Invited Symposium:
What are PIAAC process data used for?

Chair
Frank Goldhammer, Ulf Kröhne & Carolin Hahnel (DIPF | Leibniz Institute for Research and Information in Education, Germany)

Abstract
The first round of the PIAAC study 2011–2012 was innovative in many ways. It was not only the first international large-scale assessment to be mainly computer-based, but it was also the first large-scale assessment that systematically collected log data, that is, events, event-related attributes, and timestamps reflecting the test taker’s interactions with the PIAAC assessment system. Log data found their way into the public use file in the form of generic process indicators such as time on task or number of interactions by item. Moreover, the majority of countries participating in PIAAC round one provided their log data that was recorded during the computer-based assessment to make it publicly available to the research community. Together with the result data and the data from the background questionnaire, the PIAAC log data already has inspired intensive research activities (for an overview see Goldhammer et al., 2020). In this invited symposium, we have brought together four recent contributions dealing with PIAAC process data from different – both substantive and methodological – perspectives. The first presentation by Pokropek and colleagues addresses the question of how process data can be used to explore gender differences in literacy as assessed in PIAAC and PISA. The following contribution by Hahnel and colleagues investigates strategies of information processing in simulated web search environments included in the PIAAC assessment of problem solving in technology-rich environments. The third presentation by He and colleagues focuses on evaluating consistency of adult behavioral patterns across multiple problem solving tasks using PIAAC process data from the US. The final presentation by Maddox and Care expands the perspective in that it takes into account not only PIAAC log data, but other sources of (multimodal) process data such as verbal interaction, facial expressions and gesture.

Presentations
- Title: Utilizing Process Data to Examine Gender Differences in Literacy in PISA and PIAAC.
  Authors: Artur Pokropek (Institute of Philosophy and Sociology of the Polish Academy of Sciences, Poland), Francesca Borgonovi (University College London, UK, and OECD, France), & Lale Khorrmandel (Boston College, USA)
- Identifying Strategies of Information Processing in PIAAC Web Search Environments.
  Authors: Carolin Hahnel, Frank Goldhammer, & Ulf Kroehne (DIPF | Leibniz Institute for Research and Information in Education, Germany)
- Evaluating Consistency of Adult Problem-Solving Behaviors across Multiple Tasks Using PIAAC Process Data.
  Authors: Qiwei He (Educational Testing Service, USA), Dandan Liao (Cambium Assessment, Inc, USA), Hok Kan Ling (Queen’s University, Canada), & Hong Jiao (University of Maryland, USA)
- Title: Multimodal Process Data in PIAAC.
  Authors: Bryan Maddox (University of East Anglia & CEMO, University of Oslo, Norway), & Naomi Care (Assessment Micro-Analytics Ltd, UK)
Utilizing Process Data to Examine Gender Differences in Literacy in PISA and PIAAC.

Authors
Artur Pokropek (Institute of Philosophy and Sociology of the Polish Academy of Sciences, Poland), Francesca Borgonovi (University College London, UK, and OECD, France), & Laale Khorramdel (Boston College, USA)

Abstract
Gender differences in educational assessments that use standardized tests have been the subject of numerous studies for at least half a century. Strong evidence exists for two patterns: boys having higher test scores in mathematics, and girls having higher test scores in reading and literacy. To better examine the impact of problem-solving and test-taking strategies as well as differences in motivation and test-taking effort on gender differences, the current research aims to go beyond the use of classical response and rating data and will utilize log file and process data from computer-based test administrations. The proposed research aims to utilize log and process data from PISA and PIAAC cycle 1 to examine whether female and male examinees in student and adult populations use different problem solving and test-taking strategies or show differences in motivation and test-taking effort which could explain the observed differences in reading and mathematics. In a first step, existing process data indicators which are provided in the public-use data files – item-level response times, number of actions, omitted responses – will be compared between girls and boys for different item types (multiple choice versus constructed response) and at the scale and subscale level for both reading and mathematics. In a second step, big data analytics processes and data science approaches will be applied to the log data for generating new data features and indicators including data sequences, clusters, and graphs. This will be done using bottom-up as well as top-down processes and a combination of both. Theory driven decisions and analysis will be combined with expert ratings of the content domain and item development experts. Moreover, the analysis will build on findings from prior studies and modeling approaches of test-taking efforts and motivation including findings on rapid guessing behavior, careless responding and item revisit behavior.

Identifying Strategies of Information Processing in PIAAC Web Search Environments.

Authors
Carolin Hahnel, Frank Goldhammer, & Ulf Kroehne (DIPF | Leibniz Institute for Research and Information in Education, Germany)

Abstract
Nowadays, it is a common activity to use online search engines to find information needed for a specific task or to solve an information problem. The variety of information provided usually enables web users to locate information quickly and in a focused way, but it also requires them to make numerous decisions (i.e., is a search entry relevant? Is the information...
source reliable and authoritative? Is the information sufficient to solve the information problem? In order to make efficient use of limited time and cognitive resources, web users often employ cognitive heuristics to facilitate necessary decision processes (e.g., by choosing a search result for familiarity reasons or based on its position in the search result list). The present study aims at investigating adults’ approaches to process web information from search engines and their success in finding an optimal solution to a given information problem. PIAAC enables this investigation by means of two items from the domain of problem-solving in technology-rich environments (PSTRE). The items required PIAAC participants to evaluate a given search engine results page and its linked websites in order to select the search entry that is optimal for solving a respective task. More specifically, the participants were requested to select the website that provided the most credible information about a medical treatment (“Sprained ankle”), or the website that offered a product that met specific criteria (“Digital Photography Book”). Participants of the PSTRE assessment were asked to solve either one or both items. Several log data indicators (i.e., time on the search result page until first website visit, number of websites visited, order of website visits) are examined using latent class analysis to identify different groups of processing behavior (e.g., groups indicating comprehensive processing of the search result page, processing focused on the comparison of websites, or disengaged test-taking). Furthermore, we examine whether the identified processing groups differ in terms of item success and, in case of adults completing both web search items, whether processing behaviors are consistent across items. The results of this log data analysis will be presented.

Evaluating Consistency of Adult Problem-Solving Behaviors across Multiple Tasks Using PIAAC Process Data.

Authors
Qiwei He (Educational Testing Service, USA), Dandan Liao (Cambium Assessment, Inc, USA), Hok Kan Ling (Queen’s University, Canada), & Hong Jiao (University of Maryland, USA)

Abstract
The digital assessment platform provides the possibility to collect process data such as action sequences and response times along with the responses to each task. Considering the complexity and high dimensional structure of process data, most studies that draw this new data source focus on one single item. Evaluating the behavioral consistency across items, however, renders possible capturing and modeling person-related latent characteristics, in addition to the measurement by response accuracy. This study draws on process data from log files recorded in the problem-solving in technology-rich environment (PSTRE) domain in PIAAC to evaluate the consistency of behavioral patterns across multiple items. Specifically, we presented two approaches to assess respondents’ behavioral consistency across items: (1) by using aggregate-level response process variables: the number of actions and the total response time to categorize respondents into groups based on their most likely behavioral patterns, and (2) by adding finer-grained information extracted from action sequences with sequence mining techniques. The purpose of this empirical study is twofold: first, to investigate whether the consistent behavioral patterns could be identified by process data features, and second, to examine the association among the consistency of behavioral patterns with cognitive competency and background variables. In the study sample, around 80% of respondents showed consistent patterns by the two dimensions, the response time and the number of actions, when solving multiple items. Respondents who consistently used
long action sequences with short response time were found using the most similar sequences to the predefined optimal solutions. These respondents obtained the highest average PSTRE scores, had the highest ICT skills at home and at work and were the youngest group compared with their peers. Comparatively, respondents who consistently used short action sequences with fast speed had the lowest PSTRE scores and were identified as those who executed the most skipping behaviors. The findings in this study can be useful to provide information for test developers, psychometricians, and instructors for a better understanding of respondents' consistent behavior during the cognitive process and may eventually contribute to improve task and assessment design.

Multimodal Process Data in PIAAC.

Authors
Bryan Maddox (University of East Anglia & CEMO, University of Oslo, Norway), & Naomi Care (Assessment Micro-Analytics Ltd, UK)

Abstract
This presentation by Bryan Maddox and Naomi Care will discuss multimodal process data on test performance, such as verbal interaction, facial expressions and gesture. The presentation will begin with a definition of process data and its different uses. We will then provide illustrative examples with data collected in the OECD’s PIAAC assessments in Slovenia and the UK. The presentation will describe the methodological principles that inform the observation, collection, interpretation and use of multi-modal process data, including the challenges of scale, data representativeness and validity (Goldhammer and Zehner, 2017). While we will extend the notion of process data beyond that of log data, we also emphasize the value of working between modes to enhance, validate and extend the reach and reliability of process data (Maddox, Keslair and Javrh, 2019). We will discuss the importance of the situational, embodied, and temporal features of process data, and the cognitive and affective dimensions of test performance (Maddox and Zumbo, 2017). These different aspects of process data highlight the reasons for broadening the analysis of process data beyond log data, to those wider multimodal characteristics. We will describe and illustrate four primary uses of process data that are relevant to process data in PIAAC. These are: 1) Improving item design, 2) Validation practice, 3) Quality control, and 4) as Extensions of the test (see Maddox, 2020). We will provide examples of how such process data can inform the interpretation and use of PIAAC data.