

# “Dear Fresher . . .” – How Online Questionnaires can Improve Learning and Teaching Statistics

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## Abstract

Lecturers teaching statistics are faced with several challenges supporting students' learning in appropriate ways. A variety of methods and tools exist to facilitate students' learning on statistics courses. The online questionnaires presented in this report are a new, slightly different computer-based tool: the central aim was to support students to master the course content and to provide the lecturer with continuous feedback about the students' difficulties and deficits.

The aims of online questionnaires supporting teaching and learning of statistics are compared to aims of other computer-based and non-computerized methods and tools. Additionally, data from a first evaluation of the questionnaires is presented. In a first year psychology student's statistics course (bachelor program), students were offered the possibility of filling in an online questionnaire every time a specific theme had been taught. Out of the 126 first year students there were 28 who answered the online questionnaires regularly and 12 answered them sometimes. Those who answered the online questionnaires assessed them as helpful for their understanding of the course's content. The lecturer judged the online questionnaires as particular helpful for improving teaching and assessing performance deficits.

## Keywords

Computer-based learning tools, online questionnaires

## Introduction

In many undergraduate psychology programs, statistics courses are mandatory (e.g., American Psychological Association, 2007; British Psychological Society, 2012; German Psychological

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Society, 2005). At the same time, students often have negative attitudes or beliefs towards statistics (Ruggeri et al., 2008; Tremblay, Gardner, & Heipel, 2000). Thus, lecturers teaching statistics are faced with special challenges. They have to motivate students to study statistics, deal with performance extremes and support students' learning (Connors, McCown, & Roskos-Ewoldsen, 1998). Following Connors et al. (1998) lecturers can adequately address these challenges by providing concrete learning content, clarifying the practical relevance of statistics and promoting active learning. For these purposes, face-to-face statistics courses are often supplemented by accompanying tutorial classes, (assessment) exercises and/or computer-based learning tools.

This report gives an overview of computer-based learning tools used in statistics education and their contribution to a better understanding of the learning content. Additionally, we introduce the use of consecutive online questionnaires as a new computer-based tool to improve learning and teaching statistics. We describe its implementation in a first year introductory course of statistics and compare its basic aims to those of other computer-based tools and classic non-computerized methods. Finally, we present the results from a first evaluation and address critical issues and further improvements.

## Computer-based learning tools in statistics

Computer-based learning tools have been developed to offer students the possibility of actively practicing the learning content, reflecting on their learning processes – including deficits and improvements – and obtaining metacognitive knowledge about their learning, for example, self-regulation and thought processes (Ben-Zvi, 2000; Moore, 1997). It has been shown that the use of such tools can increase psychology students' performance in statistics (Aberson, Berger, Healy, Kyle, & Romero, 2000; Bliwise, 2005; Britt, Sellinger, & Stillerman, 2002; Mitchell & Jolley, 1999) and that students judge such tools to be helpful and evaluate them positively (Neumann, Neumann, & Hood, 2011).

Nowadays, a huge variety of computer-based learning tools supporting the statistics education of psychology students exists: commercial software-based tutorials include *ActivStats* (Currall, Young, & Bowman, 1997), *ConStatS* (Cohen & Chechile, 1997), *Authentic Statistics Stack (ASP)* (Lajoie, 1997), *Statistik (Statistics)* (Mittag & Stemann, 2004) and *EMILeA-stat* (Genschel, Gather, & Busch, 2002). These tools provide learning material for various topics in textual form, video clips or experimental simulations and include assessment exercises and performance feedback.

Furthermore, lecturers and students can draw on internet resources supporting statistics education (Tishkovskaya & Lancaster, 2012; West & Ogden, 1998). Applets that are tied to specific learning objectives illustrate concepts visually by letting students experiment with mathematical statements (see overview in Bush, Menzies, & Thorp, 2009; Mittag, 2002; or visit <http://www.rossmanchance.com/applets/index.html>). Also, free tutorials and learning repositories, combining supplementary course materials for statistics with interactive illustrations, data sets and assessment exercises, provide support. Tutorials can be obtained via <http://stattrek.com/> or <https://www.usablestats.com/tutorials.php>, whereas two large and continually growing repositories are MERLOT and CAUSEweb (Everson & Gundlach, 2010).

However, material from these tools can usually not be modified or extended and therefore cannot be adapted to the specific needs of a given class. Moreover, although the assessment feedback for students is often quite detailed in these tools, a feedback for lecturers, for example, regarding frequency of tool use, students' achievement and students' evaluations

of comprehensibility of the course, is usually not available. For these reasons, lecturers teaching statistics often employ individual learning platforms in their courses, enabling them to provide material they have created (or at least consciously selected) themselves and to choose between several feedback options implemented in the platforms. However, these options are usually predefined, only slightly adjustable and therefore restricted. Nevertheless, such blended learning configurations can fit well with specific needs and have been evaluated positively. Wieling and Hofman (2010) showed that the use of an online platform with videos, quizzes and feedback can increase student achievement. Neumann et al. (2011) demonstrated that the use of a learning environment providing lecture notes and multimedia presentations helped students to understand the course content.

In this report we introduce a new computer-based learning tool that has accompanied a statistics course for first year psychology students<sup>1</sup> and can be used solely or in combination with existing tools. It is a set of multiple consecutive online questionnaires<sup>2</sup> in which students reflect on the course content, work on assessment exercises followed by sample solutions, and give feedback concerning the lectures. In particular, the potential of a flexibly tailored, constant and mutual feedback between students and lecturers was exploited in the implementation, and considered especially the specific needs of the lecturer and students on that course.

## The online questionnaires

After having completed a thematic unit in the course, the lecturer announced that a questionnaire about the theme would be available online for the next seven days and published the web address via email. The main aim of the online questionnaires was to support students to master the course content. To this end, the questionnaires promoted students' reflection of their abilities and deficits, as well as their acquisition of knowledge.

Within the questionnaires students were advised to carefully reflect the course content taught in the previous face-to-face lectures, both the entire themes (e.g., probability distributions) as well as each concept of the theme (e.g., normal distribution, students' *t*-distribution). They indicated how well they have been able to follow the lectures on a scale ranging from 1 (*not at all*) to 6 (*very good*). Then they stated in an open response format what had contributed to their understanding of the lectures and what problems they had encountered. Subsequently students rated how well they understood the specific concepts from 1 (*not at all*) to 6 (*very good*). Therefore, the authors listed the most important concepts presented in the previous lectures. By indicating how well they have been able to follow the lectures and how well they have understood the concepts, students differentiated between content they did understand and content they did not understand and thereby identified difficulties and deficits. Because reflection is a key component of learning, which leads to the construction of meaning from experience and a broader understanding of the learning content (Boud, Keogh, & Walker, 1985; Costa & Kallick, 2008; Mezirow, 1990), providing students with regular possibilities to review their learning is a valuable support.

Also, each questionnaire offered the opportunity to practice the course content and to receive performance feedback. Within statistics education, realistic applications that include assessment exercises and a subsequent constructive feedback are effective (Garfield & Ben-Zvi, 2007; Lovett & Greenhouse, 2000). Thus, in the second part of each questionnaire, students were asked to solve several knowledge based questions, using either a multiple choice format with one correct answer or an open response format with a predefined text

area. Afterwards, sample solutions including stepwise explanations were presented. Again, this enabled students to identify possible deficits and to redirect their learning towards those deficits. Besides the transfer of learned content to real problems, students obtained a more objective feedback about their learning achievement than by indicating how well they “think” they understood a concept. From a didactic point of view another benefit can be added: highly relevant content was accentuated, which might help students to differentiate between major and less relevant concepts.

Another important aim of the online questionnaires was to provide the lecturer with a detailed feedback regarding the comprehensibility of the lecture and the students’ level of knowledge, enabling the lecturer to respond to students’ problems in the following lectures, for example, by explaining a concept again. Ultimately, such feedback can help lecturers to improve future lectures and instructional methods as well as their professional development (Beck, Livne, & Bear, 2005; Rolfe & McPherson, 1995). In this respect, it should be emphasized that improvements in teaching lead to better learning outcomes among students and to a higher competence and satisfaction among lecturers (Hellmann, Paus, & Jucks, 2014).

The questionnaires were created using the software package “Unipark” (Globalpark, 2007) and were accessible from any internet-supported device. It is important to note that students answered the questionnaires in a self-sufficient and independent way. Completing the questionnaires was voluntary and anonymous, and could be done at any convenient time and place within one week. Approximately three days later, the lecturer received a summary of the students’ responses.

## **Comparison with classic non-computerized methods**

In order to examine if and how the online questionnaires improve the learning and teaching of statistics, a comparison with non-computerized methods, supporting students in their statistics education, seems promising. Two frequently used methods are accompanying tutorial classes (e.g., extra classes taught by senior students) and assessment exercises in courses (e.g., provision of worksheets or mock examinations by the lecturer).

While a detailed feedback for students and lecturers that is geared to their specific needs is possible in both methods (as in the online questionnaires), the flexibility for lecturers and students (a major advantage of the online questionnaires) is quite restricted. Content and implementation of both methods are largely dependent on the structure and progress of the main course (i.e., the lecture). Thus, an entirely flexible adaptation to changes in course contents, didactic approaches or focus – for example, to respond to actual course requirements – is in principle feasible, but is associated with a lot (more) work to appropriately prepare and coordinate the supplementary methods. In contrast an online questionnaire can be edited easily and independently at any time and place. Thus, an entirely flexible adaptation to changes can be done much more quickly and with little effort. Moreover, in both non-computerized methods, regular participation and physical attendance of students at the university at a certain time is usually required (except for exercises that can be done outside class).

Finally, every method produces a certain amount of costs in terms of financial resources and time (e.g., software licenses, staff expense, preparation and coordination time), but accompanying tutorial classes produce the highest costs. In contrast, constructing and integrating online questionnaires in courses is neither very expensive nor demanding. Initially, a software license and a certain amount of time is needed for implementation, but for

**Table 1.** Systematic comparison of accompanying methods and tools.

	<i>Computer-based tools</i>			<i>Non-computerized methods</i>	
	<i>Commercial and freely available software/applets/tutorials</i>	<i>Blended learning platforms</i>	<i>Online questionnaires</i>	<i>Accompanying tutorial class</i>	<i>Assessment exercises in courses</i>
<i>Basic aims</i>					
Provision of material to review and master course contents	+	++	++	++	++
Flexibility for lecturer (adaptability on course requirements, independency from course structure, independency from time in class)	++	++	++	—	—
Flexibility for students (voluntariness of commitment, independency from time and place)	++	++	++	—	—
Detailed feedback options for lecturers	—	+	++	++	++
Detailed feedback options for students	+	+	++	++	++
Avoidance of costs (licences, staff expense, time)	—	—	—	—	—

Notes:

++: Feature is incorporated and can be tailored.

+: Feature is incorporated.

—: Feature is not incorporated, but in principle feasible under certain conditions.

—: Feature is not incorporated.

recurring courses a greater long-term benefit can be expected since at least parts of the online questionnaires can be used in later courses. A systematic comparison of the basic aims of the described methods and tools is given in Table 1.

## Evaluation

Each of the 11 online questionnaires accompanying the course was answered by 20 to 46 participants (see Table 2). On average, in the first semester, each questionnaire was answered by 35 students and in the second semester each questionnaire was answered by 25 students. Overall, participation rates decreased during the first semester and then stabilized at around 25 participants.

Since answering the online questionnaires was anonymous, there was no objective way of determining whether students participated constantly by filling in each online questionnaire, or whether students did not participate constantly, so that each online questionnaire was answered by different students. Thus, for an entire investigation of the usefulness of the online questionnaires, more data was required.

Hence, data from an ongoing longitudinal study was used for evaluation purposes. Having completed their first year, psychology students were asked to fill in a paper-and-pencil

questionnaire to assess the frequency of answering the online questionnaires from 1 (*never*) to 6 (*every time*), the helpfulness of the online questionnaires from 1 (*not helpful at all*) to 6 (*very helpful*) and were asked to give an (optional) open feedback regarding the online questionnaires. Also, students were asked for information about demographics and academic success (measured by study grades and satisfaction with the studies). Answering the paper-and-pencil questionnaire was voluntary and anonymous.

The total number of students who answered the paper-and-pencil questionnaire was 81 (69 female, 12 male;  $M_{\text{age}} = 23.22$ ,  $SD = 6.40$ ).<sup>3</sup> Almost half of them ( $n = 40$ ) stated that they answered the online questionnaires at least once and 28 out of these stated that they answered them regularly. Students who had answered at least one online questionnaire ( $n = 40$ ) evaluated them as helpful ( $M = 4.50$ ,  $SD = 1.06$ ).

Respondents from the paper-and-pencil questionnaire stated that they were satisfied with their studies ( $M = 4.24$ ,  $SD = 0.58$ ), with the course ( $M = 3.81$ ,  $SD = 1.10$ ) and with the provided support ( $M = 4.70$ ,  $SD = 1.34$ ). Of those responding, 58 students stated that they had already attended the statistics exam<sup>4</sup> (grade:<sup>5</sup>  $M = 2.90$ ,  $SD = 1.07$ , points:  $M = 54.97$  (out of 79 available points),  $SD = 11.42$ ). Pearson correlation coefficients between frequency of answering the online questionnaires and students' satisfaction and success in the statistics exam were calculated (see Table 3).

Of the respondents from the paper-and-pencil questionnaire 55 completed the open feedback regarding the online questionnaires. Positive (versus negative) feedback and suggestions for improvements were identified and counted. Overall, students referred to the

**Table 2.** Student participation in answering the online questionnaires in the 1st semester (Winter Term 2012) and in the 2nd semester (Summer Term 2013).

	<i>Winter Term</i>						<i>Summer Term</i>				
	<i>Q1</i>	<i>Q2</i>	<i>Q3</i>	<i>Q4</i>	<i>Q5</i>	<i>Q6</i>	<i>Q7</i>	<i>Q8</i>	<i>Q9</i>	<i>Q10</i>	<i>Q11</i>
N	46	44	40	25	26	29	29	28	24	20	25
Average			35						26		

Notes:

Q1 to Q11: Online questionnaires one to eleven.

N: Number of students who answered the online questionnaire.

**Table 3.** Pearson correlation coefficients between frequency of answering the online questionnaires and students' satisfaction and performance.

	<i>Satisfaction</i>		<i>Performance</i>	
	<i>with the course</i>	<i>with the support</i>	<i>grade</i>	<i>points</i>
Frequency	.22 <sup>+</sup>	.31*	-.23 <sup>+</sup>	.26 <sup>+</sup>

Notes:

+ $p < .10$

\* $p < .05$

Sample sizes were  $n = 80$  for satisfaction and  $n = 57$  for performance.

questionnaires as “great help” or “very good support” ( $n = 29$ ). Only a few students ( $n = 8$ ) gave negative feedback and stated that, because of the high workload in other courses, they did not have time to answer the online questionnaires. Additionally, four students stated that an individual, personalized feedback would be helpful and a potential improvement of the questionnaires.

To complete the evaluation, we finally assessed the judgements of the lecturer. He particularly emphasized students’ responses in the online questionnaires regarding their understanding of the concepts as helpful for improvements of the current course but also for future courses. He reported that, because of the feedback from the online questionnaires, he provided additional learning material for some basic mathematical operations he had assumed to be known and quickly talked them over during class.

## Conclusions

With regard to the comparison of the presented tools, the online questionnaires offer the highest flexibility for students and lecturers. The provision of material, and the type and detail of feedback, are easily adaptable to specific needs and students, and lecturers receive highly relevant information at relatively low costs. Thus, online questionnaires can be valuable to improve the learning and teaching of statistics, and should be seen as a new *additional* computer-based tool that can be used solely or in combination with other methods.

By establishing online questionnaires in the first year teaching of statistics we mainly pursued two goals: (1) the first aim was to implement a highly flexible method to support students’ learning of the course contents and, thus, to better prepare them for their exam and future studies. In this respect, we found that students answering the online questionnaires emphasized the helpfulness of the questionnaires for their learning progress. Thus, the online questionnaires can improve the understanding of course contents at least according to students’ self-reports; and (2) the second aim was to support the lecturer with useful feedback. In this respect, we found that the summary of students’ responses was helpful in several ways: the lecturer received feedback on whether he explained concepts clearly and on whether students understood the course contents and which difficulties and deficits they reported. Then he used this feedback in the preparation of subsequent lectures. Thus, the online questionnaires can improve lecturers teaching as well.

It should be emphasized that this evaluation provides particularly ecologically valid empirical evidence, because the results originate from a real teaching situation within the university. Nevertheless, we do not want to conceal threats of the internal validity of our results. First, besides the objective participation rates, the evaluation was carried out by self-reports, which can be socially distorted. However, it is unlikely that students hid their true attitudes, since the judgements contained positive as well as negative feedback. Second, although participation rates in the online questionnaires were satisfactory, bearing in mind the general workload of first year students and the expected number of students never answering the questionnaires, the results can be distorted by a self-selection bias. Perhaps particularly highly conscientious, motivated, interested or competent students answered the online questionnaires frequently, whereas students with low conscientiousness, motivation, interest or competencies, but a presumably high need for support, avoided the confrontation with the course content and rarely answered the online questionnaires. In addition, the frequency of answering the online questionnaires could be related to the more or less (both is conceivable) frequent usage of other forms of provided support

(consultation hours, R-tutorial, learning center). Thus, the relationship between frequency of answering the online questionnaires and academic success would represent a phenomenon similar to the “Matthew effect”, in which outcomes (e.g., frequency of use, success) are achieved through target characteristics (e.g., competence of the students) and not through the given conditions (e.g., provided support) (Merton, 1968). Therefore, it is essential to examine and control potential confounding variables in future studies. Third, due to the correlative data in our evaluation, causal inferences were not admissible. For now, we found that students who had answered the online questionnaires more often tended to perform better in the final exam. However, this finding should be interpreted with caution. Correlation coefficients between the frequency of answering the online questionnaires and success in the statistics exam had a small to medium effect (Cohen, 1988), but were not significant. Additionally, in order to trace back students’ performance and satisfaction to the usage of online questionnaires, experimental studies (with randomized assignment to the conditions) are needed. However, strengthening the internal validity (by ensuring control and standardization) usually decreases the ecological validity of a study (where particularly realistic conditions are needed). Ideally, natural and experimental data should be combined to draw reliable inferences. Thus, the validity of the presented results could be strengthened by further evaluations of the online questionnaires through experimental studies and longitudinal examinations in which (potential) confounders will have to be considered.

Finally, future improvements of the online questionnaires might be the development of a smartphone-applet of the online questionnaires, announcing new questionnaires immediately and reminding students of questionnaires they have not yet completed. The implementation of a personalized performance feedback in addition to the sample solutions seems promising, because recent studies have shown advantages for students’ academic success through personalized feedback (Cretu, & Negovan, 2012; Gallien, & Oomen-Early, 2008).

## Notes

1. All psychology students in the bachelor program at our university have to attend the course “Statistics for psychologists I and II” in their first year (1st and 2nd semester) and pass a final exam. The course is taught twice a week with 2 hours per class and covers descriptive and inferential statistics in 11 thematic units. The course started in October 2012 and enrolled 126 first year students.
2. One per thematic unit.
3. For frequency of answering the online questionnaires, helpfulness of the online questionnaires and satisfaction with the studies one missing entry per variable occurred: no participant produced more than one missing entry.
4. 51 passed the exam, 7 failed.
5. In the German education system “1” represents the best grade and “5” represent a fail.

## References

- Aberson, C. L., Berger, D. E., Healy, M. R., Kyle, D. J., & Romero, V. L. (2000). Evaluation of an interactive tutorial for teaching the central limit theorem. *Teaching of Psychology, 27*, 289–291.
- American Psychological Association. (2007). *APA guidelines for the undergraduate psychology major*. Retrieved from <http://www.apa.org/ed/precollege/about/psymajor-guidelines.pdf>
- Beck, R. J., Livne, N. L., & Bear, S. L. (2005). Teachers’ self assessment of the effects of formative and summative electronic portfolios on professional development. *European Journal of Teacher Education, 28*, 221–244.

- Ben-Zvi, D. (2000). Toward understanding the role of technological tools in statistical learning. *Mathematical Thinking and Learning*, 2, 127–155.
- Bliwise, N. G. (2005). Web-based tutorials for teaching introductory statistics. *Journal of Educational Computing Research*, 33, 309–325.
- Boud, D., Keogh, R., & Walker, D. (1985). Promoting reflection in learning. A model. In R. Edwards, A. Hanson & P. Raggatt (Eds.), *Boundaries of adult learning* (pp. 32–56). London, UK: Routledge.
- British Psychological Society. (2012). *Accreditation through partnership handbook guidance for undergraduate and conversion psychology programmes*. Retrieved from [http://www.bps.org.uk/system/files/images/undergraduate\\_accreditation\\_2012\\_web.pdf](http://www.bps.org.uk/system/files/images/undergraduate_accreditation_2012_web.pdf)
- Britt, M. A., Sellinger, J., & Stillerman, L. M. (2002). A review of ESTAT: An innovative program for teaching statistics. *Teaching of Psychology*, 29, 73–75.
- Bush, S., Menzies, G., & Thorp, S. (2009). An array of online teaching tools. *Teaching Statistics*, 31, 17–20.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.
- Cohen, S., & Chechile, R. A. (1997). Overview of ConStatS and the ConStatS assessment. In J. Garfield & G. Burrill (Eds.), *Research on the role of technology in teaching and learning statistics* (pp. 99–108). Voorburg, The Netherlands: International Statistical Institute.
- Connors, F. A., McCown, S. M., & Roskos-Ewoldsen, B. (1998). Unique challenges in teaching undergraduate statistics. *Teaching of Psychology*, 25, 40–42.
- Costa, A. L., & Kallick, B. (2008). Learning through reflection. In A. L. Costa & B. Kallick (Eds.), *Learning and leading with habits of mind: 16 essential characteristics for success* (pp. 221–235). Alexandria, VA: Association for Supervision and Curriculum Development (ASCD). Retrieved from ASCD: <http://www.ascd.org/publications/books/108008.aspx>
- Cretu, R. Z., & Negovan, V. (2012). Does providing personalized feedback in psychology teaching and learning differentiates students' academic performance? *Procedia – Social and Behavioral Sciences*, 33, 652–656.
- Currall, J., Young, S., & Bowman, A. (1997). Review of ActivStats. *Maths & Stats*, 8, 24–28.
- Everson, M., & Gundlach, E. (2010). Teaching bits: What's new with CAUSEweb and MERLOT? *Journal of Statistics Education*, 18. Retrieved from <http://www.amstat.org/publications/jse/v18n1/everson.pdf>
- Gallien, T., & Oomen-Early, J. (2008). Personalized versus collective instructor feedback in the online courseroom: Does type of feedback affect student satisfaction, academic performance and perceived connectedness with the instructor? *International Journal on E-Learning*, 7, 463–476.
- Garfield, J., & Ben-Zvi, D. (2007). How students learn statistics revisited: A current review of research on teaching and learning statistics. *International Statistical Review*, 75, 372–396.
- Genschel, U., Gather, U., & Busch, A. (2002). EMILeA-stat: Structural and didactic aspects of teaching statistics through an internet-based, multi-medial environment. In W. Härdle & B. Rönz (Eds.), *Compstat – Proceedings in Computational Statistics* (pp. 339–342). Heidelberg, Germany: Physica-Verlag.
- German Psychological Society (Deutsche Gesellschaft für Psychologie). (2005). *Empfehlungen der Deutschen Gesellschaft für Psychologie e.V. (DGPs) zur Einrichtung von Bachelor- und Masterstudiengängen in Psychologie an den Universitäten (Revision)*. (Recommendations of the German Psychological Society (DGPs) for the establishment of Bachelor and Master degree programs in psychology at the Universities (Revision)). Retrieved from <http://www.dgps.de/uploads/media/BMEmpfehlungDGPs-rev.pdf>
- Globalpark. (2007). EFS Survey (Version 10.0) (Computer Software). Hürth, Germany: Globalpark GmbH.
- Hellmann, J. H., Paus, E., & Jucks, R. (2014). How can innovative teaching be taught? Insights from higher education. *Psychology Learning & Teaching*, 13, 43–50.

- Lajoie, S. P. (1997). The use of technology for modeling performance standards in statistics. In J. Garfield & G. Burrill (Eds.), *Research on the role of technology in teaching and learning statistics* (pp. 57–70). Voorburg, The Netherlands: International Statistical Institute.
- Lovett, M., & Greenhouse, J. (2000). Applying cognitive theory to statistics instruction. *The American Statistician*, *54*, 196–206.
- Merton, R. K. (1968). The Matthew effect in science. *Science*, *159*, 56–63.
- Mezirow, J. (1990). How critical reflection triggers transformative learning. In J. Mezirow (Ed.), *Fostering critical reflection in adulthood* (pp. 1–20). San Francisco, CA: Jossey-Bass.
- Mitchell, M. L., & Jolley, J. M. (1999). The correlation: A self-guided tutorial. *Teaching of Psychology*, *26*, 298–299.
- Mittag, H. J. (2002). Java applets and multimedia catalogues for statistics education. In *Invited paper presented at the 6th International Conference on Teaching Statistics*. Cape Town, South Africa. Retrieved from [https://www.stat.auckland.ac.nz/~iase/publications/1/7a1\\_mitt.pdf](https://www.stat.auckland.ac.nz/~iase/publications/1/7a1_mitt.pdf)
- Mittag, H. J., & Stemann, D. (2004). *Statistik. Beschreibende Statistik und Explorative Datenanalyse: Interaktive Multimedia-Lernsoftware* (Statistics. Descriptive statistics and exploratory data analysis: Interactive multimedia learning software). Berlin, Germany: Hanser.
- Moore, D. S. (1997). New pedagogy and new content: The case of statistics. *International statistical review*, *65*, 123–137.
- Neumann, D., Neumann, M., & Hood, M. (2011). Evaluating computer-based simulations, multimedia and animations that help integrate blended learning with lectures in first year statistics. *Australasian Journal of Educational Technology*, *27*, 274–289.
- Rolfe, I., & McPherson, J. (1995). Formative assessment: How am I doing? *The Lancet*, *345*, 837–839.
- Ruggeri, K., Díaz, C., Kelley, K., Papousek, I., Dempster, M., & Hanna, D. (2008). International issues in education. *Psychology Teaching Review*, *14*, 65–74.
- Tishkovskaya, S., & Lancaster, G. (2012). Statistical education in the 21st century: A review of challenges, teaching innovations and strategies for reform. *Journal of Statistics Education*, *20*, 1–55.
- Tremblay, P. F., Gardner, R. C., & Heipel, G. (2000). A model of the relationships among measures of affect, aptitude, and performance in introductory statistics. *Canadian Journal of Behavioral Science*, *32*, 40–48.
- West, R. W., & Ogden, R. T. (1998). Interactive demonstrations for statistics education on the world wide web. *Journal of Statistics Education*, *6*. Retrieved from <http://www.amstat.org/publications/jse/v6n3/west.html>
- Wieling, M. B., & Hofman, W. H. A. (2010). The impact of online video lecture recordings and automated feedback on student performance. *Computers & Education*, *54*, 992–998.

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**Fridtjof W. Nussbeck** is full professor for Psychological Methods, Statistics and Evaluation at the Department of Psychology at Bielefeld University. His main research interest is in Structural Equation Modeling and Dyadic Data analysis. As a university teacher, he is also interested in new possibilities to optimize teaching in statistics and research methods as well

as providing students with information about the required skills and, if necessary, where and how to obtain them.

**Greta Ontrup** is a psychology student and a research and teaching assistant at the Department of Psychology at Bielefeld University. Within this context she is involved in the development of worksheets and online questionnaires for first year psychology students' statistics courses and supports students as a tutor in an additional exercise course, in working and learning with worksheets.