candidature when they may be defined as being "stuck" as they encounter a specific threshold concept that especially challenges them. The experience of being stuck can manifest as depression, a sense of hopelessness, "running round in circles" and so on, or in other words, a feeling of crisis. Being stuck in ways that can be counter-productive and perhaps even destructive to self-confidence and self-esteem can have serious consequences for learners; they may, for example, lose the will to remain in the program and feel unable to complete it in a timely fashion. Holbrook et al. (2014) explained that doctoral study is a difficult task, and many candidates seem to underestimate both the difficulty of completing a doctoral research as well as other intellectual and emotional pressures. This accounts for the shock some candidates described feeling when they discovered that they were not as prepared as they had believed they were. Kandiko and Kinchin (2012) noted that candidates are unable to envision the demands of a PhD; helping them clarify these demands may reduce their stress.

Expectations and Reality

The "expectation crisis" expresses the disappointment of some candidates from the doctoral program and the stress that comes with the feeling that they are "wasting their time". Reality may be quite different from the ideal picture of doctoral studies that some candidates have portrayed for themselves. If the gap between such students' expectations and daily reality is too large, it may lead to a crisis. The intensity of the crisis depends on how large that gap is (Katz, 2009). Holbrook et al. (2014) studied the initial expectations of doctoral candidates and correlated them with candidate satisfaction and well-being, finding that a satisfied student naturally feels good as a candidate in a doctoral program. The expectations crisis may be also called a crisis of a dream-failing-to-come-true. The first-year doctoral experience often leads students to question whether they made the correct decision in pursuing a doctorate degree, leading to high attrition rates at this early stage of these students' doctoral programs (Jairam & Kahl, 2012). There is evidence that the gap between expectations and experience during candidature can lead to dissatisfaction and dropout (Bair, Grant Haworth & Sandfort, 2004; Golde, 2005). Expectations during a doctoral program refer to the candidate's predetermined ideas of what will occur during their candidature and after graduation. These might range from expectations concerning career to expectations regarding supervision and study demands (Bieschke, 2000). Golde (1998) found that in the humanities, the main two reasons for attrition from the doctoral program were that the practice of the discipline did not meet expectations and that the academic life did not meet expectations either. Wadman (1998) reported that increasing numbers of graduate students and postdoctoral fellows in life sciences are failing to find long-term jobs. This situation has created a crisis of expectations among young doctoral scientists in that field. In a study on attrition, Lovitts (2001) found that students who left their doctoral program, entered graduate school with inappropriate expectations about what research is really about (p. 25).

Emotional Challenges

An "emotional crisis" describes a situation in which candidates have to deal with deep and sometimes overwhelming feelings that might distract them from concentrating on the daily tasks of their doc-

toral research project (Katz, 2009). Holbrook et al. (2014) cite students expressing their experiences as candidates:

> *"I was prepared for it to be hard intellectually…but no one said to me that it is really isolating and that depression is really a big factor in PhD students' lives…I would have really liked someone in the faculty who could have given me more emotional support"*

Eisenberg, Gollust, Golberstein, and Hefner (2007) conducted a comprehensive study that included 2,843 students and found that the estimated prevalence of any depressive or anxiety disorder was 13.0% among graduate students. Furthermore, students reporting financial struggles were at higher risk for mental health problems. Ali and Kohun (2007) described two particular issues that contribute to the development of a feeling of isolation among doctoral students. First, students feel isolated because they are confused about the program and its requirements. Second, students feel lack or insufficient communication with their adviser or with other students.

Survival Problems

A "survival crisis" refers to the practical aspects of a doctoral candidate's life, to his or her financial or economic situation. Students who received fellowships or research assistantships had higher completion rates and shorter times-to-degree than students who received teaching assistantships or tuition waivers, or who were totally self-supporting (Ehrenberg & Mavros, 1996). A major finding in this study was that the impact of financial support patterns on the fraction of students who complete programs was much larger than its impact on mean durations of times-to-degree. Appel and Dahlgren (2003) studied different aspects of student insecurity such as financial insecurity, insecurity concerning one's own capacity, and difficulties combining an academic career and a family. Each of these insecurities may become the first step towards attrition. Students reported that uncertainties concerning financial support were stressful and had a negative effect on their research. Lovitts (2001) wrote that deans of graduate studies explained that the primary reason for student attrition is lack of financial resources (p. 22). Neumann (2007) identified numerous factors that can hinder a student's doctoral experience, among them financial and resource issues.

The International Student

The "international student crisis" is related to the challenges that international students face, namely language and culture, isolation and loneliness. Hyun, Quinn, Madon, and Lustig (2007) reported that approximately 44% of international graduate students reported having an emotional or stress-related problem that significantly affected their well-being or academic performance. International students who reported having good relationships with their advisers or as feeling greater financial confidence were less likely to report having an emotional or stress-related problem. Trice (2007) stated that many international students are isolated from their local peers and suffer from loneliness and depression. They often face significant challenges, including adjusting to different values and a new educational system. Faculty interviewed believed that the strong ties international students form with co-nationals, their weak English skills, and their lack of time to invest in friendships all play a role in their isolation. Erichsen & Bolliger (2011) explained that international graduate students depend more on student-adviser relationships in building social networks. Advisers need to be more aware of their role and contribution to the development of international scholars' social networks. It is well recognized that the graduate student experience can be stressful, and it is especially so for international students.

GOALS OF THE STUDY

The first goal of this study was to identify typical crises in doctoral research projects and their patterns, and specifically:

- To compare crises patterns that characterize different academic disciplines in Israel; and
- To compare crises patterns of S&E candidates from Israel with those of S&E candidates from Western Europe.

In addition, we tried to find a relationship between selected parameters that characterize doctoral candidates' background and learning habits and the reported crises with the objective of addressing four research questions:

- Is there a relationship between being enrolled as an external candidate and the number of crises reported?
- Is there a relationship between time invested in research and the number of crises reported?
- Is there a relationship between the frequency of student-adviser meetings and the number of crises reported?
- Did students who stated that they love their research and enjoy their life as candidates report less crises?

We compared answers from Israeli candidates in different disciplines and from Western European S&E students.

METHODOLOGY

Doctoral candidates at five leading Israeli research universities and at three leading European technological universities, in Italy, Portugal and Switzerland, participated in the study. The research survey consisted of a uniform questionnaire of multiple-choice questions. The questionnaire was sent to the personal email address of all doctoral candidates enrolled at each of the eight research institutions. Students were asked to reply anonymously and submit the answers as a Google Docs file. In all, over 10,000 candidates received our questionnaire. The typical rate of reply from each university was in the range of 12-18% with a mean of 16.4%.

Although this response rate may be regarded low, two references that studied email surveys sent to students show response rates in the same range. In a study by Kaplowitz, Hadlock, and Levine (2004) about 17,000 questionnaires were sent to Michigan State University students receiving response rate of 20.7%. Sills and Song (2002) sent 4,635 questionnaires to Arizona State University enrolled international students with response rate of 22%. In both surveys the university sent an administrative survey to its enrolled students, unlike in our survey that the students received a request to assist a third-party researches whom they did not know.

Saldivar (2012) presents an interesting discussion on the relations between response rates and the possibility of nonresponse bias. The contemporary literature on survey research generally views higher response rates as useful for reducing the possibility of nonresponse bias. However, citing a study by Groves (2006) he wrote: "there is little empirical support for the notion that low response rate surveys de facto produce estimates with high nonresponse bias."

The survey included 26 questions of which seven questions are included in the current analysis: three that relate to crises and four that relate to our research questions. Katz (2016) presented an analysis of the answers to other survey questions that related to doctorate management. The first four questions on the questionnaire aimed to collect general information: the student's age at enrollment, enrollment status, i.e., internal (full-time) or external (part-time) candidate, their motivation to pursue a

PhD; and their learning habits. Other questions were related to candidate-adviser relationship, research management skills, and candidate's feeling and experience throughout the doctoral studies. Answers were all multiple choice, and the candidates were asked to select and mark one. Candidates were then asked to indicate their academic discipline, choosing one of 17 options. For Israeli universities, we decided to include in the study only academic disciplines that received over 100 responses each. Four disciplines met this criterion: sciences, engineering, social sciences, and humanities. Due to this criterion, we subsequently included only 772, of the 1013 replies received from Israeli students. The second part of the study focused on comparing science and engineering candidates from Israel with their counterparts from the three aforementioned Western European countries. We included in the study answers from 360 of the 457 questionnaires completed by sciences and engineering students in Western Europe. Answers to these 360 questionnaires were compared with answers from 466 questionnaires completed by Israeli science and engineering students. In total, out of the 1420 received responses we included in the analysis 1132 responses from students.

In 2015 the total population of doctoral students in the four participating countries was 87,800 according to Eurostat (2015). For evaluating the required sampling size we assumed in our design the following criterion for confidence level, confidence interval and the population size (CL=.95%, CI=3%, Pop=87,800) and the required sample size is 1055 subjects.

Tables 1, 3 and 4 present the data collected for each of the three crisis-related questions. Each table presents one question and its multiple choice answers, as stated in the questionnaire. When the students were requested to select the type of crisis they experienced, they were restricted to choosing only one type, under the assumption that it will be the most significant one. The questionnaire did not include definitions of each crisis and students were required to choose according to their understanding or intuition. After observing the collected data and analyzing the survey results, we decided to further aggregate the information according to the different academic disciplines. We noted that different patterns characterized answers given by candidates enrolled in "hard science" disciplines, namely natural sciences and engineering (S&E) as opposed to candidates enrolled in "soft sciences" disciplines, namely social sciences and humanities (SS&H). We did not include invalid answers in the statistical analysis; these are denoted in the tables as "not specified." In order to analyze the typical pattern of students' answers to each question, we applied Pearson's chi-square test, which clearly revealed a "different pattern" ($p<0.05$), indicating a significant difference between answers from the compared populations (academic disciplines or countries). In addition, we defined four research questions and analyzed the relationship among parameters using Fisher's exact test and logistic regression procedure.

ANALYSIS AND RESULTS

PATTERN ANALYSIS

In the following paragraphs we reveal patterns found in the candidates' answers to the three questions about crises during the doctoral studies. We wished to learn whether the answer patterns from SS&H students and S&E students in Israel differ significantly. We also wanted to see whether the answers from S&E candidates in Israel and Western Europe differ significantly.

Q1: Have you faced a crisis situation during your research work? What was the background?

About 40% of students replied that they had not experienced a crisis. Table 1 reveals that the most prevalent crisis among Israeli SS&H students was emotional crisis, reported by 18.3% of students, while among Western Europe S&E students, expectation crisis ranks highest, at about 27%. Significantly different patterns emerge when the answers from Israeli SS&H and S&E students who reported a crisis are compared ($DF=4$, $\chi2=34.41$, $p<0.0001$) as well as when comparing the answers from S&E students in Israel and S&E students in Western Europe who reported a crisis ($DF=4$, $\chi2=5.21$, $p=0.0225$).

Table 1: Have you faced a crisis situation during your research work? What was the background?

	Israel		Israel		Western Europe	
	Social Sciences N=153	Humanities N=153	Sciences N=344	Engineering N=122	Sciences N=103	Engineering N=257
Professional	4.58%	5.88%	10.47%	19.67%	11.65%	8.95%
Emotional	18.30%	18.30%	13.37%	8.20%	18.45%	14.79%
Expectations	8.50%	3.27%	12.50%	9.84%	28.16%	26.46%
Economical	11.11%	15.03%	8.14%	2.46%	1.94%	5.84%
Other crises	16.99%	16.99%	12.21%	8.20%	3.88%	5.84%
Not faced a crisis	38.56%	36.60%	42.44%	50.00%	34.95%	37.35%
Not Specified	1.96%	3.92%	0.87%	1.64%	0.97%	0.78%

In addition, we decided to analyze each of the crises categories indicated in Table 1 separately. Table 2 presents the aggregated percentage of Israeli SS&H and S&E and Western European S&E students who reported each of the crises categories. For each crisis category, we compared between the two academic disciplines in Israel (SS&H and S&S) as well as between S&E students in both regions, presenting the calculated chi-square value and p-value for each category. For example, 8.79% Israeli SS&H students reported a professional crisis while 91.21% reported all other crises. On the other hand, 23.62% Israeli S&E candidates reported a professional crisis while only 76.38% reported all other crises (DF=1, and $\chi 2=16.203$, $p<0.0001$). This means that a significantly higher percentage of S&E students faced professional crisis than did SS&H candidates. Table 2 also reveals that a significantly higher percentage of SS&H students reported experiencing an emotional crisis than did S&E students, and a significantly higher percentage of S&E students experienced an expectation crisis compared with SS&H students, significantly more of whom reported an economic crisis compared with S&E students.

Table 2: Statistical analysis of individual crises

	Israel	Israel		Israel	Western Europe	
	SS&H N=182	S&E N=254	Chi-square P-value	S&E N=254	S&E N=225	Chi-square P-value
			DF=1			DF=1
Professional crisis	8.79%	23.62%	16.203	23.62%	15.56%	4.883
Other crises	91.21%	76.38%	<0.0001	76.38%	84.44%	0.027
			DF=1			DF=1
Emotional crisis	30.77%	22.05%	4.225	22.05%	25.33%	0.715
Other crises	69.23%	77.95%	0.039	77.95%	74.67%	0.397
			DF=1			DF=1
Expectation crisis	9.89%	21.65%	10.525	21.65%	43.11%	25.358
Other crises	90.11%	78.35%	0.0012	78.35%	56.89%	<0.0001
			DF=1			DF=1
Economic crisis	21.98%	12.20%	7.429	12.20%	7.56%	2.86
Other crises	78.02%	87.80%	0.006	87.80%	92.44%	0.091

Next, we compared crisis patterns reported by S&E doctoral students in Israel and in Western Europe. We found that significantly more students in Israel reported having a professional crisis than did students in Western Europe. As to economic crises, no significant difference was found between the pattern observed in Israel and in Western Europe ($p=0.397$). A strong difference was revealed in the pattern of expectation crises reported: Israeli S&E students experienced significantly less expectations crises than did S&E students in Western Europe.

Q2: In case you did face a crisis, did you look for professional assistance during the crisis or stress periods (for example, did you see a psychologist or a social worker)

It is interesting to note that among students who reported crisis, over 67% "did not look for professional advice" as indicated in Table 3. Only less than 20% of all candidates who reported crisis "used professional assistance", and about 5% of them "found professional assistance not useful".

No significant difference emerged between the answer patterns of Israeli SS&H and S&E students who did not seek assistance ($DF=3$, $\chi2 =5.378$, $p=0.146$) nor between those of S&E students in Israel and in Western Europe who did not use assistance ($DF=3$, $\chi2=2.129$, $p=0.546$).

These results show that avoiding professional assistance is a common pattern among doctoral candidates. Indeed, the majority of students who experience crisis do not seek professional assistance, which is readily available at most research universities.

Table 3: In case you did face a crisis, did you look for professional assistance during crisis or stress periods (for example, did you see a psychologist or a social worker)

	Israel		Israel		Western Europe	
	Social Sciences N=91	Humanities N=91	Sciences N=195	Engineering N=59	Sciences N=66	Engineering N=159
Used professional assistance	20.87%	20.87%	14.87%	16.94%	12.12%	12.57%
Used & enjoyed professional assistance	0.00%	1.09%	0.00%	1.69%	0.00%	0.00%
Found professional assistance not useful	5.49%	9.89%	4.61%	1.69%	4.54%	5.03%
Did not look for professional advice	69.23%	67.03%	78.46%	76.27%	81.81%	81.76%
Not specified	4.39%	1.09%	2.05%	3.38%	1.51%	0.62%

Q3: In case you did face a crisis, how did it affect your research?

The students who reported crises were asked to describe how the crisis affected their doctoral research. Table 4 summarizes their answers. Analysis of the responses of Israeli students who experienced a crisis revealed that the answer pattern of SS&H students differs significantly from that the S&E students ($DF=4$, $\chi2=42.771$, $p<0.0001$). Over 40% of SS&H candidates reported that their work was delayed and about 25% answered that their work was not affected. Of the S&E students, on the other hand, about 25% reported that they considered stopping their doctoral program, while approximately 25% said that the quality of their research was affected.

No significant difference was found between the response pattern of S&E students in Israel and in Western Europe who were affected by the crisis (DF=4, $\chi 2=3.629$, $p=0.458$). We may conclude that crisis affected the doctoral research of S&E students from both regions in similar ways.

It is interesting to see that facing a crisis affected doctoral research differently in the "soft sciences" as opposed to the "hard sciences". While in SS&H, the doctoral research was mainly delayed or unaffected, in S&E crisis affected the quality of the research and more candidates reached the stressful situation of seriously considering leaving the doctoral program.

Table 4: In case you did face a crisis, how did it affect your research?

	Israel		Israel		Western Europe	
	Social Sciences N=91	Humanities N=91	Sciences N=195	Engineering N=59	Sciences N=66	Engineering N=159
My work was delayed	42.85%	46.15%	24.10%	28.81%	13.63%	27.67%
I seriously considered stopping my PhD	16.48%	16.48%	23.58%	30.50%	28.78%	27.04%
The quality of my research was affected	6.59%	8.79%	31.28%	22.03%	30.30%	24.52%
I decided to leave my adviser	2.19%	0.00%	2.56%	1.69%	0.00%	0.62%
My research was not affected	26.37%	23.07%	15.89%	13.55%	27.27%	16.98%
Not specified	5.49%	5.49%	2.56%	3.38%	0.00%	3.14%

Relationship Between Reported Crises and Other Parameters

Crises reported by external, part-time students

In the General Information section of the survey we asked the students whether they were enrolled as internal, full-time students or as external, part-time students. The answers are presented Table A-1, in the appendix. Our assumption was that external students may experience and report more crises than internal students. To test this assumption statistically, we categorized each reply listed in Table A-1 individually and compared the number of external students and internal students who reported facing a crisis.

Table 5: External candidates and crises

	Israel		Israel		Western Europe	
	SS&H		S&E		S&E	
	N	% students reporting crises	N	% students reporting crises	N	% students reporting crises
Internal student	202	59.90%	422	55.92%	325	62.77%
External student	91	64.84%	34	47.06%	31	67.74%

Table 5 presents the percentage of internal and external students who reported crisis in each field and in each geographic region. For example, of the 202 internal SS&H students in Israel, 59.90% reported a crisis while of the 91 external students, 64.84% reported a crisis. Applying Fisher's exact test separately for this group (SS&H Israeli students) revealed no significant difference between the percentage of internal and external students who reported crises (p=0.4395). This procedure was repeated for S&E students in Israel, showing again that there is no significant difference between internal and external candidates (p=0.3712). The analysis of Western European S&E students' responses also showed no significant difference in the percentage of internal and external candidates who faced crisis (p=0.6980). In other words, for all three sub-populations, survey results did not support our assumption.

Relationship between time devoted to research and crises development

In the General Information section of the survey, we asked the students to assess how many hours they invested in their doctoral research per week (Table A-2) in order to answer the research question: Is there a relationship between time invested in research and the percentage of crises reported? A priori, we were not sure whether a high investment of time leads to stress and crises or whether a low investment of time leads to poor academic performance and crises, or both? We decided to aggregate the answers in Table A-2 into three "weekly hours" categories: up to 30 weekly hours, 30-60 weekly hours, and over 60 hours per week. For example, in Table 6, N=163 represents the number of Israeli S&H students who invested less than 30 hours per week on their doctoral research, of which 63.80% reported crisis.

Table 6: Devoted time to research and crises

	Israel		Israel		Western Europe	
	SS&H		S&E		S&E	
Weekly hours	N	% students reporting crises	N	% students reporting crises	N	% students reporting crises
Less than 30	163	63.80%	57	52.63%	40	77.50%
30-60	111	53.15%	300	52.33%	250	59.60%
Over 60	23	82.61%	104	64.42%	67	67.16%

The data in Table 6 reveals that the lowest percentage of crises in all three sub-populations is reported by students who devoted 30-60 weekly hours to their studies. The majority of SS&H students invested less than 30 weekly hours while a majority S&E student in both regions invested 30-60 weekly hour to their research. It is also quite interesting to note which answer category in Table A-2 scored highest in terms of the percent of students who reported crisis, prior to the aggregation process shown in Table 6. Ninety percent of Israeli SS&H candidates and 78% of Israeli S&E students who answered "all my time, 24/7", reported crisis. In Western Europe, the answer "0-15 weekly hours" ranked highest, with 79% of S&E students in this category reporting crisis. Due to the aggregation process, this data is not presented explicitly in Table 6.

To compare crisis appearance among the three "weekly hours" groups, logistic regression procedure was applied separately for each sub-population (academic discipline or geographic region). The analysis showed a significant difference in the number of crises reported by Israeli SS&H students who spent 30-60 hours on their studies and those who spent over 60 hours (z=2.16, p=0.014), and likewise between Israeli S&E students who invested 30-60 hours and those who invested over 60 hours (z=2.13, p=0.033). In Western Europe too, S&E students who studied less than 30 hours per week

reported significantly more crises than students who studied 30-60 hours weekly (z=2.12, p=0.034). We can, thus, conclude that students who invested 30-60 weekly hours in their doctoral research reported less crises than the other two "weekly hours" groups.

Relationship between the frequency of adviser meetings and crises reported

In the General Information section of the survey, we asked the candidates to report on the frequency of their meetings with their adviser. Table A-3 presents their answers. Our assumption was that higher student-adviser meeting frequencies create more interaction between them and as a result lead to better relationships, which may reduce the number of crises reported. We found that the meeting pattern of Israeli SS&H students was extremely different from that of Israeli S&E candidates: only about 12% of SS&H students met with their adviser weekly as opposed to over 50% of S&E students, as presented in Table A-3. We therefore decided to compare the crisis reporting of SS&H students who met their adviser at least *once every other week* to that of the rest of the students. For S&E students, we compared the crisis reporting of those who met the adviser *once a week* with that of all the rest, as shown in Table 7.

Table 7: Frequency of adviser meetings and crises

	Israel		Israel		Western Europe	
	SS&H		S&E		S&E	
Meeting frequency	N	% students reporting crises	N	% students reporting crises	N	% students reporting crises
Once a week			291	53.95%	156	58.33%
At least once every other week	78	51.30%				
Other	217	65.00%	166	57.83%	201	66.67%

For example, 51.3% of the 78 Israeli SS&H students who met their adviser at least once every other week reported experiencing a crisis. A total of 217 students met their adviser once a month, once a semester, or once a year, of which 65% reported crises. An analysis of the answers given by SS&H students revealed a significant difference in the percentage of students who met their adviser at least once every other week and reported crises compared with the rest of the students (Fisher's exact test, p=0.040).

Table 7 shows that S&E students who met their adviser every week, reported less crises than the other students who met with their adviser at other frequencies. However, a statistical analysis of the answers from S&E students in both Israel and Western Europe, showed no significant difference in crisis reporting between students who met their adviser once a week and all the rest (Fisher's exact test, Israel p=0.4354, Western Europe p=0.1219).

Our findings are quite interesting. In the S&E disciplines, over two thirds of students met their adviser once or twice a week, but that did not significantly lower the percentage of students who reported crises. On the other hand, among SS&H students, whose frequency of meeting with their adviser was found to be lower, those candidates who met their adviser at least once every other week, reported significantly less crises.

Overall feeling of candidates who experienced crisis

One of the summarizing questions in the survey referred to the student's overall feeling as a doctoral candidate, as shown in Table A-4. Our assumption was that students who reported that they "love

their research and enjoy life as candidates" will also report less crises. In order to analyze this assumption, we examined individual replies from students who answered "I love my research and enjoy my life as a PhD candidate" and found the percentage of those who reported crisis, as shown in Table 8.

Table 8: Crises and feelings as doctoral candidate

	Israel		Israel		Western Europe	
	SS&H		S&E		S&E	
Feelings	N	% students reporting crises	N	% students reporting crises	N	% students reporting crises
I love my research and enjoy my life as candidate	206	54.37%	335	47.16%	203	44.83%
Other	88	79.55%	125	76%	154	87%

For example, only 54.37% of the 206 Israeli SS&H students who replied "I love my research and enjoy my life as candidate" reported crises as opposed to 79.55% of the 88 students who replied "I do not enjoy my life", "I am disappointed" or "I regret choosing this path".

Analyzing the answers using Fisher's exact test, we revealed strong, significant differences in crisis reporting within each of the three sub-populations (academic discipline or region). In all three sub-populations, students who replied "I love my research and enjoy my life as a PhD candidate" reported less crises compared with students who expressed negative feelings or disappointment ($p<0.0001$ for each sub-population).

These results suggest that any crisis that occurs during a candidate's doctoral studies may affect his or her quality of life and reduce the student's satisfaction along the doctoral journey.

DISCUSSION

Prior to discussing the results, we consider the issue of potential nonresponse bias due to the limited response rate to our survey. While the study is based on responses of students from various academic disciplines in eight universities at four different countries, nonresponse bias may still be a concern. In particular, it is possible that students who experienced serious problems or a crisis during their doctoral research are more likely to respond to our questionnaire on this specific topic. Our main investigation focuses on characterizing those who reported facing a crisis, and most of our analysis is conditioned on that (Tables 2-8). Therefore, we assume that the resulting conclusions would not be affected by this type of nonresponse bias. However, our conclusions might be affected by other potential nonresponse biases.

In this study, we examined reported crises that occur during doctoral studies. The study focused on two aspects: 1. An analysis of crisis patterns among doctoral candidates in various disciplines and geographic regions; 2. An analysis of four research questions of interest.

CRISIS PATTERNS

Crisis patterns differed significantly among Israeli SS&H and S&E students. Professional crises were more prevalent among S&E students than among SS&H students, possibly due to the high and stressful uncertainty inherent in doctoral research, mainly in the natural sciences. A higher percentage of S&E candidates experienced expectation crisis than did SS&H students, a finding that can be ex-

plained by the fact that significantly more SS&H students begin their doctoral program at a considerably older age (Katz, 2016), many of them have work experience and a better understanding of what to expect from a doctorate. On the other hand, more SS&H students reported economic crisis, which may be explained by the lower availability of scholarships and financial support in SS&H disciplines compared with S&E.

Crisis patterns among S&E students in Israel and Western Europe also differed significantly: In Israel, a significantly higher percentage of students experienced professional crisis while in Western Europe, a significantly higher percentage of candidates reported expectation crises.

It is complicated to explain the difference in the reporting of professional crises by S&E students in Israel and in Western Europe. More Israeli students experienced professional crises and it is possible that research requirements or advisers' demands in Israel are higher or more stressful than in Western Europe. There was also a significant difference in the responses to the expectations crises question. A much higher percentage of students in Western Europe reported that their doctoral studies do not meet their expectations. This may be explained by the fact that students in those countries begin their doctoral programs at a relatively young age (Katz, 2016) and are perhaps less mature and less able to understand the promises and limitations of a doctoral research. Many S&E students in Israel who enroll in the program are 3 to 5 years older than their peers in Western Europe due to mandatory military service. No significant differences were found between the patterns of emotional crises and economic crises in the two regions. The similarity in reported economic crises can be explained by the fact that many S&E students in both regions work on funded projects and have access to grants, scholarships, and financial support. We were not able to find any referenced research on these topics.

Only about 20% of candidates who reported crisis, used professional support services, which are available at most research universities. This pattern is common to all candidates, regardless of academic discipline or region. Possible reasons for avoiding professional help may be lack of information about the services, shame, or neglect. As described by Jairam and Kahl (2013), students feeling stress and social isolation seek social support by aligning themselves with a group of academic friends, and by seeking assistance from family members or their advisers.

We asked candidates who experienced crisis, how it affected their research. The pattern of replies differed significantly among SS&H students and S&E students in Israel. A higher percentage of SS&H students reported delays in their research due to crisis and a higher percentage of them also claimed that their research was not affected by the crisis. On the other hand, among the S&E students who reported crises, a higher percentage seriously considered leaving their doctoral program and a higher percentage also reported that the crisis had affected the quality of their research. It looks like the consequences of facing a crisis in SS&H are less severe than in S&E, a finding that may be explained by the difference in length and intensity of research in these two disciplines. Many S&E research projects are funded and have time-limited grants and advisers expect timely delivery of results. A substantial percentage of S&E students perform experimental research that requires laboratory work. Innovative research, as required for doctoral thesis in S&E disciplines, requires operating advanced equipment, mastering challenging software and using exotic materials. It therefore entails a greater risk of getting stuck than in SS&H disciplines, and thus any crisis endangers successful completion. Even if the student somehow manages to plow through the crisis, it affects his or her quality of research. In SS&H, delays in doctoral research are less stressful since doctoral studies are typically longer. Following a report published in 2008 by the US Council of Graduate Schools, only 24.7% of history doctoral students will have graduated after 7 years, whereas 69% of civil engineers will have completed their program in the same period.

RESEARCH QUESTIONS

-Is there a relationship between being enrolled as an external candidate and the number of crises reported?

Our assumption was that external, part-time students will experience and report more crises than internal, full-time students. Gardner and Gopaul (2012) studied the experience of part-time doctoral students and showed that academic discipline makes a difference in this regard. The authors found that in academic disciplines where they represent a minority, external students encounter isolation and less funding opportunities. Our statistical analysis showed no significant difference between the percentage of internal and external students who reported crises among Israeli SS&H students. 30.7% of the Israeli SS&H are enrolled in their doctoral programs as external part time students (Katz, 2016). There was also no significant difference between the percentage of internal and external students who reported crises among Israeli S&E students and among Western European S&E students. Only 7.3% of the Israeli S&E doctoral students and 8.6% of the Western European S&E doctoral students are enrolled as external part time students (Katz, 2016). In summary, we could not prove our assumption that external, part time students report more crises than internal, full time students.

-Is there a relationship between time invested in research and the number of crises reported?

We planned to investigate whether a high investment of time in research leads to stress and to higher percentage of reported crises or whether low investment of time leads to poor research performance and, as a result, to crises. We found that students who reported a balanced investment of 30-60 weekly hours in their doctoral research, reported the lowest percentage of crises. Students who replied that their life is focused only on their studies, "all my time, 24/7", reported the highest crisis level. Students who failed to invest enough time in research, i.e., 0-15 weekly hours, and probably exhibited poor research performance, also reported high percentage of crises. We were not able to find in the literature any study that discussed related results.

- Is there relationship between frequency of student-adviser meetings and the number of crises reported?

Following the vast literature on this topic, we assumed that a higher frequency of meetings with the adviser will improve the student-adviser relationship and result in a lower percentage of reported crises. One of the most powerful influences on doctoral persistence is the relationship doctoral students develop with their advisers (Girves & Wemmerus, 1988). Protivnak and Foss (2009) showed that collaboration between students and faculty members was an important factor for successfully completing doctoral studies. Mason (2012) stated that having a collegial relationship with advisers is also critical for student satisfaction and motivation, and so such relationships should be encouraged. The isolation that accompanies doctoral studies must be balanced with peer or supervisor support, otherwise isolation can lead to attrition (Gardner, 2010). Good relations with the adviser are, therefore, critical for the candidate's well-being and success.

We found very different patterns of student-adviser meetings in "soft sciences" as opposed to "hard sciences". Specifically, most SS&H students did not meet with their advisers frequently, i.e., once a month or less. Only about 25% of SS&H students met with their adviser at least once every other week. On the other hand, over 70% of S&E students, both in Israel and in Western Europe, met with their adviser once a week or once every other week (Table A-3). It seems that SS&H students who met their adviser at least once every other week, succeeded in developing good relationships and understandings with their adviser and reported significantly less crises than did their peers who met their adviser once a month, once a semester, or even once a year. The situation in S&E was quite different. Among all S&E students, both Israeli and Western European, no significant difference was found in crisis reporting of students who met with their adviser every week and those who met at a lower frequency. One possible explanation is the nature of meetings in S&E disciplines; weekly meetings are required due to the intensity of research and the need for immediate feedback and guidance. Such meetings may be regarded as "business-like" meetings, in which weekly tasks, the advancement of experiments, and troubleshooting are discussed. These meetings might be much less personal, are focused on "delivering the goods", and many times do not address the student's needs or feelings. We

were unable to find any research in the literature that discusses these differences between disciplines or that support our suggested explanation.

-Did students who reported loving their research and enjoying their life as candidates report less crises?

We found that students who answered that they enjoy their life as doctoral candidates reported significantly less crises than did candidates who replied that they did not enjoy their life as candidates and were disappointed from the program. This pattern was expected and is common to all sub-populations of students, regardless of their discipline or geographic location.

CONCLUSIONS

We present conclusions from the pattern analysis of candidates' answers followed by conclusions regarding our research questions.

Patterns analysis:

- A significantly higher percentage of S&E students faced professional crisis than SS&H candidates. A significantly higher percentage of SS&H students reported emotional crisis than S&E students. A significantly higher percentage of S&E students experienced expectation crisis than SS&H. Significantly more SS&H students reported economic crisis than S&E students.
- Among students who reported crisis, over two-thirds did not seek professional assistance. Less than 20% of candidates who reported crisis used professional services.
- Facing a crisis affects the doctoral research differently in "soft sciences" and in "hard sciences". In SS&H the doctoral research is mainly delayed or not affected, while in S&E it affects the quality of the research and more students seriously consider dropping out of the doctoral program.

Research questions:

- There is no significant difference in the reporting of crises between internal, full-time and external, part-time candidates.
- Candidates who invested 30-60 weekly hours in their research reported less crises than both peers who invested over 60 hours per week and students who invested less than 30 hours per week.
- Social Sciences and Humanities students who met with their adviser at least once every other week reported less crises than their peers who met with their adviser at a lower frequency. In the Natural Sciences and Engineering, the frequency of adviser meetings did not significantly affect the percentage of students who reported crises.
- Students who replied "I love my research and enjoy my life as a PhD candidate" reported significantly less crises than students who did not enjoy their life or were disappointed with the program. This clearly shows that crises strongly affect the feelings and the quality of life of doctoral candidates.

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APPENDIX

In the appendix, we present four tables with student answers that were used earlier in the study. In these tables, "Total" represents all students who responded to our survey, including from disciplines other than SS&H and S&E.

Table A-1: Are you enrolled in the PhD program as a full-time doctoral student?

	Israel					Western Europe		
	Total	**Social Sciences**	**Humanities**	**Sci.**	**Eng.**	**Sci.**	**Eng.**	**Total**
	n=1013	n=153	n=153	n=344	n=122	n=103	n=257	n=457
I am an internal, full-time doctoral student	76.5%	64.7%	71.2%	95.6%	80.3%	98.1%	88.3%	91.4%
I am an external, part-time doctoral student	22.5%	34.0%	27.5%	3.2%	18.9%	1.9%	11.3%	8.4%
Not Specified	1.0%	1.3%	1.3%	1.2%	0.8%	0.0%	0.4%	0.2%

Table A-2: How much time per week do you devote to your doctoral research?

	Israel					Western Europe		
	Total	**Social Sciences**	**Humanities**	**Sci.**	**Eng.**	**Sci.**	**Eng.**	**Total**
	n=1013	n=153	n=153	n=344	n=122	n=103	n=257	n=457
All my time, 24/7	6.1%	5.2%	1.3%	9.0%	8.2%	3.9%	8.6%	7.4%
Over 60 hours per week	8.8%	3.9%	5.2%	13.1%	14.8%	15.5%	10.1%	10.8%
45-60 hours per week	25.7%	8.5%	15.7%	39.8%	31.1%	54.4%	36.6%	39.8%
30-45 hours per week	25.6%	24.2%	24.8%	29.9%	21.3%	23.3%	30.4%	30.2%
15-30 hours per week	18.4%	28.1%	27.5%	6.1%	18.9%	1.9%	9.3%	7.6%
0-15 hours per week	15.3%	30.1%	24.8%	2.0%	5.7%	1.0%	5.1%	4.2%
Not Specified	0.2%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%

Table A-3: How frequently do you meet with your adviser?

	Israel					Western Europe		
	Total	**Social Sciences**	**Humanities**	**Sci.**	**Eng.**	**Sci.**	**Eng.**	**Total**
	n=1013	n=153	n=153	n=344	n=122	n=103	n=257	n=457
Once a week	37.7%	14.4%	8.5%	64.5%	59.0%	48.5%	42.0%	41.0%
Once every other week	18.8%	17.6%	11.1%	21.2%	25.4%	23.3%	26.8%	25.3%
Once a month	23.9%	35.9%	36.6%	10.5%	10.7%	17.5%	24.5%	24.8%
Once a semester	16.8%	28.8%	37.9%	1.7%	4.1%	10.7%	6.2%	8.6%
Once a year	1.6%	2.6%	3.9%	0.6%	0.0%	0.0%	0.4%	0.2%
Not Specified	1.3%	0.7%	2.0%	1.5%	0.8%	0.0%	0.0%	0.0%

Table A-4: Which statement best expresses your feelings as a PhD candidate

	Israel					Western Europe		
	Total	**Social Sciences**	**Humanities**	**Sci.**	**Eng.**	**Sci.**	**Eng.**	**Total**
	n=1013	n=153	n=153	n=344	n=122	n=103	n=257	n=457
I love my research and enjoy my life as a PhD candidate	70.3%	63.4%	73.2%	71.5%	73.8%	60.2%	55.6%	56.8%
I have learned a lot but I do not enjoy my life as a candidate	20.4%	30.7%	15.7%	17.4%	18.9%	24.3%	27.6%	26.0%
I am disappointed. The experience is far below my expectations	4.0%	2.0%	2.6%	5.8%	2.5%	9.7%	9.7%	10.3%
I regret choosing this path, but now I just have to complete it and get on with my life	3.6%	2.6%	4.6%	4.7%	4.9%	5.8%	6.6%	6.6%
Not Specified	1.7%	1.3%	3.9%	0.6%	0.0%	0.0%	0.4%	0.2%

BIOGRAPHY

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