GESIS Leibniz Institute for the Social Sciences

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GESIS Spring Seminar 2026

"Advanced Problems in Structural Equation Modeling"

Lecturers:	Suzanne Jak	Terrence D. Jorgensen
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Date: 23 – 27 March 2026
Time: Mo: 10:00 – 17:00, Tu – Fr: 09:30 – 16:30
Venue: GESIS Cologne | Zoom (Hybrid Course)

About the Lecturers

Suzanne Jak is an associate professor in the Faculty of Social and Behavioural Sciences at the University of Amsterdam. She is interested in structural equation modeling (SEM) in general, and specifically in combination with measurement invariance, multilevel data, or meta-analysis (MASEM). MASEM combines using the most informative data with a technique that is so versatile that many other methods can come to be viewed as a form of SEM. With the MASEM lab, she aims to make the technique better known and more user friendly for researchers, and to develop new MASEM methods where needed. This has led to several publications on new methods, as well as tutorial articles, Shiny applications, and an instructive book (second edition forthcoming). Suzanne's research was funded by prestigious VENI (2016) and VIDI (2020) awards from the Dutch Research Council.

Terrence Jorgensen is an assistant professor in the Faculty of Social and Behavioural Sciences at the University of Amsterdam. His areas of expertise span structural equation modeling (SEM), multilevel modeling (MLM), social-relations modeling (SRM), and their intersections (i.e., ML-SEM and the SR-SEM), as well as Bayesian inference and modern missing data methods. His psychometric research interests involve reliability for complex data structures and ways to evaluate measurement invariance / differential item functioning. The Dutch Research Council has twice funded his research to expand SEM's applicability to "round-robin" (or "social network") data, which he accomplishes by integrating it with the social relations model (SRM) in the lavaan.srm R package. As a research software engineer, Terrence also coauthors the lavaan package itself and several critical extensions, such as lavaan.mi (for multiple imputations), semTools, simsem, and blavaan (the "Bayesian lavaan").

Course Description

Structural equation modelling (SEM) is a very general statistical technique, as it has regression analysis, path analysis, and factor analysis as special cases. It is also possible to combine the advantages of these techniques, which makes SEM one of the most general and most flexible techniques available to researchers. As a result, SEM presently is also one the most widely used techniques in the social and behavioral sciences.

In this course you will be introduced to advanced topics in SEM (e.g., measurement invariance, multilevel SEM, meta-analytic SEM, growth curve models, SEM with incomplete and categorical data) and its applications, which can be useful in analyzing your own data as well as in reading and understanding scientific articles in your field in which SEM is applied. You will learn to use the open-source SEM software lavaan to fit these models.

Organizational Structure of the Course

There will be a 3-hour morning session and a 3-hour afternoon session. Each session consists of 1.5–2 hours lecture and 1–1.5 hour practical lab, during which you will apply SEM, mostly with lavaan. We encourage you to try applying these methods you learn to your own data, so you can consult with us when questions arise. If you do not have example data ready to apply a particular method to, we have prepared exercises with example data for you to practice each method. We have 15 min breaks on the hour and 1 hour break for lunch.

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Keywords

Structural equation modeling, SEM, multilevel SEM, measurement invariance, meta-analytic SEM, categorical SEM

Target Group

You will find the course useful if:

- You have plans to apply structural equation modeling in your research
- You want to be able to critically evaluate research articles in which SEM is applied
- You are a student with the plan to apply SEM in your thesis

Course and Learning Objectives

By the end of the course, you will:

- Have a good conceptual understanding of SEM
- Be able to fit the discussed models in lavaan
- Critically evaluate applications of SEM

Course Prerequisites

Participants are expected to have basic knowledge of SEM, some experience with the software R, and to be familiar with the fundamental statistical concepts of regression analysis, basic matrix algebra, and data screening techniques. We will provide reading materials about matrix algebra or R for participants who need to fresh up their knowledge.

Software and Hardware Requirements

Course participants will need to bring a laptop with R/RStudio installed. The latest versions of R and RStudio are available for free at https://cran.r-project.org/ and https://www.rstudio.com/. Participants will need to be able to download files from the internet (free Wifi is provided by GESIS) and will need to have the rights to install R packages on their laptops during the course.

Recommended Literature to Look at in Advance

We use our own open SEM book called 'A lavaan Compendium for Structural Equation Modeling in Educational Research' during this course: https://tdjorgensen.github.io/SEM-in-Ed-compendium/.

Chapters 1 to 20 are recommended to look at in advance, as they introduce the very basics of SEM and of using lavaan (e.g., importing relevant data formats, running familiar regression and ANOVA models as types of SEM). Given the limited time for reading during the week of the course, students may consider reading the chapters (and other literature) recommended for each day in the schedule below.

Day-to-day Schedule and Literature

We use our own open SEM online book called 'A lavaan Compendium for Structural Equation Modeling in Educational Research' during this course: https://tdjorgensen.github.io/SEM-in-Ed-compendium/. The 'Chapters' mentioned below refer to chapters of this book.

Day	Topic(s)
1	<u>Morning</u> ▪ Refresher on the basics of SEM ▪ Measurement equivalence/invariance in multiple groups ▪ MIMIC models

	Afternoon ▪ Moderated nonlinear factor analysis ▪ Measurement equivalence/invariance in dependent measures
	Literature ▪ *Chapters 21–26* ▪ Kolbe, L., Molenaar, D., Jak, S., & Jorgensen, T. D. (2024). Assessing measurement invariance with moderated nonlinear factor analysis using the R package OpenMx. *Psychological Methods, 29*(2), 388–406. https://doi.org/10.1037/met0000501 ▪ Bauer, D. J. (2017). A more general model for testing measurement invariance and differential item functioning. *Psychological Methods, 22*(3), 507–526. https://doi.org/10.1037/met0000077
2	Morning ▪ Latent growth curve models Afternoon ▪ Autoregressive and cross-lagged panel models
	Literature ▪ *Chapters 13 and 29* ▪ Jak, S., Jorgensen, T.D., ten Hove, D. & Nevicka, B. (2023). Modeling cluster-level constructs measured by individual responses: Configuring a shared approach. *Advances in Methods and Practices in Psychological Science,* 6, 1–18. https://doi.org/10.1177/25152459231182319
3	Morning ▪ Multilevel SEM Afternoon ▪ SEM with incomplete data
	Literature ▪ *Chapters 13 and 29* ▪ Jak, S., Jorgensen, T.D., ten Hove, D. & Nevicka, B. (2023). Modeling cluster-level constructs measured by individual responses: Configuring a shared approach. *Advances in Methods and Practices in Psychological Science,* 6, 1–18. https://doi.org/10.1177/25152459231182319
4	Morning ▪ Meta-analytic SEM (on summary statistics) Afternoon ▪ Meta-analytic SEM (on raw data)
	Literature ▪ Jak, S., Li, H., Kolbe, L., de Jonge, H., & Cheung, M.W.-L. (2021). Meta-analytic structural equation modeling made easy: A tutorial and web application for one-stage MASEM. *Research Synthesis Methods, 12*(5), 590–606. https://doi.org/10.1002/jrsm.1498 ▪ Groot, L.J., Kan, K. J., & Jak, S. (2024). Checking the inventory: Illustrating different methods for individual participant data meta-analytic structural equation modeling. *Research Synthesis Methods, 15*(6), 872–895. https://doi.org/10.1002/jrsm.1735 ▪ Groot, L.J., Kan, K. J., & Jak, S. (2025). Does cluster-robust estimation provide within-study effects? A comparison of individual participant data methods in MASEM. *Structural Equation Modeling, 32*(5), 801–813. https://doi.org/10.1080/10705511.2025.2505995

5	Categorical SEM Morning ▪ Path models with categorical predictors, outcomes, and mediators Afternoon ▪ Factor models with categorical indicators, measurement equivalence/invariance
	Literature ▪ *Chapters 12 and 28* ▪ Svetina, D., Rutkowski, L., & Rutkowski, D. (2020). Multiple-group invariance with categorical outcomes using updated guidelines: An illustration using M*plus* and the lavaan/semTools packages. *Structural Equation Modeling, 27*(1), 111–130. https://doi.org/10.1080/10705511.2019.1602776 ▪ Wu, H., & Estabrook, R. (2016). Identification of confirmatory factor analysis models of different levels of invariance for ordered categorical outcomes. *Psychometrika, 81*(4), 1014–1045. https://doi.org/10.1007/s11336-016-9506-0

Additional Recommended Literature

- Jak, S., Jorgensen, T.D., Verdam, M.G.E., Oort, F.J. & Elffers, L. (2020). Analytical power calculations for structural equation modeling: A tutorial and shiny app. *Behavior Research Methods, 54*, 1385–1406.
- Jak, S., Cheung, M. W.-L., Acar, S., & Kindred, R.A. (preprint). *Evaluating differences in latent means across studies: Extending meta-analytic confirmatory factor analysis with the analysis of means*. https://doi.org/10.31234/osf.io/35gtz_v3
- Kamata, A., & Bauer, D. J. (2008). A note on the relation between factor analytic and item response theory models. *Structural Equation Modeling, 15*(1), 136–153. https://doi.org/10.1080/10705510701758406
- Ke, Z., Zhang, Q., & Tong, X. (2019). Bayesian meta-analytic SEM: A one-stage approach to modeling between-
- studies heterogeneity in structural parameters. *Structural Equation Modeling: A Multidisciplinary Journal*, *26*(3), 348–370.
- Mehta, P. D., Neale, M. C., & Flay, B. R. (2004). Squeezing interval change from ordinal panel data: Latent growth curves with ordinal outcomes. *Psychological Methods, 9*(3), 301–333. https://doi.org/10.1037/1082-989x.9.3.301
- Newsom, J. T., Hachem, Z. A., Granger, A. M., & Denning, E. C. (2023). Where did I go wrong with my model? Ten tips for getting results in SEM. *Structural Equation Modeling*, *30*(3), 491–500. https://doi.org/10.1080/10705511.2022.2101113