A Commentary on Mueller (1997)

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Structural equation modeling (SEM) is a popular statistical procedure in social science. Lots of technological advances have provided users a variety of tools to perform SEM, even though users may not really familiar with the underlying statistical theory and building blocks of SEM (Mueller, 1997). Mueller (1997) provide a series of reminders on some of neglected topics, including specification, identification, estimation, and evaluation. Also, Mueller (1997) mentioned the software-driven properties of SEM. The present article aims to provide a serious discussion regarding the software-driven properties of SEM.

Mueller (1997) reviewed the progress of major software packages, such as LISREL (Joreskog & Sorbom, 1996) and EQS (Bentler, 1995). Previously, users have to completely understand several complex matrix in order to obtain a result. Nowadays, users only have to click some slide bars or some pull down menus through user-friendly graphical user interface (GUI). However, these user-friendly tools may not be always good because users without any understanding of SEM can also easily use the tool and propose some results. Some mistakes may be made and may hamper the development of scientific theory. I really believe that this phenomenon exists not only in SEM but in every domains. For example, in functional Magnetic Resonance Imaging (fMRI) domain, the most popular package is SPM, Statistical Parametric Mapping. Lots of researcher used SPM to analyze their collected fMRI data. However, SPM is a black box. Only imaging experts with MATLAB programming skills know how to build up and how SPM works. I am confident that at least half of people used SPM do not understand how it works, but we still use it to analyze data and interpret results. Does it hamper the development of neuroimaging research ? Not really. It actually makes the fMRI data more attractive and more accessible. Does it produce problems ? Yes, it does. Methodological issues always exists in fMRI data due to the problematic usage of SPM. Another example is SPSS, which is the most popular statistical software in the world. Tons of psychologist

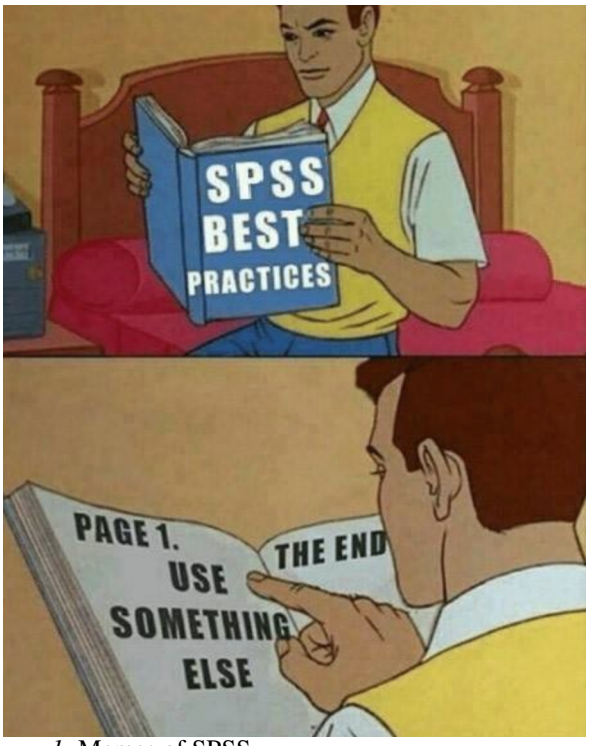

Figure 1. Memes of SPSS

used SPSS, although it is also a black box with GUI. Anyone without clear understandings of a statistical method can use SPSS to produce some results. There is a meme created to discourage the usage of SPSS (Figure 1). The same situation can also be suitably applied to the development of SEM. An user-friendly software is a double-edged sword. It can provide a successful progress in SEM, but also let users forget some important topics of SEM.

In my opinion, I think that there are some potential solutions to partially address these issues. First, some exploratory procedures should be provided. Without going through the exploratory data analysis, the software should not allow users to go to the next step. Second, some automatic detections, e.g., distribution, co-linearity, identifications, can be provided. It may provide an opportunity for users to reconsider heir dataset and their model. For example, if a model users specified is not identified, the software should reject the model and require adjustments from users. Third, based on some automatic

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Draft can be found on https://github.com/PsyChiLin.

detections and exploratory data analysis, some appropriate defaults can be provided. For example, if the input data has the properties of multivariate normality and has enough sample size, maximum likelihood estimation can be automatically set as a default. If not, other corrected method can be automatically adjusted as a default. Finally, these procedure should be integrated into a single platform. Users could easily input their data and get the results with minimum errors and efforts. Whether or not this kind of software will obstruct the way of a researcher to become a SEM expert is not clear (Users who mistakenly use other softwares may not be interested in being a SEM expert. They just want to apply.), but what is clear is that it will let the produced results with minimum errors. I believe that this kind of software developments may have its importance in advancing the scientific progress. In fact, previous research have tried this direction on exploratory factor analysis (EFA) and provided a user-friendly applications with good default arguments (Yu & Sheu, 2018). Maybe it can somehow be applied to SEM community.

However, any adjustments or improvements of software can only address the easy part of SEM. "The hard part is constructing causal models that are consistent with sound theory" (Mueller, 1997). It is not only the most hard part but also the most important part, because SEM can only benefit the model with strong theoretical background. Also, this hardest part can not be trained or addressed within a few days. It required a long time to establish the well understandings toward a domain. Optimistically speaking, although this part is really hard and important, I think that it will not be an issue for behavioral scientist or psychologist who have solid domain knowledge. A researcher with solid background, combined with an useful software or a SEM expert, would be able to deal with any statistical and theoretical issue.

In summary, SEM, like many other methodologies, is software-driven. This phenomenon will not change and will keep progress as long as the increasing of SEN techniques. The present commentary provide some own perspectives to somehow partially address the gap between users and this method. In the near future, maybe some advanced softwares with clear guides can actually be developed for analyses purposes and tutorial purposes. Definitely, do not forget to back to theortical formulations, the basis and most important part of SEM.

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