Research paper

The organisation and evaluation of a statistical consulting service for psychology students

Denise Kerkhoff & Anne Hagemann

Statistics and methodology play a crucial role in psychological research, and university psychology courses teach students the theory and application of various statistical methods. However, students who conduct their own research projects oftentimes face problems which are specific to their data and cannot be solved using standard curricular procedures. Instead, these issues need to be solved on a case-by-case basis. This article presents the organisation and evaluation of a statistical consulting service for students who face methodological issues in applied research. We describe the scope, contents, workload, and administrative framework of the service and evaluate its effectiveness and helpfulness as reported by the consultees over a two-semester period. Results show that the service is frequently used and well-received, and that consultants are adequately compensated for their work. We further provide recommendations for teachers and consultants regarding the organisation of the service and the consulting process from a practical perspective.
Keywords: *Statistical consulting, statistics learning, extracurricular support, teaching methods.*

STATISTICS and quantitative methods are of high importance in psychology (Cowles, 2005) and an integral part of undergraduate and graduate psychology courses. However, students often struggle with negative attitudes towards statistics and/or a lack in mathematical skills (Carpenter & Kirk, 2017; Doyle, 2017; Macher et al., 2011). For this reason, many universities offer support methods, such as supplementary learning materials (Bebermeier & Hagemann, 2019; Neumann et al., 2013) or additional support tools (Aberson et al., 2000; Allen et al., 2019; Bates & Poole, 2003; Bebermeier & Kerkhoff, 2019; Bliwise, 2005; Britt et al., 2002; Chance et al., 2007). These support options usually focus specifically on the topics taught in curricular statistics courses and might therefore be limited to easy-to-use datasets or ideal research conditions.

When psychology students are required to apply their knowledge in their own research project, e.g. for a thesis or in laboratory courses, they might be confronted with various violations of assumptions for statistical tests, complex raw datasets, or results which are hard to interpret. For researchers who face such methodological issues, statistical consulting is a flexible and effective support option, which is accessible in many universities (Stegman, 1985; Vance, 2015; Windmann & Kauermann, 2007). While consulting services greatly vary in factors such as scale, clientele, organisation and funding (e.g. Gullion & Berman, 2006), common experiences and overarching topics exist. Kirk (1991) describes five steps of a typical consulting process: establishing rapport, identifying the problems, specifying the required steps, agreeing on responsibilities of the consultant and consultee, and summing-up the consulting results. Many methodological issues revolve around standard procedures (e.g. analysis of variance, regression analysis; Van Belle, 1982, p.350), but technological advancements have made complex statistical procedures and software available to researchers,

which requires consultants to have comprehensive knowledge regarding statistical techniques and tools (Vance, 2015). Johnson and Warner (2004) further identified personal qualities of a consultant (e.g. enthusiasm) as an important factor for a successful consultation. The consultant needs to create a constructive working relationship with the consultee by establishing the roles the consultant and consultee take within the consultation. Altogether, the consulting process is a demanding activity for both consultants and consultees.

For students, statistical consulting as a form of extracurricular support is still rare, and the abovementioned issue of role expectations poses ethical and administrative challenges. Since students are required to earn credit points through their own effort and achievements, the consulting needs to take place within clear-cut boundaries and responsibilities. Additionally, offering statistical consulting at universities is often not adequately compensated (Kirk, 1991; Vance, 2015) and student consulting does not entail collaborative work on publications. Thus, offering this service might be unattractive to teachers.

In conclusion, statistical consulting presents a potentially helpful service for students who struggle with methodological issues in their research project, but it needs to be well embedded in the departmental organisation to be attractive for both students and teachers.

The aims of this article are two-fold: First, we aim at illustrating how a statistical consulting service for psychology students (bachelor's and master's degree) is implemented at our university in Germany. Therefore, we outline the aims, departmental organisation, and workflow of the consulting service. Our second aim is to assess to what extent this support option is used and to evaluate its helpfulness as perceived by the students who used the service. To achieve this, we investigate (a) if students use the consulting service and, if so, how frequently, (b) typical topics and problems students use the service for, and (c) if students perceive the service as helpful and recommendable.

By answering these questions, we provide teachers and researchers with insights into strengths and challenges of a statistical consulting service for students and conclude with recommendations from a practical perspective.

Statistical consulting for psychology students

Each year, about 200 students complete their bachelor's or master's thesis in psychology at our university. The consulting service is a support option for students who have problems with the statistical analyses for their thesis which go beyond what is covered in the regular curriculum (e.g. violation of multiple assumptions). Table A in the supplementary material gives an overview of the topics taught in the statistics courses at bachelor's and master's level.

The consulting service provides students with resources and tools, e.g. analysis methods, literature, or software packages, which enable them to solve their problems themselves. Specifically, the service does not offer any data analyses, interpretations of results, or related services which students are required to carry out independently.

The service is open to all psychology students, and the consultants are academic staff members with teaching experience in statistics. The expected workload of the service – for the timeframe relevant to this article – is 135 minutes per week over the course of two 15-week semesters, which equates 67 hours and 30 minutes and is split between two consultants. The consultants are compensated for their work by an equal reduction of their teaching load.

Students are informed about the service on the department homepage. As a first step, they are required to complete an inquiry form (see supplementary material B for a translated inquiry form) where they provide general information (e.g. name, degree), describe the methodology of their thesis (e.g. hypotheses, data structure, sample) and

specify their issue (e.g. violation of assumptions). After sending the form via e-mail, it is checked by a consultant and the issue is either solved via e-mail correspondence or the consultant offers an appointment for a consulting session. In both cases, the consultant (a) confirms the information from the form to prevent misunderstandings, (b) narrows down the issue to specific problems, (c) provides the students with explanations, information, and resources to solve the problems, and (d) clarifies further questions and confirms that the student knows how to proceed. Without having to fill out the form again, students may then contact the consultant again if further issues arise.

Information on the progress of each inquiry is collected by the consultants. For this, information such as the date of the inquiries and answers, the topic of the issues, the date and contents of the consulting sessions, and the required consulting time (including preparation, research and post-processing) are tabulated. We henceforth refer to this information as 'data provided by the consultants'.

Evaluation

Data and Method

The basis of our evaluation is data gathered from consulting inquiries over the course of two semesters (October 2017 to September 2018) with the same two consultants. Using the data provided by the consultants, we identified 80 inquiries from 44 students. From the tabulated data, we gathered information on the type of consulting (session, e-mail, or both), workload in minutes (preparation time, duration of a session or an e-mail answer), and the number of inquiries per student.

To further evaluate the consulting, the 44 students were contacted via e-mail in December 2018 and invited to participate in an anonymous survey via Questback (EFS Survey, 2018, see supplementary material C for a translation of the full questionnaire). Students were informed that participation is voluntary and that the information they provide is analysed to evaluate and improve the service. The students were first asked to provide information on their aspired degree (bachelor's, master's, or 'I don't know'), the type of consulting received (e-mail, session, or both), the statistical analysis or method related to the inquiry (multiple answers were possible, e.g. confirmatory factor analysis, data management), and the topics of the consulting (multiple answers were possible, e.g. selection of the correct method, handling of missing values). They were then asked to rate the quality of the consulting session or e-mail correspondence (nine items, e.g. 'My questions were answered sufficiently') and the consulting service in general (five items, e.g. 'I would recommend the consulting service'). All items were answered on a 6-point-Likert scale (1 = 'not at all' to 6 = 'completely'). Lastly, students were asked to summarise their experiences by grading the service (6 = 'deficient' to 1 = 'very good') and to provide the grade for their thesis as a free text input.

Results

Table 1 presents the distribution of the inquiries and the associated workload as documented by the consultants. Of the 80 inquiries, 27 (33.8 per cent) were followed up by consulting sessions, which show a large range in duration with 10 to 105 minutes per session (*Mdn* = 60). The preparation time was 5 to 120 minutes (*Mdn* = 20), and the time for e-mail consulting was 3 to 60 minutes (*Mdn* = 30). The total workload over the two-semester period was 4083 minutes, which equates 68 hours and 3 minutes.

The inquiries were made by 18 students seeking a bachelor's degree and 26 students seeking a master's degree (Table 2). Twenty-six of these students made one inquiry (59.1 per cent, not tabulated), and the maximum number of inquiries was six (one student, not tabulated). Twenty-one students received answers via e-mail only (47.7 per cent), while the remaining 23 students received at least one consulting session (Table 2).

Of the 44 students, 21 (47.7 per cent) answered the evaluation survey (9 bachelor's,

Table 1: Information on consulting inquiries (*N* = 80) and workload

Type of consulting	*Mdn*	*M*	*SD*	Range	Cum. Sum
Consulting session: *N* = 27 (33.8%)					
Preparation time for sessions (minutes)	20.0	34.63	29.68	5 - 120	935
Duration of consulting sessions (minutes)	60.0	55.19	22.93	10 - 105	2425
E-mail consulting: *N* = 53 (66.3%)					
Time for e-mail consulting (minutes)	30.0	31.28	16.42	3 - 60	4083

Note. Cum. Sum= cumulative sum of minutes over the two semesters: 4083 minutes equate 68 hours and 3 minutes.

Table 2: Sample characteristics for all consultees and for survey participants

	All consultees *N* = 44	Survey participants *N* = 21
	N (%)	*N* (%)
Aspired degree		
Bachelor's degree	18 (40.9%)	9 (42.9%)
Master's degree	26 (59.1%)	12 (57.1%)
Type of consulting		
E-mail consulting	21 (47.7%)	5 (23.8%)
Consulting session	16 (36.4%)	4 (19.0%)
E-Mail and consulting session	7 (15.9%)	12 (57.1%)

12 master's, Table 2). Sixteen students (79.2 per cent) stated to have received a consulting session. Notably, 12 students reported to have received support via both e-mail and consulting session, whereas only 7 students have been recorded as having received both support forms by the consultants. This is assumedly a result of differing perceptions as to what is considered an e-mail consulting.

Table 3 lists the reported topics of the inquiries and contents of the consulting. The statistical analyses that the students most frequently stated as the reason for their inquiry were linear regression (*N* = 4, 19 per cent of participants), analysis of variance (*N*= 4, 19.0 per cent), and structural equation modeling (*N*= 3, 14.3 per cent), and the most frequently stated topics on which they received help were the selection of the correct method (*N*= 10, 47.6 per cent), the handling of violations of assumptions (*N*= 9, 42.9 per cent), and the correct analysis procedure (*N*= 7, 33.3 per cent).

Table 4 presents the rated quality of the consulting experience. Altogether, the students had a positive perception of the consulting session or e-mail consulting. For example, the students stated that their questions were answered sufficiently (*Mdn* = 6.0) and that not much additional work was required to follow the contents of the consulting (*Mdn* = 2.0).

Table 3: Survey results – Content of inquiries and consulting (*N* = 21)

Statistical analysis	*N*	%	Topics of consulting	*N*	%
Linear regression	4	19.0	Selection of the correct method	10	47.6
Analysis of variance	4	19.0	Violation of assumptions	9	42.9
Structural equation modeling	3	14.3	Analysis procedure	7	33.3
Non-parametric tests	2	9.5	Interpretation of results	4	19.0
Correlation	2	9.5	Testing assumptions	4	19.0
t-test	2	9.5	Implementation in SPSS/ AMOS	4	19.0
Exploratory factor analysis	2	9.5	Model specification/ selection	3	14.3
Confirmatory factor analysis	2	9.5	Missing values	3	14.3
Data management	2	9.5	Estimation issues	3	14.3
Software	2	9.5	Reporting results	2	9.5
Classical test theory	1	4.8	Software issues	2	9.5
Path modeling	1	4.8	Multiple comparisons	1	4.8
Cluster analysis	1	4.8	Implementation in R	1	4.8
Other	4	19.0	Other	1	4.8

Note. Multiple answers were possible.

Furthermore, they reported that the consultant asked questions for clarification (*Mdn* = 5.0), was able to explain complex issues (*Mdn* = 5.0) and did not regard the service as purely a matter of duty (reverse-coded; *Mdn* = 1.0).

The consulting service in general was considered helpful (*Mdn* = 6.0) and recommendable (*Mdn* = 6.0). Students perceived that they were able to improve the quality of their theses (*Mdn* = 5.0) and save time (*Mdn* = 5.0). Overall, 17 students (81.0 per cent) rated the service as '1 (very good)' (not tabulated; additionally, two students rated the service as 'good', and two as 'poor'[1]). Of the 16 students (79.2 per cent) providing a grade for their thesis, 12 reported an 'excellent' grade (not tabulated). Due to the low variability in both the evaluation of the consulting and in the grades, we did not draw any statistical inferences.

Discussion

Our results on a statistical consulting service for psychology students show that with 80 inquiries made by 44 students, the service is used frequently, with an average of two to three inquiries per week within the two 15-week semester periods. In sum, the actual workload of 68 hours and 3 minutes corresponded very closely to the expected workload of 67 hours and 30 minutes. Using the median workload for one consulting session (20 minutes preparation and 60 minutes per session) and one e-mail consulting (30 minutes), the estimated workload of 135 minutes per week equates two consulting sessions per week, or one session and two e-mails, or four e-mails. In comparison, e-mail consulting was used more frequently than consulting sessions. In our personal experience, the students' questions and methodological issues can be solved

[1] The data show that the negative evaluations throughout the questionnaire stem from the same two students.

Table 4: Survey results - Evaluation of the consulting (*N* = 21)

	Mdn	*M*	*SD*	Range
Reported quality of the consulting session or e-mail consulting				
The advice was given in a structured way.[a]	6.0	5.25	1.52	1 - 6
The consulting session was comprehensibly structured.[a]	6.0	5.35	1.39	1 - 6
The contents were explained comprehensibly.	6.0	5.38	1.20	2 - 6
The consultant was able to make complex issues comprehensible.[a]	5.0	5.00	1.38	1 - 6
My questions were answered sufficiently.	6.0	5.19	1.50	1 - 6
The consultant asked clarifying questions.[a]	5.0	4.25	1.68	1 - 6
A connection between theory and my specific questions was established.[a]	6.0	5.25	1.48	1 - 6
The consultant seemed to consider the session as purely a matter of duty or routine.	1.0	1.81	1.54	1 - 6
A lot of extra work was necessary to understand the advice.[b]	2.0	2.58	1.35	1 - 6
Rating of the consulting service in general				
Overall, the consulting was helpful.	6.0	5.38	1.36	1 - 6
I would recommend the consulting service.	6.0	5.43	1.50	1 - 6
I was able to improve the quality of my thesis because of the consulting.	5.0	4.67	1.49	1 - 6
I was able to finish my thesis sooner because of the consulting.	5.0	4.52	1.63	1 - 6
I had to invest even more work in my thesis because of the consulting.	2.0	1.76	0.94	1 - 4

Note. Value range: 1 ('not at all') – 6 ('completely').
[a] *N* = 20 (due to missing values). [b] *N* = 19 (due to missing values).

more comprehensively and in better alignment with the students' statistics skills during a consulting session, whereas e-mail consulting offers the advantage of faster communication.

Survey results show that the service is perceived as very helpful and of good quality. However, the data also show that two consultees rated the service as unhelpful and overall negative. Our experience and informal feedback suggest that – while we state scope and limits of the service on the website – some students overlook or misunderstand this statement, or their expectations nevertheless exceed what the service can provide. As a result, there might be discrepancies in the role the student expects the consultant to assume and the role the consultant sees herself or himself in (cf. Kirk, 1991; Stegman, 1985), which in turn results in a disappointing experience if these expectations are not met. It is therefore of high importance to clearly state the aims and limits of the service wherever possible, e.g. on the homepage of the service and additionally on the inquiry form. In practice, we recommend consultants to keep in

mind that consultees might have unsatisfiable expectations and to ensure that the consultee knows which issues lie within his or her responsibility or – if applicable – the supervisor's responsibility (e.g. in the case of theses).

Typical issues of the inquiries concern standard procedures such as regression analysis and analysis of variance, which is in line with previous findings (Van Belle, 1982). Notably, a common topic of the consulting was the selection of the correct statistical method. This might be because in curricular statistics courses, students are taught the meaning and application of each statistical method, but in the majority of practical sessions, they do not have to choose the correct methods themselves for a given dataset and research question. Therefore, we recommend that statistics courses more regularly incorporate lessons and practical sessions on how to differentiate between methods and how to choose the correct analysis procedure. If a consultee has issues with choosing the correct method or procedure, we recommend that the consultant first identifies which potentially adequate methods have been part of the statistics courses for the student, then assesses the nature of the disconnection between the data structure and the research question (e.g. difficulties with the scales of the variables, or potential violation of assumptions), and in a next step decides which curricular or extra-curricular method is appropriate and manageable for the student. By going through these steps with the students, the consultant can teach them how to identify and pinpoint future problems, and how to proceed in finding a solution. In this respect, the consulting service can play an important role in teaching psychology students to confidently plan their future research and conduct their own analyses.

However, our evaluation of the consulting service has some limitations. Firstly, the survey response rate was 47.7 per cent, which is comparable to other surveys in this field (e.g. Windmann & Kauermann, 2007; Gullion & Berman, 2006; Johnson & Warner, 2004). A comparison between the total number of consultees and the survey participants (cf. Table 2) shows that students who received e-mail consulting only are underrepresented in the survey (e-mail only: 5 participants of 21 consultees, 24 per cent; other: 16 participants of 23 consultees, 70 per cent). On the one hand, this might indicate that the invitation to participate in the survey or the survey questions did not adequately address students who did not receive a consulting session. On the other hand, students who experienced the service via e-mail only might generally not feel as compelled to provide feedback as students who participated in a session, since the sessions are associated with a higher degree of personal involvement and commitment on the part of the students, which in turn might facilitate the willingness to provide feedback. If a comprehensive feedback on the service is desired, consultants may ask consultees to rate their experience a short time after the consulting has ended, regardless of the type of consulting. However, since in the university context, consultants might know their consultees from other courses and be required to grade them, requests for feedback must be made in a way that ensures anonymity.

Apart from that, we did not compare statistics grades and factors such as achievement motivation or statistics skills of consultees and students not seeking consultation. Although some students provided the grade of their thesis in the survey, we cannot exclude bias in this data, and information on grades of students without consultation was not available. Consequentially, we cannot conclude if the consulting service has an overall impact on the grades or students' attitudes towards statistics. This question could be addressed in future research.

In conclusion, this article presented the organisation and evaluation of a statistical consulting service for psychology students, which complements the curricular statistics courses in an effective way. As both consultants and teachers, we were able to build on the students' knowledge from previous statistics courses and provide them with information that enabled them to solve their methodological issues. We showed that the service

is frequently used and well-received by the students, and that it can be implemented in a way that adequately rewards the consultants.

Authors

Denise Kerkhoff, Konstanz University, Konstanz, Germany
Anne Hagemann, Society for Epilepsy Research, Bielefeld, Germany

Corresponding author

Denise Kerkhoff is a research associate in Methods for Intensive Data in Psychology in Konstanz University, Department of Psychology, PO Box 14, D-78457 Konstanz, Germany.
E-mail: denise.kerkhoff@uni-konstanz.de.
Tel: +49 7531 88-4210

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Supplementary material

Supplementary table A. Contents of statistics courses for psychology students at bachelor's and master's level

Bachelor psychology	
Statistics I	• measurement theory • univariate and bivariate descriptive statistics • simple and multiple linear regression • probability and probability distribution
Statistics II	• basics of inferential statistics (sampling distributions, confidence intervals) • statistical hypothesis tests for metric variables (t-tests, analysis of variance, linear regression) • statistical hypothesis tests for nominal variables (chi-square test)
Statistics III	• non-parametric tests • logistic regression • mediation and moderation in linear regression
Test theory and test construction	• item analysis and reliability • exploratory factor analysis • confirmatory factor analysis
Master's level	
Multivariate analyses I	• path modeling • multilevel modeling • structural equation modeling
Multivariate analyses II	• log-linear models • time-to-event analysis • latent class analysis

Supplementary material B. Inquiry form for statistical consulting (translated)

1. Name:
➔

2. Type of thesis (Bachelor, Master):
➔

3. Please outline the research question of your thesis briefly. In case of multiple research questions, please mark the one where the problem occurred.
➔

4. Which are your statistical hypotheses (mark the one where the problem occurred)?
➔

5. Please describe the design of your study:
a) Which are your dependent variables (DV, incl. level of measurement)?
➔

b) Which are your independent variables (IV; level of measurement, factor levels, with / without repeated measurements)?
➔

c) How is your sample composed?
➔

6. Which statistical methods do you want to use?
➔

7. Which software do you want to use for your analyses?
➔

8. Which specific problem do you want to discuss?
➔

9. Do you have other remarks?
➔

10. In which research group do you write your thesis? (In case of external supervision please name the company/institution)
➔

Supplementary material C. Evaluation questionnaire (translated)

During your studies at *(name of city)* University you made use of the S**tatistical Consulting Service.**

We cordially invite you to briefly evaluate the consulting. With your feedback we will be able to further optimize the consulting.
Of course, your answers cannot be traced back to you personally and will only be analyzed on group level.
For further information concerning data protection, please contact (*e-mail address*).
Thank you.

First, we would like to know about the general conditions of your consulting inquiry.

For which type of thesis did you contact the statistical consulting service?
❍ Bachelor ❍ Master ❍ I don't know

Which type of consulting did you receive?
❍ e-mail consulting ❍ consulting session ❍ e-mail & consulting session
❍ I don't know

Which statistical method or topic did your consulting inquiry relate to?
❒ Contingency tables / chi-square test
❒ Non-parametric tests (e.g., Mann-Whitney U test, Wilcoxon test, Friedman ANOVA)
❒ Correlation / partial correlation
❒ Linear regression
❒ t-test
❒ Analysis of variance (ANOVA with/without repeated measurements, ANCOVA, MANOVA)
❒ Classical test theory / item analysis / reliability / MTMM
❒ Exploratory factor analysis (EFA)
❒ Confirmatory factor analysis (CFA)
❒ Path modeling
❒ Structural equation modeling (SEM)
❒ Cluster analysis
❒ Discriminant analysis
❒ Data management
❒ Handling statistical software
❒ Other: _____

For which problem area did you receive advice?
❒ Selection of the correct method (Which method is most appropriate? Is a specific method appropriate? Is there a method that can do what I want?)
❒ Selection of the correct analysis procedure (e.g., selection of predictors in regression, coding of nominal predictors, decisions about aggregating or transforming variables)
❒ Interpretation of results
❒ Model specification/model selection
❒ Testing assumptions
❒ Dealing with violated assumptions
❒ Handling missing values

- ❒ Multiple comparisons
- ❒ Model estimation issues
- ❒ Reporting / presenting results
- ❒ Implementation in SPSS/ AMOS
- ❒ Implementation in R
- ❒ Specific Problem with statistical software (e.g., error message in R, installation of R packages, SPSS Syntax)
- ❒ Other: _____

Please answer the following questions with regard to the specific consulting you received.

	not at all					completely
The advice was given in a structured way.	❍	❍	❍	❍	❍	❍
The contents were explained comprehensibly.	❍	❍	❍	❍	❍	❍
My questions were answered sufficiently.	❍	❍	❍	❍	❍	❍
A connection between theory and my specific questions was established.	❍	❍	❍	❍	❍	❍
The consulting session was comprehensibly structured.	❍	❍	❍	❍	❍	❍
A lot of extra work was necessary to understand the advice.	❍	❍	❍	❍	❍	❍
The consultant asked clarifying questions.	❍	❍	❍	❍	❍	❍
The consultant seemed to consider the session as purely a matter of duty or routine.	❍	❍	❍	❍	❍	❍
The consultant was able to make complex issues comprehensible.	❍	❍	❍	❍	❍	❍
The consultant was motivating	❍	❍	❍	❍	❍	❍
The consultant was friendly	❍	❍	❍	❍	❍	❍
The consultant was arrogant	❍	❍	❍	❍	❍	❍
The consultant was condescending	❍	❍	❍	❍	❍	❍

Please give us an overall evaluation of the consulting.

	not at all					completely
Overall, the consulting was helpful.	❍	❍	❍	❍	❍	❍
I would recommend the consulting service.	❍	❍	❍	❍	❍	❍
I was able to improve the quality of my thesis because of the consulting.	❍	❍	❍	❍	❍	❍
I was able to finish my thesis sooner because of the consulting.	❍	❍	❍	❍	❍	❍
I had to invest even more work in my thesis because of the consulting.	❍	❍	❍	❍	❍	❍

Which grade would you assign to the consulting as a whole?

❍ 6 (Insufficient) ❍ 5 ❍ 4 ❍ 3 ❍ 2 ❍ 1 (Very good)

Which grade did you receive for your thesis? (This entry is optional):

_____

Thank you for your answers.
We wish you a successful progress of your studies/occupational career!