Research Methods & Statistical Analysis in Education

MODULE HANDBOOK

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Rationale for introducing this course

As the name implies, the "*Science* of Learning" is reliant on the scientific method in studying how humans learn. In turn, the scientific method is the manifestation of modern science as we know if from Karl Popper, Thomas Kun and Paul Feuerabend. As a consequence, if one intends to practise the Science of Learning, one has to know how modern science is conceptualised in the form of research methods and operationalised by means of data-analytical techniques. In addition, since the Science of Learning is frequently associated with the application of neuroscientific methods, it seems appropriate to incorporate some educational neuroimaging techniques, such as functional near-infrared spectroscopy, in the standard repertoire of research methods. Finally, it is not sufficient to be only proficient in the application of research methods and statistical data analyses, but one should also be able to effectively communicate the procedures involved and the results obtained. Thus, academic report-writing is a vital skill every educational researcher should master.

Aims and objectives

The aim of the course is to provide the participants with a sound understanding of what modern science entails. Once this theoretical foundation has been laid, a large proportion of the course is devoted to the study of quantitative research methods including cross-sectional studies, longitudinal studies, randomised-controlled trials and more sophisticated methods to address some of the methodological challenges researchers are facing in educational settings (e.g., carry-over effects, quasi-randomisation of students).

As a next step, the participants will learn how to operationalise various research designs and how to conduct appropriate statistical analyses. Participants will learn how to apply basic statistical techniques, such as correlation, t-tests and analyses of variance and will then move on to more sophisticated statistical approaches, such as multiple regression analysis.

Armed with a sound understanding of research design and statistical techniques, participants will then be introduced to neuroscientific approaches in the context of educational research. Particular attention will be devoted to functional near-infrared spectroscopy (fNIRS) since this portable neuroimaging system is highly suitable to be used in educational settings.

Finally, participants will undergo training in academic writing with a particular focus on the Methods and Results sections of a scientific article. This will enable the participants to adequately communicate their methodological approach and findings with other scientists.

Instructional method

This module will be conducted in Team-Based Learning (TBL) format. TBL typically consists of 3 distinct phases (see Figure below). The first phase is the preparation phase, and it occurs before the actual TBL session. During the preparation phase, students study assigned learning resources to prepare themselves for the topics to be discussed during the TBL session. The second and third phases unfold during the TBL session itself. The second phase is referred to as the readiness assurance phase and allows students to complete a test of their knowledge and understanding of the topic at hand, individually and within a small team, without referring to any learning resources. This test consists of multiple-choice questions that are first completed individually (Individual Readiness Assurance Test [iRAT]) and then again with a team (Team Readiness Assurance Test [tRAT]). Teams are composed of 4 to 5 students. They discuss each question, collaboratively decide on the best answer, and receive an immediate scoring of their answer. The scoring is done electronically and creates the opportunity for further discussion if the team answers incorrectly. At the end of the tRAT, teams spend time discussing the most difficult questions, look up answers to questions they were unsure of, and seek clarification from the teacher. The teacher provides confirmatory and corrective feedback to the students and, if necessary, further instruction. The third and final phase is the

application phase. During this phase, students are presented with case studies or vignettes that reflect significant real- world problems faced by professionals in the field. Within their teams, the students apply the course content they learned in the previous phases by proposing specific solutions to the problems presented and discussing their solutions with the class. The teacher calls on students to justify their solutions and critique each other's responses. At the end of this class discussion, the teacher typically presents best-practice solutions to the problems presented and summarizes the topics addressed during the session.

The 3 Consecutive Phases of Team-Based Learning[a]

Phase 1: Preparation (preclass)	Phase 2: Readiness assurance (in-class)	Phase 3: Application (in-class)
Assigned study material	Individual test (iRAT)	Problem-solving in teams
Individual preparation	Team test (tRAT) with immediate scoring	Simultaneous reporting of solutions
	Students seek clarification	Facilitated interteam discussion
	Teachers offer feedback in response to "burning questions"	

Abbreviations: iRAT indicates Individual Readiness Assurance Test; tRAT, Team Readiness Assurance Test.
[a]Adapted from Michaelsen et al.[8]

This module will be conducted in mini-TBL format which entails a short version of TBL as well as practical sessions, where students can apply what they have learned. Typically, a TBL session constitutes one day of preparation and one day for the actual TBL session. The mini-TBL session will entail a 3 hours preparation and a 3 hours TBL session. The iRAT/tRAT and AE scores will be part of the in-course assessment (i.e., continuous assessment).

Assessment

The assessment is based on the principles of programmatic assessment, which entails that performance of the students will be determined based on in-course tests and assignments. For each mini-TBL session, students will have to complete the individual readiness assurance test (iRAT) and conduct the team readiness assurance test (tRAT) as well as the application exercises (AEs). Students' TBL performance will be determined by means of aggregating the iRAT and AE scores. The iRAT scores are based on percentage correct scores and the AE scores are based on observational scores of two independent examiners. Two elements will be graded: (1) intra-team performance; how well the team members are engaged with each other while working on the AE questions, and (2) between-team performance; how teams interact with each other, e.g., provide feedback, question other teams, and overall engagement. Whereas the iRAT score is an individual score, the AE score is a team score (needs improvement, meets expectations, exceeds expectations). The second assessment component, which is the skills component, is determined by students' individual performance on the assignments for each practical session. Both, the knowledge and skills components, have equal weightage. The minimum pass mark is 60% for this module.

Assessment components

Individual	Group
• iRAT (4) 25% • Assignments (5) 50%	• AE (4) 25%

Overview of the module

Date	Type of session	Venue	Description	Duration
Week 1 **11 Jan**	Zoom Prep	Zoom (444 322 3234, passcode: 1234561)	**Welcome to the course and Introduction to TBL** Content: • Welcome and introduction of the module • Structure of the module • Introduction to the TBL procedure • Preparation for first mini-TBL	**4hrs total** 1hr Welcome 3hrs prep next mini-TBL
Week 2 **18 Jan**	Mini-TBL 6-9 PM	Seminar room 121 Level 2	**Planning for educational research, sampling and psychometrics** Content: • Planning educational research (3) • Sampling (4) • Validity and reliability (6)	**3hrs total**
Week 3 **25 Jan**	Mini-TBL prep	Zoom (444 322 3234, passcode: 1234561)	Prep mini-TBL **Survey research** Content: • Surveys, longitudinal, cross-sectional and trend studies (9) • Optional: students can refer for further details to (15)	**4hrs total** 1hr Q&A 3hrs prep next mini-TBL
Week 4 **01 Feb**	BREAK		**CNY – Fun research project**	4hrs total
Week 5 **08 Feb**	Mini-TBL 6-9 PM	Seminar room 121 Level 2	**Survey research** Content: • Surveys, longitudinal, cross-sectional and trend studies (9) • Optional: students can refer for further details to (15)	**3hrs total**
Week 6 **15 Feb**	Practical 6-9 PM	Seminar room 121 Level 2	**Hands-on: Introduction to SPSS** Content: • Prep: choosing a statistical test (26) • Conduct basic statistics: Importing data into SPSS, descriptive statistics and graphs	**4hrs total** 1hr prep 3hrs practical
Week 7 **22 Feb**	Mini-TBL prep	Zoom (444 322 3234, passcode: 1234561))	Prep mini-TBL **Constructing a Test** Content: • Constructing a test (19) • Optional Questionnaires (15)	**4hrs total** 1hr Q&A 3hrs prep next mini-TBL
Week 8 **01 Mar**	Mini-TBL 6-9 PM	Seminar room 121 Level 2	**Constructing a test** Content: • Constructing a test (19)	**3hrs total**
Week 9 **08 Mar**	Practical 6-9 PM	Seminar room 121 Level 2	**Hands-on: Advanced statistical procedures 1** Content: • Choosing a statistical test (26) • Analysis of associations (correlation and regression)	**4hrs total** 1hr prep 3hrs practical
Week 10 **15 Mar**	Mini-TBL prep	Zoom (444 322 3234, passcode: 1234561)	Prep mini-TBL **Experimental research** Content: • Experiments, quasi-experiments, single case research and meta-analysis (13)	**4hrs total** 1hr Q&A 3hrs prep next mini-TBL
Week 11 **22 Mar**	Mini-TBL 6-9 PM	Seminar room 121 Level 2	**Experimental research** Content: • Experiments, quasi-experiments, single case research and meta-analysis (13)	**3hrs total**
Week 12 **29 Mar**	Practical 6-9 PM	Seminar room 121 Level 2	**Hands-on: Advanced statistical procedures 2** Content: • Analysis of mean differences (t-test, ANOVA)	**4hrs total** 1hr prep 3hrs practical
Week 13 **05 Apr**	Practical 6-9 PM	Seminar room 121 Level 2	**Hands-on: fNIRS** Content: • Setup a portable fNIRS system for data collection	**4hrs total** 1hr prep 3hrs practical
Week 14 **12 Apr**	Practical 6-9 PM	Seminar room 121 Level 2	**How to (read and) write a research paper** Content: • How a paper is structured (PBL paper as example)	**4hrs total** 1hr prep 3hrs practical
			4AU (1AU=13hrs)	**52hrs**

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Week 1: Welcome to the course and introduction to mini-TBL

Content:
In this one-hour session, students will be welcomed to the course by introducing the instructors and students. Then, an overview will be provided of the module objectives and its individual sessions; the innovative mini-TBLs, the practical sessions and the assessment requirements. The remainder of the introduction session will be devoted to familiarising the students with the mini-TBL approach. Students will watch the TBL introductory video. This will provide them with a first overview of what to expect. The instructors will then brief the students on the phases involved in TBL and their purpose (i.e., preparation phase, readiness assurance phase and application phase). Finally, students will be instructed how to prepare for the first mini-TBL and what is expected from them in terms of preparation and the iRAT.

Delivery mode:
Online Zoom session (443 776 3343, passcode: 1234561).

Learning objectives:
After completion of the session students will be able to:

1. Describe how the module is structured;
2. Explain what the assessment requirements are of this module;
3. Describe the three phases of the TBL methodology;
4. Start preparing for the first mini-TBL session;
5. Differentiate between the four major research design elements;
6. Operationalise research questions;
7. Generate hypotheses;
8. Describe what the null- and alternative hypotheses entails;
9. Differentiate between instruments and methodologies in research;
10. Explain how causality in research can be established;
11. Explain the criteria for deciding which from of data analysis to undertake;
12. Apply the planning sequence of research and its stages;
13. Determine sample size;
14. Differentiate between probability and non-probability sampling;
15. Explain the role of triangulation in establishing validity;
16. Describe the threads to validity in the design stage research;
17. Differentiate between the three main types of reliability in quantitative research.

Materials:
TBL video
Book: Research Methods in Education 6th edition (Cohen, Manion, & Morrison, 2007)
Chapter 3: Planning educational research
Chapter 4: Sampling (selected sections)
Chapter 6: Validity and reliability (selected sections)

Q&A Problem statement:

- Most researchers would agree that conducting research in education, hinges on a good research question. But there is more to it than meets the eye! Scientific research is a complex process that consists of sequential phases, each with specific objectives. What are these processes and how can they be used to operationalise research?