APPENDIX

D

ITEM RESPONSE THEORY-BASED MODELS FOR MEASURING MOTIVATION AND LEARNING OUTCOMES

For the empirical studies conducted in this PhD thesis dissertation, statistical instruments based on the Item Response Theory (IRT) had been used to estimate the participants' motivation and the learning outcomes. Instead to use the average scores of motivation surveys as measurement of motivation, Rating Scale Model (RSM) is used to estimate the intrinsic motivation and the level of motivation. The learning outcomes had been calculated as gains in skill/knowledge by stacking pre-test and post-test data with Generalized Partial Credit Model (GPCM) to estimate the changes in skill/knowledge when the data were gathered from multiple choice knowledge questionnaires and programming tasks. The first section (section D.1) details the construction and validation procedure of IRT-based models employed in the construction of instruments for measuring the motivation and learning outcomes in the empirical studies. The second section (section D.2) details the procedure for stacking the pre-test data and post-test data with IRT-based models for estimating changes in the latent trait estimates from the pre-test to post-test phase.

The rest of sections are organized as follows:

- section D.3 presents the validation and results of the RSM-based instrument used to estimate the intrinsic motivation in the pilot empirical study;
- section D.4 presents the validation and results of the RSM-based instrument used to estimate the intrinsic motivation in the first empirical study;
- section D.5 presents the validation and results of the RSM-based instrument used to estimate the intrinsic motivation in the second empirical study;

- section D.6 presents the validation and results of the RSM-based instrument used to estimate the intrinsic motivation in the third empirical study;
- section D.7 presents the validation and results of the RSM-based instrument used to estimate the level of motivation in the third empirical study;
- section D.8 presents the validation and stacking procedure for estimating gains in skill/-knowledge of the pilot empirical study;
- section D.9 presents the validation and stacking procedure for estimating gains in skill/-knowledge of the first empirical study;
- section D.10 presents the validation and stacking procedure for estimating gains in skill/-knowledge of the second empirical study; and
- section D.11 presents the validation and stacking procedure for estimating gains in skill/-knowledge of the third empirical study;

D.1 Construction and Validation of IRT-based Models

Let be $i = \{1,2,...,I\}$ the items in a set of responses; and let be $x = \{0,1,...,X\}$ the categories of responses for the item i; then, the probability that a person n scores x on the item i is described in a nonparametric IRT-based model by the item response model (ADAMS; WU, 2007; ADAMS; WILSON; WU, 1997) as:

$$P(X_{n,i} = x|\theta_n) \propto exp(b_{i,x}\theta_n + a_{i,x}\xi).$$

where the symbol "$\propto$" means that the probabilities in the responses are normalized such that $\sum_{x=0}^{X} P(X_{n,i} = x|\theta_n) = 1$; the parameter $a_{i,x}\xi$ is the item intercept ($AXsi$) related to the location on latent trait; and the parameter $b_{i,x}$ is the slope related to the item discrimination.

As this item response model is a generalization of nonparametric models (such as Rasch model, Rating Scale Model - RSM, Partial Credit Model - PCM, General Partial Credit Model - GPCM, and Nominal Response Model - NRM), to be used as an instrument for measuring unidimensional latent traits such as the motivation and skill/knowledge of participants in the empirical studies, three fundamental assumptions related to unidimensional nonparametric models must be checked. These assumptions are the the unidimensionality of data structure, the local independence of items, and the monotonicity of the item characteristic curve. The unidimensionality determines whether items in the instrument measure only one latent trait θ, the local independence verifies the statistical relationship between examinees' responses for each pair of items in the instrument, and the monotonicity checks the relationship between the item responses and the latent trait θ measured by the instrument.

After to check these three fundamental assumptions, the values for the intercept and slope parameters are estimated by means of the Marginal Maximum Likelihood (MML) method

(BOCK; AITKIN, 1981); then, the latent trait θ that represents the measurement of motivation or skill/knowledge for the participants in the empirical studies are computed by the Weighted Likelihood Estimator (WLE) (WARM, 1989).

D.1.1 Checking Assumptions

Test of Unidimensionality

Currently, there are a variety of statistic methods to assess the dimensionality of IRT-based models (HATTIE, 1985; NANDAKUMAR *et al.*, 1998), but not one of them is universal to determine the dimensionality. The most common statistic methods are based on factor analysis with eigenvalue-greater-than-one rule, ratio of first-to-second eigenvalues, parallel analysis, Root Means Square Error of Approximation (RMSEA) or chi-square tests. For the data gathered by means of motivation surveys, the unidimensional Confirmatory Factor Analysis (CFA) (BROWN, 2014) and the DETECT analysis (STOUT *et al.*, 1996; ZHANG, 2007) had been carried out to determine the dimensionality of IRT-based models.

Indices based on factor analysis, Chi-square (χ^2), Adjusted Goodness of Fit Index (AGFI), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI) are used in the unidimensional CFA as indices to evaluate whether the items in is unidimensional (BROWN, 2014). Lower values of the Chi-square (χ^2) indicates best fit. Values of AGFI, TLI and CFI are considered acceptable for the range of 0.90 to 0.95, and they indicate good fit when these values are higher than 0.95. The DETECT analysis under a conditional covariance-based nonparametric multidimensionality assessment computes the indices DETECT, ASSI and RATIO (ZHANG, 2007), where DETECT index greater than 1.00 indicates strong multidimensionality, DETECT index between 0.40 and 1.00 indicates moderate multidimensionality, DETECT index between 0.20 and 0.40 indicates weak multidimensionality, and DETECT index lower than 0.20 indicates essential unidimensionality. *Essential unidimensionality* in the data structure is indicated when the ASSI < 0.25 and RATIO < 0.36, and *essential deviation from unidimensionality* is indicated when the ASSI > 0.25 and RATIO > 0.36.

The test of unidimensionality had been carried out in R software version 3.4.3 (R Core Team, 2017) in which the lavaan package version 0.5 (ROSSEEL, 2012) and the sirt package version 2.6 (ROBITZSCH, 2018) had been used to conduct the unidimensional CFA and the DETECT analysis, respectively. The R scripts for the test of unidimensionality are available at the URL: <https://geiser.github.io/phd-thesis-evaluation/>

Test of Local Independence

For unidimensional IRT models:

> "Local independence means that when abilities influencing test performance are held constant, examinees' responses to any pair of items are

> statistically independent. In other words, after taking examinees' abilities into account, no relationship exists between examinees' responses to different items. Simply put, this means that the abilities specified in the model are the only factors influencing examinees' responses to test items" (HAMBLETON; SWAMINATHAN; ROGERS, 1991)

Thus, the independence is tested by the $Q3$ statistic of item pairs i and j in which the correlation of items i and j is calculated as $Q3_{i,j} = Cor(e_{n,i}; e_{n,j})$, where $e_{n,i} = X_{n,i} - E(X_{n,i})$ represents the residual between the response of a person n for the item i and the expected response. According to the null test in the condition of independence, the effect size of model fit is defined by the average of absolute values of adjusted correlation Q3 ($MADaQ3$), and by the maximum adjusted correlation Q3 ($maxaQ3$). In this sense, under local independence the average of absolute of adjusted correlation Q3 is slightly smaller than zero ($MADaQ3 \approx 0$), and the null condition is not rejected ($p > 0.05$).

The TAM: Test analysis modules package version 2.10 (ROBITZSCH; KIEFER; WU, 2018) is employed to carried out the test of local independence in R software version 3.4.3 (R Core Team, 2017). The R scripts for the test of local independence are available at the URL: <https://geiser.github.io/phd-thesis-evaluation/>

Test of Monotonicity

For evaluating the manifest monotonicity in the IRT-based models, the Mokken scale analysis (MOKKEN, 1971; Van der Ark, 2007) had been carried out with the data gathered through motivation surveys. In this analysis, the monotone homogeneity model and the double monotonicity model are used to check the assumptions of monotonicity. Employing these models, the *item step response function* $P(X_i \geq x|\theta)$ calculates the ordering of the scores for each item i reflecting the hypothesized ordering on the latent trait θ. The violation of monotonicity in this function is indicated at a significance level $\alpha = 0.05$ when the criteria *minvi* is greater than 0.03.

The test of monotonicity is carried out in R software version 3.4.3 (R Core Team, 2017) by employing the mokken package version 2.8.10 (Van der Ark, 2012; Van der Ark, 2007). The R scripts for the test of monotonicity are available at the URL: <https://geiser.github.io/phd-thesis-evaluation/>

D.1.2 Estimating Item Parameters

Employing the Marginal Maximum Likelihood (MML) method (BOCK; AITKIN, 1981), the item intercepts *AXsi* ($a_{i,k}\xi$) and the slopes related to the item discrimination ($b_{i,x}$) had been calculated by the TAM: Test analysis modules package version 2.10 (ROBITZSCH; KIEFER; WU, 2018) in the R software version 3.4.3 (R Core Team, 2017). The R scripts used for estimating the item parameters are available at the URL: <https://geiser.github.io/phd-thesis-evaluation/>

D.1.3 Obtaining the Latent Trait Estimates

The latent trait estimates (intrinsic motivation, level of motivation and skill/knowledge) is calculated by the Weighted Likelihood Estimator (WLE) (WARM, 1989) in which the latent trait distribution is assumed as a normal distribution with mean of $\mu = 0$ and units in *logits*. These estimates had been calculated in the R software version 3.4.3 (R Core Team, 2017) employing the TAM: Test analysis modules package version 2.10 (ROBITZSCH; KIEFER; WU, 2018). The R scripts used to obtain the latent trait estimates are available at the URL: <https://geiser.github.io/phd-thesis-evaluation/>

D.2 Stacking Procedure with IRT-based Models

Traditionally, the measures of changes in latent traits estimates (e.g. motivation, mood, and skill/knowledge) are calculated as a difference of scores in the IRT-base gathering instruments. Such difference is calculated by subtracting the initial score obtained in a pre-test phase from the final score obtained in post-test phase, but this measurement causes some errors of measurements and misinterpretation (LORD, 1956; LORD, 1958). In addition, the variance, correlations, and reliability of score difference are dependent of population. To overcome these difficulties, different statistical methods such as residual change scores, and multi-wave methods have been proposed for measuring changes in latent traits estimates (DIMITROV; RUMRILL, 2003; ROGOSA; WILLETT, 1985), but the use of IRT-based models is the most effective in solving the classical problems in the measurement of change in latent trait estimates (GLÜCK; SPIEL, 1997; QUEIROZ *et al.*, 2013).

Measurement of change in the latent trait estimates using IRT-based models presents a challenge in which the measurement from Time 1 to Time 2 should also consider a change in the item parameters. To measure this change, it is necessary to define a reference frame encompassing both times in one unambiguous representation. This process of placing Time 1 data and Time 2 data together in an unique frame of reference is known as *stacking procedure* (WRIGHT, 2003). For the empirical studies conducted in this dissertation, the stacking procedure involves the treating of formative assessments as source of data in which the Time 1 is the pre-test phase and Time 2 is the post-test phase. As these data are gathered from programming tasks and multiple knowledge choice questionnaires, the General Partial Credit Model (GPCM) (MASTERS; WRIGHT, 1996) had been used as instrument to estimate the skill/knowledge. With this model, the measure of gains in skills and knowledge is carried out in three steps: (1) Data verification, (2) Item splitting, and (3) Calculating changes. This stacking procedure had been carried out in the R software version 3.4.3 (R Core Team, 2017) using the TAM: Test analysis modules package version 2.10 (ROBITZSCH; KIEFER; WU, 2018). The R scripts for the stacking procedure with GPCM are available at the URL: <https://geiser.github.io/phd-thesis-evaluation/>

D.2.1 Step 1: Data Verification

The data verification consists into carried out GPCM analyses for the data gathered in pre-test phase and post-test phase, independently. This verification aims to detect and eliminate gross errors in the data entry. As result of these analyses, items and observations that distort or degrade the measurement system had been removed from the stacked analysis. For the identification of these items and observations, *Infit* and *Outfit* statistics are used in which mean-square values greater than 2 indicate the distortion and degradation. The stability of the reference frame is also obtained in this step by plotting the item parameters estimated by the GPCM analyses with the post-test data (Time 2 data) against those item parameters estimated with the pre-test data (Time 1). In this plot, a close fit to the identity line indicates stability in the reference frame.

Prior to the data verification, the responses gathered from multiple choice questionnaires and the programming tasks are scored according to the rules described below.

Scoring-rule for Multiple Choice Questionnaires

Let NBC be the number of correct responses which have been checked, NM be the number of wrong responses; and NMC be the number of wrong responses which have been checked; then, the scoring rule for a n-th question in a multiple choice questionnaire is given by:

$$score(n) = \begin{cases} 0 & \text{if } NBC = 0 \text{ or} \\ (NBC)(NM+1) - NMC & \text{otherwise} \end{cases}$$

Construction of Guttman-based Scoring-rules for Programming Tasks

Guttman-based scoring rules for programming tasks (GUTTMAN, 2017) are scoring rules based on the principle of Guttman scale in which a unidimensional scale is defined as an aggregation of different indicators. In this sense, a Guttman-based scoring rule consists in a function that defines the combination of indicators based on a set of thresholds. For example, giving the indicators of correctness (Q) and time (T); and the thresholds of $Q = 1$ when the programming task has been solved adequately, and $T_n = 1$ when the time to solve the programming task is less than n-th percentile; then, a Guttman-structure scoring rule can be defined by the cartesian product $Q \times T_{75} \times T_{50} \times T_{25}$ as follows (x denotes either of 0 and 1):

$(0,x,x,x) = 0$	when the solution is incorrect and the solving time is irrelevant
$(1,0,x,x) = 1$	when the solution is correct and the solving time is greater than 75-th percentile (3rd quartile)
$(1,1,0,x) = 2$	when the solution is correct and the solving time is greater than 50-th percentile (median)
$(1,1,1,0) = 3$	when the solution is correct and the solving time is greater than 25-th percentile (1st quartile)
$(1,1,1,1) = 4$	when the solution is correct and the solving time is less than 25-th percentile (1st quartile)

Let P_i be a programming task solved by the participants during the pre-test and post-test phases, it has been scored according to the following four Guttman-based scoring rules:

P_iS_1: Q

$(0) = 0$	when the solution is incorrect
$(1) = 0$	when the solution is correct

P_iS_2: $Q \times T_{50}$

$(0,x) = 0$	when the solution is incorrect and the solving time is irrelevant
$(1,0) = 1$	when the solution is correct and the solving time is greater than median
$(1,1) = 2$	when the solution is correct and the solving time is less than median

P_iS_3: $Q \times T_{67} \times T_{33}$

$(0,x,x) = 0$	when the solution is incorrect and the solving time is irrelevant
$(1,0,x) = 1$	when the solution is correct and the solving time is greater than 33-th percentile
$(1,1,0) = 2$	when the solution is correct and the solving time is greater than 67-th percentile
$(1,1,1) = 3$	when the solution is correct and the solving time is less than 67-th percentile

P_iS_4: $Q \times T_{75} \times T_{50} \times T_{25}$

$(0,x,x,x) = 0$	when the solution is incorrect and the solving time is irrelevant
$(1,0,x,x) = 1$	when the solution is correct and the solving time is greater than 75-th percentile (3rd quartile)
$(1,1,0,x) = 2$	when the solution is correct and the solving time is greater than 50-th percentile (median)
$(1,1,1,0) = 3$	when the solution is correct and the solving time is greater than 25-th percentile (1st quartile)
$(1,1,1,1) = 4$	when the solution is correct and the solving time is less than 25-th percentile (1st quartile)

After scoring the programing tasks with the four Guttman-based scoring rules (P_iS_1, P_iS_2, P_iS_3 and P_iS_4) defined above, each possible combination of rules is tested one by one using the GPCM and a set of programming tasks related to the pre-test phase or post-test phase. With the results of these tests, the measurement instrument of skill/knowledge for the pre-test phase or post-test phase is built employing the combination of rules that best fits with the data gathered over the empirical studies. The chosen set of Guttman-based scoring rules is the one that has best indices in the tests of unidimentionality, local independence and monotonicity for the GPCM (detailed in subsection D.1.1).

D.2.2 Step 2: Item Splitting

In this step, data gathered from the pre-test phase (Time 1) and post-test phase (Time 2) are stacked together vertically, so that each participant in the empirical study appears twice times

and each item appears once time. With these stacked data, the item parameters are estimated employing the MML method in the GPCM. These item parameters are used to plot the stability of reference frame, where: (1) items that are away from the identity line are "*splitting*" into two separate items by splitting their responses into two data sets with missing data at the other time point in which the item is defined; and (2) items that are close to the identity line defines the calibration items for calculating the changes in skill/knowledge.

D.2.3 Step 3: Calculating Changes in Latent Trait Estimates

For calculating the changes in skill/knowledge as changes in the latent trait estimates, the post-test phase (Time 2) is installed as the benchmark to measure the change from the pre-test phase (Time 1). Item parameters ($D2$) and skill/knowledge ($B2$) for the calibration of measurement system are obtained by a GPCM using data gathered from the post-test phase (Time 2). These item parameters ($D2$) are applied in the GPCM with the data gathered from the pre-test phase (Time 1) for estimating the skill/knowledge ($B1$) and the item parameters for the split items ($D1$).

With the skill/knowledge measured in the pre-test phase (Time 1, $B1$) against the skill/-knowledge in the post-test phase (Time 2, $B2$), the changes in the skill/knowledge are calculated as $B2 - B1$ that define an unambiguously frame of reference.

D.3 RSM-based Instrument for Measuring the Intrinsic Motivation in the Pilot Empirical Study

D.3.1 Checking Assumptions

Test of Unidimensionality

Table 38 shows the results for the test of unidimensionality in which the goodness of fit statistics indicate moderate multidimensionality ($0.40 < DETECT < 1.00$) to measure the intrinsic motivation with a DETECT index of 0.565. Essential unidimensionality ($ASSI < 0.25$ and $RATIO < 0.36$) is indicated by the ASSI and RATIO indices with values of 0.020 and 0.015, respectively. The index of $AGFI = 0.945$ in the unidimensional CFA indicates an acceptable fit for measuring the *Intrinsic Motivation*. The sub-scales of *Interest/Enjoyment*, *Perceived Choice*, *Pressure/Tension* and *Effort/Importance* have a good fit indicated by the AGFI index with values greater than 0.95. A good fit with the unidimensional CFA is indicated by the TLI and CFI indices for all the sub-scales with exception of the *Perceived Choice*. The ASSI index indicates essential unidimensionality in the sub-scales of *Interest/Enjoyment* and *Perceived Choice*, and it indicates an essential deviation from unidimensionality in the sub-scales of *Pressure/Tension* and *Effort/Importance*. Essential unidimensionality is indicated by the RATIO index in the sub-scales

of *Interest/Enjoyment* and *Effort/Importance*, and essential deviation from unidimensionality is indicated in the sub-scale of *Perceived Choice* and *Pressure/Tension* by this index.

Table 38 – Goodness of fit statistics related to the test of unidimensionality in the RSM-based instrument for measuring the intrinsic motivation in the pilot empirical study

	df	chisq	AGFI	TLI	CFI	DETECT	ASSI	RATIO
Intrinsic Motivation	8.451	19.955	0.945	0.690	0.729	0.565	0.020	0.015
Interest/Enjoyment	2.468	1.426	0.998	1.023	1.000	0.716	0.067	0.049
Perceived Choice	3.064	9.713	0.978	0.711	0.788	22.998	0.200	0.714
Pressure/Tension	1.982	0.534	0.998	1.117	1.000	17.068	0.333	0.873
Effort/Importance	0.000	0.000	1.000	1.000	1.000	10.746	0.333	0.358

df: degree of freedom; AGFI: Adjusted Goodness of Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index;

Test of Local Independence

Results from the test of local independence in the RSM-based instrument for measuring the intrinsic motivation in the pilot empirical study are summarized in Table 39. According to the p-values, the null condition of local independence is not rejected in any of the four sub-scales of RSM-based instrument. The Standardized Root Mean Squared Residual (SRMSR) indicates a good fit (< 0.10) for the sub-scales of *Interest/Enjoyment* and *Effort/Importance*, and acceptable fit (0.10s) for the *Perceived Choice* and *Pressure/Tension*.

Table 39 – Item residual correlation statistics related to the test of local independence in the RSM-based instrument for measuring the intrinsic motivation in the pilot empirical study

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Interest/Enjoyment	498.445	0.353	0.157	0.083	1.000
Perceived Choice	114.058	0.500	0.248	0.165	0.093
Pressure/Tension	36.673	0.302	0.214	0.153	0.696
Effort/Importance	38.718	0.066	0.044	0.037	1.000

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

Test of Monotonicity

Table 40 summarizes the test of monotonicity in the RSM-based instrument for measuring the intrinsic motivation in the pilot empirical study. These results indicates that there are no one violation of monotonicity in the items at the significance level $\alpha = 0.05$.

Table 40 – Test of monotonicity in the RSM-based instrument for measuring the intrinsic motivation in the pilot empirical study

	ItemH	ac	vi	vi/ac	maxvi	sum	sum/ac	zmax	zsig	crit
Interest/Enjoyment:Item22IE	0.85	0	0		0.00	0.0		0	0	0
Interest/Enjoyment:Item09IE	0.79	0	0		0.00	0.0		0	0	0
Interest/Enjoyment:Item12IE	0.81	0	0		0.00	0.0		0	0	0
Interest/Enjoyment:Item24IE	0.77	4	0	0.0	0.00	0.0	0.00	0	0	0

vi: number of violations; vi/ac: proportion of active pairs; maxvi: maximum violations;
sum: sum of all violations; zmax: maximum z-value; zsig: number of significant z-values; crit: critical value

Table 40 – *(continued)*

	ItemH	ac	vi	vi/ac	maxvi	sum	sum/ac	zmax	zsig	crit
Interest/Enjoyment:Item21IE	0.72	0	0		0.00	0.0		0	0	0
Interest/Enjoyment:Item01IE	0.69	0	0		0.00	0.0		0	0	0
Perceived Choice:Item17PC	0.60	4	0	0.0	0.00	0.0	0.00	0	0	0
Perceived Choice:Item15PC	0.47	4	0	0.0	0.00	0.0	0.00	0	0	0
Perceived Choice:Item06PC	0.52	1	0	0.0	0.00	0.0	0.00	0	0	0
Perceived Choice:Item02PC	0.47	5	0	0.0	0.00	0.0	0.00	0	0	0
Perceived Choice:Item08PC	0.38	0	0		0.00	0.0		0	0	0
Pressure/Tension:Item16PT	0.53	0	0		0.00	0.0		0	0	0
Pressure/Tension:Item14PT	0.45	3	0	0.0	0.00	0.0	0.00	0	0	0
Pressure/Tension:Item18PT	0.56	4	0	0.0	0.00	0.0	0.00	0	0	0
Pressure/Tension:Item11PT	0.36	0	0		0.00	0.0		0	0	0
Effort/Importance:Item13EI	0.46	0	0		0.00	0.0		0	0	0
Effort/Importance:Item03EI	0.44	0	0		0.00	0.0		0	0	0
Effort/Importance:Item07EI	0.48	0	0		0.00	0.0		0	0	0

vi: number of violations; vi/ac: proportion of active pairs; maxvi: maximum violations; sum: sum of all violations; zmax: maximum z-value; zsig: number of significant z-values; crit: critical value

D.3.2 Item Parameters

Table 41 shows the estimated parameters for the RSM-based instrument used to measure the *Interest/Enjoyment* in the pilot empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat*x*" and column "*i*" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat*x*" and column "*i*" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system of *Interest/Enjoyment* is not distorted or degraded by the items.

Table 41 – Estimated parameters in the RSM-based instrument for measuring the interest/enjoyment in the pilot empirical study

	Item01IE	Item09IE	Item12IE	Item21IE	Item22IE	Item24IE
xsi.item	0.888	−0.023	0.368	−0.132	0.332	0.472
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	0.451	1.362	0.971	1.471	1.007	0.867
AXsi.Cat2	0.349	2.172	1.390	2.390	1.460	1.180
AXsi.Cat3	0.783	3.517	2.345	3.844	2.450	2.030
AXsi.Cat4	−0.153	3.493	1.929	3.929	2.070	1.510
AXsi.Cat5	−2.115	2.442	0.487	2.987	0.663	−0.037
AXsi.Cat6	−5.328	0.140	−2.205	0.794	−1.995	−2.834
Outfit	1.532	0.815	0.773	1.058	0.580	0.836
Infit	1.386	0.882	0.801	1.284	0.635	0.957

Table 42 shows the estimated parameters for the measurement instrument of *Perceived Choice* in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 42 – Estimated parameters in the RSM-based instrument for measuring the perceived choice in the pilot empirical study

	Item02PC	Item06PC	Item08PC	Item15PC	Item17PC
xsi.item	0.112	−0.237	−0.491	0.030	−0.469
B.Cat0	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	1.185	1.534	1.788	1.267	1.766
AXsi.Cat2	0.898	1.597	2.104	1.062	2.061
AXsi.Cat3	2.082	3.130	3.891	2.328	3.826
AXsi.Cat4	1.103	2.500	3.515	1.431	3.428
AXsi.Cat5	0.368	2.115	3.383	0.779	3.275
AXsi.Cat6	−0.674	1.422	2.944	−0.181	2.814
Outfit	1.066	0.968	1.452	1.025	0.700
Infit	1.007	0.994	1.375	1.001	0.704

Table 43 shows the estimated parameters for the measurement instrument of *Pressure/Tension* in the pilot empirical study in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 43 – Estimated parameters in the RSM-based instrument for measuring the pressure/tension in the pilot empirical study

	Item11PT	Item14PT	Item16PT	Item18PT
xsi.item	−0.036	0.288	−0.054	0.347
B.Cat0	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000
B.Cat5	5.000	0.000	0.000	0.000
B.Cat6	6.000	0.000	0.000	0.000
AXsi.Cat0	0.000	0.000	0.000	0.000
AXsi.Cat1	1.034	0.272	0.614	0.213
AXsi.Cat2	1.249	−0.275	0.410	−0.392
AXsi.Cat3	2.096	−0.190	0.837	−0.367
AXsi.Cat4	1.895	−1.152	0.217	−1.387
AXsi.Cat5	1.711			
AXsi.Cat6	0.216			
Outfit	1.355	1.000	0.861	0.850
Infit	1.361	0.915	0.842	0.919

Table 44 shows the estimated parameters for the measurement instrument of *Effort/Importance* in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 44 – Estimated parameters in the RSM-based instrument for measuring the effort/importance in the pilot empirical study

	Item03EI	Item07EI	Item13EI
xsi.item	−1.793	−1.571	−1.620
B.Cat0	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000
AXsi.Cat1	7.416	7.195	7.243
AXsi.Cat2	9.886	9.444	9.541
AXsi.Cat3	9.821	9.158	9.303
AXsi.Cat4	10.943	10.059	10.252
AXsi.Cat5	10.732	9.626	9.868
AXsi.Cat6	10.756	9.429	9.719
Outfit	1.012	1.063	0.987
Infit	0.992	1.035	1.030

D.3.3 Intrinsic Motivation as Latent Trait Estimates

Table 45 shows the latent trait estimates by the RSM-based instrument for measuring the *Intrinsic motivation* in the pilot empirical study.

Table 45 – Latent trait estimates and person model fit of the RSM-based instrument for measuring the intrinsic motivation in the pilot empirical study

	Intrinsic Motivation				Interest/Enjoyment				Perceived Choice				Pressure/Tension				Effort/Importance			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10116	−0.404	0.154	0.569	0.557	−0.114	0.340	0.991	1.063	−0.842	0.347	0.487	0.456	0.207	0.387	0.482	0.499	−0.595	0.444	0.020	0.021
10120	0.969	0.240	0.595	0.566	1.906	0.483	0.791	0.888	1.372	0.492	0.530	0.588	−1.126	0.578	0.398	0.306	0.694	0.577	0.864	0.879
10121	0.050	0.161	0.661	0.694	0.399	0.382	1.481	1.713	0.587	0.361	0.402	0.425	0.345	0.396	0.487	0.452	−0.119	0.426	0.017	0.017
10122	−0.171	0.155	1.833	1.867	−2.052	0.572	0.878	0.690	1.170	0.443	0.441	0.480	−0.488	0.420	1.565	1.940	−0.119	0.426	1.391	1.366
10123	−0.311	0.154	0.497	0.495	−0.832	0.330	0.240	0.260	0.236	0.340	0.375	0.387	0.207	0.387	0.821	0.793	−0.430	0.428	0.672	0.685
10126	0.490	0.188	0.917	0.803	1.273	0.443	0.452	0.457	1.170	0.443	0.156	0.122	−0.488	0.420	0.854	0.996	−0.119	0.426	1.376	1.400
10127	0.183	0.167	1.085	1.042	1.906	0.483	0.740	0.808	0.236	0.340	0.780	0.781	−0.195	0.390	0.330	0.359	−0.779	0.473	0.434	0.443
10128	−0.521	0.155	2.364	2.405	−3.515	1.347	0.087	0.096	0.587	0.361	3.270	3.014	−0.336	0.401	2.149	2.637	−2.817	1.034	0.766	0.763
10129	−0.794	0.164	0.817	0.850	−1.785	0.486	0.427	0.471	−0.622	0.335	0.418	0.391	3.173	1.487	0.122	0.133	0.043	0.438	1.521	1.516
10130	−0.147	0.155	0.870	0.817	0.553	0.395	0.119	0.119	−0.305	0.330	0.676	0.674	1.413	0.633	0.328	0.321	0.694	0.577	0.282	0.288
10131	0.239	0.170	1.986	2.120	2.400	0.530	2.083	2.163	−0.959	0.358	1.745	1.866	−0.860	0.496	0.247	0.199	0.429	0.504	0.534	0.572
10132	−0.474	0.154	1.148	1.144	−3.515	1.347	0.087	0.096	−0.199	0.330	1.129	1.136	−0.195	0.390	0.252	0.298	0.221	0.462	0.454	0.421
10134	−0.666	0.159	0.281	0.298	−1.285	0.375	0.139	0.130	−0.731	0.340	0.743	0.778	0.345	0.396	0.232	0.232	−0.595	0.444	0.020	0.021
10135	−0.025	0.159	1.089	1.052	0.399	0.382	1.010	1.099	0.349	0.345	2.289	2.180	0.345	0.396	0.861	0.901	−0.274	0.422	0.757	0.757
10136	−1.021	0.178	0.958	0.997	−3.515	1.347	0.087	0.096	−1.371	0.418	0.510	0.401	0.073	0.383	1.402	1.309	−1.869	0.792	0.419	0.393
10137	0.969	0.240	0.854	0.798	1.474	0.455	0.324	0.317	1.372	0.492	1.290	1.524	−2.621	1.373	0.129	0.145	0.694	0.577	1.150	1.098
10138	−0.001	0.159	0.790	0.756	0.553	0.395	0.711	0.716	−0.410	0.330	0.489	0.492	0.345	0.396	0.297	0.304	1.902	1.193	0.177	0.179
10139	−0.099	0.157	1.163	1.175	−0.223	0.334	0.920	0.888	0.125	0.336	2.016	2.018	−0.488	0.420	1.866	1.854	−0.595	0.444	0.269	0.266
10140	−0.617	0.157	0.514	0.490	−1.045	0.346	0.503	0.513	−0.199	0.330	0.115	0.115	0.845	0.472	1.194	1.258	−1.004	0.524	0.275	0.277
10141	−0.218	0.154	0.484	0.470	0.002	0.349	0.430	0.449	−0.410	0.330	0.483	0.485	−0.060	0.384	0.718	0.632	−0.430	0.428	0.455	0.450
10142	0.076	0.162	0.798	0.791	0.553	0.395	0.872	0.821	−0.305	0.330	0.364	0.365	−0.860	0.496	1.680	1.816	−0.119	0.426	0.500	0.494
10143	0.102	0.163	0.125	0.127	0.125	0.358	0.118	0.119	0.349	0.345	0.140	0.137	−0.060	0.384	0.136	0.149	0.429	0.504	0.028	0.029
10145	−0.357	0.154	0.864	0.851	−0.631	0.324	0.606	0.600	−0.842	0.347	0.785	0.731	0.493	0.411	0.398	0.413	1.902	1.193	0.177	0.179
10146	0.327	0.176	0.384	0.356	0.895	0.420	0.102	0.108	0.349	0.345	0.135	0.136	−0.336	0.401	1.140	1.388	0.694	0.577	0.282	0.288
10148	0.076	0.162	1.010	0.904	0.257	0.370	0.588	0.542	0.714	0.373	0.766	0.739	0.845	0.472	1.200	1.263	0.694	0.577	0.301	0.323
10149	−0.716	0.161	1.830	1.804	−0.936	0.337	3.322	3.288	−1.083	0.371	2.091	1.735	3.173	1.487	0.122	0.133	0.221	0.462	2.008	2.064
10152	0.562	0.194	2.241	1.987	5.221	1.494	0.080	0.089	0.714	0.373	0.625	0.606	−0.195	0.390	0.201	0.184	−0.595	0.444	2.314	2.363
10153	−0.001	0.159	0.675	0.682	0.553	0.395	1.292	1.194	−0.199	0.330	0.880	0.877	−0.336	0.401	0.073	0.082	−0.274	0.422	0.853	0.854
10154	−0.741	0.162	0.489	0.499	−1.160	0.358	1.153	1.092	−1.218	0.391	0.078	0.091	0.493	0.411	0.679	0.655	−0.430	0.428	0.455	0.450
10158	1.160	0.269	1.112	1.220	3.026	0.623	0.865	0.850	0.587	0.361	0.827	0.784	−2.621	1.373	0.129	0.145	1.902	1.193	0.177	0.179

D.4 RSM-based Instrument for Measuring the Intrinsic Motivation in the First Empirical Study

D.4.1 Checking Assumptions

Test of Unidimensionality

Table 46 shows the results for the test of unidimensionality in which the goodness of fit statistics indicate weak multidimensionality ($0.20 < DETECT < 0.40$) to measure the intrinsic motivation with a DETECT index of 0.227. Essential unidimensionality ($ASSI < 0.25$ and $RATIO < 0.36$) in the data structure is indicated for the intrinsic motivation by the ASSI and RATIO indices with values of 0.221 and 0.008, respectively. The index of $AGFI = 0.980$ in the unidimensional CFA indicates an acceptable fit for measuring the *Intrinsic Motivation*. The sub-scales of *Interest/Enjoyment*, *Perceived Choice*, *Pressure/Tension* and *Effort/Importance* have a good fit indicated by the AGFI index with values greater than 0.95. A good fit with the unidimensional CFA is indicated by the TLI and CFI indices for all the sub-scales. The ASSI index indicates essential unidimensionality in the data structure for the sub-scales of *Pressure/Tension* and *Effort/Importance*, essential deviation from unidimensionality is indicated in the data structure of the scales: *Interest/Enjoyment* and *Perceived Choice*. The Ratio index in all the sub-scales indicate essential deviation from unidimensionality.

Table 46 – Goodness of fit statistics related to the test of unidimensionality in the RSM-based instrument for measuring the intrinsic motivation in the first empirical study

	df	chisq	AGFI	TLI	CFI	DETECT	ASSI	RATIO
Intrinsic Motivation	16.260	44.744	0.980	0.649	0.456	0.227	0.221	0.008
Interest/Enjoyment	2.040	2.245	0.996	0.993	0.994	8.710	0.467	0.553
Perceived Choice	2.848	3.640	0.997	0.983	0.975	12.694	0.400	0.605
Pressure/Tension	1.676	2.886	0.979	0.924	0.925	5.922	0.333	0.480
Effort/Importance	0.000	0.000	1.000	1.000	1.000	13.237	0.333	0.564

df: degree of freedom; AGFI: Adjusted Goodness of Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index;

Test of Local Independence

Results from the test of local independence in the RSM-based instrument for measuring the intrinsic motivation in the first empirical study are summarized in Table 47. Although the null condition of local independence are rejected in the sub-scale of *Interest/Enjoyment* and *Pressure/Tension*, their Standardized Root Mean Squared Residual (SRMSR) indicates a good fit (< 0.10) for the sub-scale of *Pressure/Tension*, and and acceptable fit (0.10s) for the *Interest/Enjoyment*, *Perceived Choice* and *Effort/Importance*.

Table 47 – Item residual correlation statistics related to the test of local independence in the RSM-based instrument for measuring the intrinsic motivation in the first empirical study

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Intrinsic Motivation	147.064	0.616	0.190	0.225	0.000
Interest/Enjoyment	519.944	0.495	0.200	0.107	0.003
Perceived Choice	67.919	0.355	0.149	0.106	0.073
Pressure/Tension	42.092	0.397	0.159	0.099	0.017
Effort/Importance	49.082	0.057	0.038	0.015	1.000

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

Test of Monotonicity

Table 48 summarizes the test of monotonicity in the RSM-based instrument for measuring the intrinsic motivation in the first empirical study. These results indicates that there are no one violation of monotonicity in the items at the significance level $\alpha = 0.05$.

Table 48 – Test of monotonicity in the RSM-based instrument for measuring the intrinsic motivation in the first empirical study

	ItemH	ac	vi	vi/ac	maxvi	sum	sum/ac	zmax	zsig	crit
Intrinsic Motivation.Item22IE	0.38	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item09IE	0.47	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item12IE	0.43	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item24IE	0.28	6	1	0.00	0.00	0.00	0.01	0	0	0
Intrinsic Motivation.Item21IE	0.39	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item01IE	0.36	4	0	0.00	0.00	0.00	0.00	0	0	0
Intrinsic Motivation.Item17PC	0.44	3	0	0.00	0.00	0.00	0.00	0	0	0
Intrinsic Motivation.Item15PC	0.36	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item06PC	0.26	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item02PC	0.37	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item08PC	0.41	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item16PT	0.07	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item14PT	0.28	2	0	0.00	0.00	0.00	0.00	0	0	0
Intrinsic Motivation.Item18PT	0.36	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item13EI	0.10	0	0		0.00	0.00		0	0	0
Intrinsic Motivation.Item03EI	0.11	5	1	0.00	0.00	0.00	0.00	0	0	0
Intrinsic Motivation.Item07EI	0.12	0	0		0.00	0.00		0	0	0
Interest/Enjoyment.Item22IE	0.59	0	0		0.00	0.00		0	0	0
Interest/Enjoyment.Item09IE	0.66	0	0		0.00	0.00		0	0	0
Interest/Enjoyment.Item12IE	0.69	3	0	0.00	0.00	0.00	0.00	0	0	0
Interest/Enjoyment.Item24IE	0.57	5	0	0.00	0.00	0.00	0.00	0	0	0
Interest/Enjoyment.Item21IE	0.59	0	0		0.00	0.00		0	0	0
Interest/Enjoyment.Item01IE	0.57	0	0		0.00	0.00		0	0	0
Perceived Choice.Item17PC	0.69	0	0		0.00	0.00		0	0	0
Perceived Choice.Item15PC	0.63	0	0		0.00	0.00		0	0	0
Perceived Choice.Item06PC	0.53	0	0		0.00	0.00		0	0	0
Perceived Choice.Item02PC	0.59	3	0	0.00	0.00	0.00	0.00	0	0	0
Perceived Choice.Item08PC	0.62	0	0		0.00	0.00		0	0	0
Pressure/Tension.Item16PT	0.63	0	0		0.00	0.00		0	0	0
Pressure/Tension.Item14PT	0.61	0	0		0.00	0.00		0	0	0
Pressure/Tension.Item18PT	0.54	0	0		0.00	0.00		0	0	0

vi: number of violations; vi/ac: proportion of active pairs; maxvi: maximum violations;
sum: sum of all violations; zmax: maximum z-value; zsig: number of significant z-values; crit: critical value

Table 48 – *(continued)*

	ItemH	ac	vi	vi/ac	maxvi	sum	sum/ac	zmax	zsig	crit
Pressure/Tension.Item11PT	0.56	0	0		0.00	0.00		0	0	0
Effort/Importance.Item13EI	0.44	0	0		0.00	0.00		0	0	0
Effort/Importance.Item03EI	0.48	0	0		0.00	0.00		0	0	0
Effort/Importance.Item07EI	0.47	0	0		0.00	0.00		0	0	0

vi: number of violations; vi/ac: proportion of active pairs; maxvi: maximum violations;
sum: sum of all violations; zmax: maximum z-value; zsig: number of significant z-values; crit: critical value

D.4.2 Item Parameters

Table 49 shows the estimated parameters for the RSM-based instrument used to measure the *Interest/Enjoyment* in the first empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system of *Interest/Enjoyment* is not distorted or degraded by the items.

Table 49 – Estimated parameters in the RSM-based instrument for measuring the interest/enjoyment in the first empirical study

	Item01IE	Item09IE	Item12IE	Item21IE	Item22IE	Item24IE
xsi.item	−0.353	−0.989	−0.529	−0.661	−0.661	−0.307
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	1.419	2.055	1.595	1.727	1.727	1.373
AXsi.Cat2	2.794	4.066	3.145	3.408	3.408	2.701
AXsi.Cat3	4.736	6.644	5.262	5.657	5.657	4.595
AXsi.Cat4	4.182	6.726	4.884	5.411	5.411	3.995
AXsi.Cat5	3.581	6.762	4.458	5.117	5.117	3.348
AXsi.Cat6	2.121	5.937	3.173	3.963	3.963	1.840
Outfit	1.044	0.756	0.625	0.996	1.003	1.402
Infit	1.039	0.775	0.640	1.106	1.101	1.427

Table 50 shows the estimated parameters for the measurement instrument of *Perceived Choice* in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 50 – Estimated parameters in the RSM-based instrument for measuring the perceived choice in the first empirical study

	Item02PC	Item06PC	Item08PC	Item15PC	Item17PC
xsi.item	−0.541	−0.688	−1.117	−0.292	−1.284
B.Cat0	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	1.607	1.754	2.183	1.358	2.350
AXsi.Cat2	2.434	2.729	3.587	1.937	3.920
AXsi.Cat3	3.944	4.386	5.674	3.199	6.174
AXsi.Cat4	3.608	4.197	5.914	2.614	6.581
AXsi.Cat5	3.659	4.396	6.542	2.417	7.375
AXsi.Cat6	3.245	4.129	6.704	1.754	7.704
Outfit	1.046	1.396	0.895	1.013	0.619
Infit	1.090	1.313	0.835	1.071	0.701

Table 51 shows the estimated parameters for the measurement instrument of *Pressure/Tension* in the first empirical study in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 51 – Estimated parameters in the RSM-based instrument for measuring the pressure/tension in the first empirical study

	Item11PT	Item14PT	Item16PT	Item18PT
xsi.item	1.344	2.034	1.310	1.765
B.Cat0	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000
B.Cat5	5.000	0.000	0.000	0.000
B.Cat6	6.000	0.000	0.000	0.000
AXsi.Cat0	0.000	0.000	0.000	0.000
AXsi.Cat1	−0.810	−1.566	−0.843	−1.298
AXsi.Cat2	−1.985	−3.498	−2.051	−2.960
AXsi.Cat3	−2.780	−5.050	−2.880	−4.243
AXsi.Cat4	−5.108	−8.135	−5.241	−7.059
AXsi.Cat5	−6.783			
AXsi.Cat6	−8.065			
Outfit	0.998	0.879	0.892	1.110
Infit	1.276	0.827	0.922	1.111

Table 52 shows the estimated parameters for the measurement instrument of *Effort/Importance* in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 52 – Estimated parameters in the RSM-based instrument for measuring the effort/importance in the first empirical study

	Item03EI	Item07EI	Item13EI
xsi.item	−1.543	−1.880	−2.684
B.Cat0	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000
AXsi.Cat1	6.967	7.305	8.108
AXsi.Cat2	8.636	9.312	10.918
AXsi.Cat3	9.827	10.840	13.250
AXsi.Cat4	10.075	11.426	14.639
AXsi.Cat5	10.097	11.785	15.802
AXsi.Cat6	9.256	11.282	16.102
Outfit	0.861	1.087	1.070
Infit	0.821	1.174	1.162

D.4.3 Intrinsic Motivation as Latent Trait Estimates

Table 53 shows the latent trait estimates by the RSM-based instrument for measuring the *Intrinsic motivation* in the first empirical study.

Table 53 – Latent trait estimates and person model fit of the RSM-based instrument for measuring the intrinsic motivation in the first empirical study

	Intrinsic Motivation				Interest/Enjoyment				Perceived Choice				Pressure/Tension				Effort/Importance			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10169	0.081	0.188	0.888	0.884	0.774	0.401	0.405	0.433	−0.345	0.341	1.313	1.394	0.822	0.443	0.896	1.063	0.214	0.594	0.216	0.194
10170	0.435	0.216	0.331	0.341	0.339	0.388	0.339	0.339	0.813	0.497	0.318	0.249	−0.914	1.254	0.135	0.149	0.214	0.594	0.256	0.188
10171	0.435	0.216	0.568	0.585	0.774	0.401	0.317	0.325	0.432	0.415	0.202	0.149	−0.007	0.714	0.299	0.321	−0.083	0.547	1.865	2.092
10172	0.012	0.184	0.999	0.735	0.339	0.388	0.336	0.333	0.010	0.363	0.536	0.587	−0.914	1.254	0.135	0.149	−1.296	0.509	1.656	1.655
10174	0.046	0.186	0.467	0.460	0.045	0.393	0.810	0.799	−0.565	0.334	0.044	0.045	−0.007	0.714	0.299	0.321	1.115	0.851	0.303	0.292
10175	0.582	0.233	2.160	1.196	0.774	0.401	0.317	0.325	2.481	1.316	0.105	0.119	−0.914	1.254	0.135	0.149	−0.587	0.505	3.794	3.400
10176	−0.179	0.176	0.651	0.702	−0.622	0.399	0.340	0.354	0.279	0.393	1.286	1.460	1.277	0.383	0.045	0.047	−0.823	0.499	0.796	0.836
10178	0.152	0.192	0.554	0.392	0.194	0.389	0.058	0.058	0.279	0.393	0.537	0.513	0.990	0.414	0.669	0.586	0.214	0.594	0.256	0.188
10179	−0.413	0.169	0.513	0.532	−0.944	0.376	0.155	0.162	−1.210	0.340	0.129	0.119	0.822	0.443	0.131	0.133	1.115	0.851	0.303	0.292
10181	0.152	0.192	0.669	0.743	−0.447	0.403	0.984	0.992	0.432	0.415	0.764	0.654	−0.914	1.254	0.135	0.149	0.214	0.594	1.183	1.322
10183	−0.209	0.175	0.441	0.436	−0.790	0.389	0.316	0.340	0.010	0.363	0.863	0.820	1.277	0.383	0.098	0.109	−0.083	0.547	0.104	0.101
10184	0.116	0.190	0.662	0.648	−0.275	0.402	0.257	0.253	0.140	0.376	1.263	1.339	0.990	0.414	0.528	0.497	1.115	0.851	0.303	0.292
10185	−0.385	0.170	0.159	0.141	−0.790	0.389	0.054	0.055	−0.565	0.334	0.295	0.282	0.990	0.414	0.383	0.393	−0.587	0.505	0.339	0.307
10186	0.189	0.195	1.271	1.106	−0.111	0.398	1.043	1.019	0.605	0.448	1.257	1.383	1.407	0.376	0.389	0.301	2.256	1.456	0.164	0.191
10187	0.826	0.269	2.906	1.891	3.747	1.435	0.083	0.086	0.432	0.415	1.176	1.163	1.658	0.376	1.921	1.937	1.115	0.851	0.303	0.292
10188	−0.269	0.173	0.261	0.248	−0.944	0.376	0.205	0.205	−0.231	0.346	0.243	0.233	0.372	0.563	0.530	0.438	−0.823	0.499	0.101	0.100
10189	−0.269	0.173	1.213	1.010	−0.790	0.389	1.412	1.439	−0.113	0.354	0.599	0.616	1.658	0.376	1.136	1.096	0.581	0.677	0.154	0.093
10190	−0.117	0.178	0.697	0.774	−0.275	0.402	0.272	0.268	0.279	0.393	1.277	1.423	0.625	0.488	0.148	0.100	−1.296	0.509	0.472	0.498
10191	0.081	0.188	1.074	1.161	0.774	0.401	0.821	0.878	−0.113	0.354	1.116	1.184	−0.007	0.714	0.316	0.348	−1.057	0.501	1.676	1.705
10192	0.081	0.188	1.990	2.285	1.281	0.457	1.176	1.304	−0.565	0.334	3.047	3.084	−0.914	1.254	0.135	0.149	−1.057	0.501	1.495	1.458
10193	−0.148	0.177	0.463	0.473	0.045	0.393	0.301	0.301	−0.565	0.334	0.648	0.671	−0.007	0.714	0.299	0.321	−0.823	0.499	0.356	0.360
10195	0.116	0.190	0.477	0.417	0.482	0.389	0.097	0.098	−0.456	0.337	0.694	0.648	−0.914	1.254	0.135	0.149	0.214	0.594	0.256	0.188
10196	−0.179	0.176	0.960	0.999	−0.790	0.389	0.054	0.055	−0.672	0.332	2.341	2.358	−0.914	1.254	0.135	0.149	0.581	0.677	0.678	0.730
10197	0.306	0.204	1.249	1.259	0.045	0.393	0.562	0.568	1.495	0.741	0.470	0.516	−0.914	1.254	0.135	0.149	−0.587	0.505	2.915	3.082
10198	3.433	1.352	0.030	0.034	3.747	1.435	0.083	0.086	2.481	1.316	0.105	0.119	−0.914	1.254	0.135	0.149	2.256	1.456	0.164	0.191
10199	0.046	0.186	1.503	1.549	−0.790	0.389	2.383	2.418	2.481	1.316	0.105	0.119	1.277	0.383	1.793	1.898	−0.823	0.499	0.101	0.100
10200	0.390	0.212	1.049	0.755	1.495	0.495	0.461	0.473	0.010	0.363	0.341	0.350	−0.914	1.254	0.135	0.149	−0.587	0.505	1.515	1.343
10201	0.637	0.240	1.181	0.671	1.495	0.495	0.942	1.004	0.279	0.393	0.242	0.281	0.822	0.443	0.902	0.618	2.256	1.456	0.164	0.191
10202	−0.607	0.166	1.613	1.457	−0.790	0.389	0.054	0.055	−1.210	0.340	0.914	0.856	4.700	1.542	0.119	0.147	2.256	1.456	0.164	0.191
10203	0.081	0.188	2.427	2.880	−0.790	0.389	8.029	7.999	2.481	1.316	0.105	0.119	−0.007	0.714	0.316	0.348	−0.823	0.499	0.796	0.836
10204	0.983	0.298	1.019	1.077	2.625	0.830	0.476	0.536	0.605	0.448	1.257	1.383	−0.914	1.254	0.135	0.149	0.214	0.594	0.498	0.462
10206	0.081	0.188	0.802	0.674	−0.275	0.402	0.520	0.525	1.082	0.578	0.504	0.410	1.658	0.376	0.425	0.464	−0.083	0.547	0.104	0.101

Table 53 – *(continued)*

	Intrinsic Motivation				Interest/Enjoyment				Perceived Choice				Pressure/Tension				Effort/Importance			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10208	0.582	0.233	1.369	1.071	1.495	0.495	0.379	0.346	0.140	0.376	0.917	0.940	0.625	0.488	1.162	1.350	2.256	1.456	0.164	0.191
10209	−0.662	0.166	1.676	1.710	−1.436	0.337	0.586	0.597	−2.665	0.591	0.229	0.180	−0.914	1.254	0.135	0.149	2.256	1.456	0.164	0.191
10210	−0.716	0.166	1.157	1.122	−1.210	0.352	1.032	0.992	−1.441	0.354	0.066	0.068	2.074	0.423	0.873	1.001	1.115	0.851	0.303	0.292
10211	−0.413	0.169	1.845	1.928	1.281	0.457	0.565	0.578	−1.324	0.346	0.741	0.764	0.822	0.443	0.740	0.814	−2.515	0.681	0.463	0.364
10212	0.435	0.216	1.137	0.867	1.495	0.495	0.770	0.812	0.432	0.415	0.713	0.827	1.140	0.395	0.373	0.451	0.214	0.594	0.216	0.194
10213	−0.117	0.178	1.603	1.681	0.626	0.393	1.743	1.790	−0.456	0.337	1.967	2.002	−0.914	1.254	0.135	0.149	−1.820	0.555	0.539	0.451
10214	−0.634	0.166	0.420	0.397	−1.540	0.332	0.482	0.499	−0.885	0.332	0.140	0.141	0.822	0.443	0.742	0.866	−1.296	0.509	0.617	0.639
10215	0.531	0.227	0.983	0.952	0.194	0.389	0.780	0.781	2.481	1.316	0.105	0.119	−0.914	1.254	0.135	0.149	0.214	0.594	1.821	1.335
10216	0.347	0.208	1.114	1.342	0.045	0.393	3.186	3.120	0.813	0.497	0.948	1.241	−0.007	0.714	0.866	0.660	0.581	0.677	0.154	0.093
10217	0.152	0.192	0.965	1.090	−0.944	0.376	0.591	0.609	1.495	0.741	0.385	0.451	−0.914	1.254	0.135	0.149	−0.083	0.547	1.077	1.102
10218	−0.298	0.172	0.812	0.794	−1.326	0.343	0.387	0.387	0.010	0.363	0.740	0.683	1.658	0.376	0.227	0.198	0.581	0.677	0.632	0.507
10219	−0.385	0.170	0.454	0.427	−1.083	0.364	0.171	0.174	−0.456	0.337	0.676	0.666	−0.914	1.254	0.135	0.149	−1.296	0.509	0.275	0.263
10220	0.531	0.227	1.140	1.367	0.626	0.393	1.926	1.943	0.813	0.497	1.707	1.863	−0.914	1.254	0.135	0.149	0.214	0.594	1.183	1.322
10221	0.116	0.190	0.353	0.320	−0.275	0.402	0.110	0.109	0.010	0.363	0.579	0.523	−0.914	1.254	0.135	0.149	0.581	0.677	0.154	0.093
10222	−1.430	0.190	0.779	0.811	−4.054	1.200	0.092	0.099	−2.382	0.505	0.215	0.148	1.787	0.385	0.258	0.195	−0.823	0.499	0.101	0.100
10223	0.637	0.240	0.738	0.466	1.495	0.495	0.346	0.303	0.813	0.497	0.164	0.108	−0.007	0.714	0.316	0.348	−0.344	0.520	0.845	0.793
10224	−0.179	0.176	1.965	2.040	1.757	0.553	0.376	0.354	−1.564	0.364	1.337	1.314	0.372	0.563	1.401	1.249	−0.823	0.499	0.101	0.100
10226	−0.413	0.169	0.841	0.835	−0.944	0.376	0.610	0.685	−1.324	0.346	0.251	0.256	0.372	0.563	1.401	1.249	1.115	0.851	0.303	0.292
10227	−0.825	0.167	0.743	0.729	−1.643	0.331	1.498	1.501	−0.672	0.332	0.324	0.321	2.074	0.423	0.205	0.235	−1.296	0.509	0.326	0.334
10228	−0.239	0.174	0.522	0.406	−0.790	0.389	0.275	0.279	−0.345	0.341	0.448	0.464	0.990	0.414	1.138	0.983	0.214	0.594	0.256	0.188
10230	−0.441	0.169	1.544	1.607	−1.744	0.331	1.999	2.063	0.010	0.363	2.000	1.786	1.533	0.373	1.534	1.752	−0.587	0.505	1.301	1.300
10231	1.664	0.476	0.874	0.975	3.747	1.435	0.083	0.086	1.495	0.741	0.273	0.309	−0.914	1.254	0.135	0.149	0.581	0.677	0.678	0.730
10232	0.189	0.195	0.477	0.528	0.626	0.393	1.330	1.273	−0.113	0.354	0.313	0.345	1.407	0.376	1.445	1.785	0.214	0.594	0.498	0.462
10233	−0.689	0.166	0.712	0.715	−1.950	0.341	0.518	0.527	−0.992	0.333	0.935	0.941	−0.007	0.714	0.602	0.575	−0.587	0.505	0.042	0.043
10234	−0.580	0.167	0.808	0.818	−1.326	0.343	1.571	1.543	−0.885	0.332	0.978	0.983	−0.007	0.714	0.866	0.660	−1.296	0.509	0.326	0.334
10237	−0.021	0.182	0.792	0.859	0.045	0.393	0.988	0.961	0.010	0.363	0.999	1.060	−0.914	1.254	0.135	0.149	−1.057	0.501	1.059	1.029
10238	−0.716	0.166	0.825	0.771	−0.944	0.376	0.330	0.302	−1.324	0.346	0.586	0.541	2.074	0.423	0.873	1.001	−0.083	0.547	0.104	0.101
10240	−0.743	0.166	0.948	0.943	−1.210	0.352	0.707	0.686	−2.168	0.453	0.379	0.357	−0.914	1.254	0.135	0.149	−0.823	0.499	0.391	0.391

D.5 RSM-based Instrument for Measuring the Level of Motivation in the Second Empirical Study

D.5.1 Checking Assumptions

Test of Unidimensionality

Table 54 shows the results for the test of unidimensionality in which the goodness of fit statistics indicate strong multidimensionality ($DETECT > 1.00$) with a DETECT index of 2.305. Essential unidimensionality ($ASSI < 0.25$ and $RATIO < 0.36$) in the data structure is indicated for the level of motivation by the ASSI and RATIO indices with values of 0.212 and 0.152, respectively. The index of $AGFI = 0.990$ in the unidimensional CFA indicates an acceptable fit for measuring the *Level of Motivation*. The sub-scales of *Attention*, *Relevance*, and *Satisfaction* have a good fit indicated by the AGFI index with values greater than 0.95. A good fit with the unidimensional CFA is indicated by the TLI and CFI indices for all the sub-scales. The ASSI index indicates essential unidimensionality in the data structure for the sub-scale of *Attention*, essential deviation from unidimensionality is indicated in the data structure of the scales: *Relevance* and *Satisfaction*. The Ratio index in all the sub-scales indicate essential deviation from unidimensionality.

Table 54 – Goodness of fit statistics related to the test of unidimensionality in the RSM-based instrument for measuring the level of motivation in the second empirical study

	df	chisq	AGFI	TLI	CFI	DETECT	ASSI	RATIO
Level of Motivation	6.883	11.704	0.990	0.951	0.912	2.305	0.212	0.152
Attention	4.632	4.865	0.998	0.998	0.993	5.641	0.067	0.506
Relevance	1.427	1.133	0.997	1.018	1.000	19.151	0.667	0.669
Satisfaction	0.000	0.000	1.000	1.000	1.000	10.099	0.333	0.495

df: degree of freedom; AGFI: Adjusted Goodness of Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index;

Test of Local Independence

Results from the test of local independence in the RSM-based instrument for measuring the level of motivation in the second empirical study are summarized in Table 55. The null condition of local independence is only rejected in the sub-scale of *Relevance* but its Standardized Root Mean Squared Residual (SRMSR) indicates an acceptable fit (0.10s) with value of 0.120. The null condition of local independence are not rejected in the sub-scale of *Attention* and *Satisfaction*, and their SRMSRs indicates a good fit (< 0.10).

Table 55 – Item residual correlation statistics related to the test of local independence in the RSM-based instrument for measuring the level of motivation in the second empirical study

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Level of Motivation	288.358	0.485	0.163	0.124	0.022

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

Table 55 – *(continued)*

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Attention	286.339	0.237	0.134	0.061	1.000
Relevance	68.696	0.366	0.151	0.120	0.040
Satisfaction	54.715	0.237	0.158	0.074	0.237

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

Test of Monotonicity

Table 56 summarizes the test of monotonicity in the RSM-based instrument for measuring the level of motivation in the second empirical study. These results indicates that there are no one violation of monotonicity in the items at the significance level $\alpha = 0.05$.

Table 56 – Test of monotonicity in the RSM-based instrument for measuring the level of motivation in the second empirical study

	ItemH	ac	vi	vi/ac	maxvi	sum	sum/ac	zmax	zsig	crit
Level of Motivation.Item12A	0.64	2	0	0	0	0	0	0	0	0
Level of Motivation.Item19A	0.52	0	0		0	0		0	0	0
Level of Motivation.Item04A	0.64	0	0		0	0		0	0	0
Level of Motivation.Item20A	0.59	0	0		0	0		0	0	0
Level of Motivation.Item16A	0.62	0	0		0	0		0	0	0
Level of Motivation.Item01A	0.63	0	0		0	0		0	0	0
Level of Motivation.Item15R	0.42	0	0		0	0		0	0	0
Level of Motivation.Item21R	0.59	0	0		0	0		0	0	0
Level of Motivation.Item10R	0.53	5	0	0	0	0	0	0	0	0
Level of Motivation.Item13S	0.58	4	0	0	0	0	0	0	0	0
Level of Motivation.Item14S	0.60	4	0	0	0	0	0	0	0	0
Level of Motivation.Item17S	0.51	0	0		0	0		0	0	0
Attention.Item12A	0.77	2	0	0	0	0	0	0	0	0
Attention.Item19A	0.66	0	0		0	0		0	0	0
Attention.Item04A	0.70	0	0		0	0		0	0	0
Attention.Item20A	0.72	0	0		0	0		0	0	0
Attention.Item16A	0.70	0	0		0	0		0	0	0
Attention.Item01A	0.71	0	0		0	0		0	0	0
Relevance.Item15R	0.43	0	0		0	0		0	0	0
Relevance.Item21R	0.53	0	0		0	0		0	0	0
Relevance.Item10R	0.49	0	0		0	0		0	0	0
Relevance.Item08R	0.35	0	0		0	0		0	0	0
Satisfaction.Item13S	0.70	0	0		0	0		0	0	0
Satisfaction.Item14S	0.66	0	0		0	0		0	0	0
Satisfaction.Item17S	0.61	0	0		0	0		0	0	0

vi: number of violations; vi/ac: proportion of active pairs; maxvi: maximum violations;
sum: sum of all violations; zmax: maximum z-value; zsig: number of significant z-values; crit: critical value

D.5.2 Item Parameters

Table 57 shows the estimated parameters for the RSM-based instrument used to measure the *Attention* in the second empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the

item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system of *Attention* is not distorted or degraded by the items.

Table 57 – Estimated parameters in the RSM-based instrument for measuring the attention in the second empirical study

	Item01A	Item04A	Item12A	Item16A	Item19A	Item20A
xsi.item	−0.004	0.053	0.015	−0.290	0.034	0.090
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	1.688	1.632	1.670	1.974	1.651	1.594
AXsi.Cat2	2.833	2.720	2.795	3.405	2.757	2.644
AXsi.Cat3	4.141	3.971	4.084	4.999	4.028	3.858
AXsi.Cat4	3.591	3.365	3.516	4.735	3.440	3.214
AXsi.Cat5	1.928	1.645	1.833	3.357	1.739	1.456
AXsi.Cat6	0.023	−0.317	−0.090	1.739	−0.203	−0.543
Outfit	1.048	1.029	0.606	0.961	1.313	1.046
Infit	1.119	1.075	0.630	0.995	1.425	0.863

Table 58 shows the estimated parameters for the measurement instrument of *Relevance* in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 58 – Estimated parameters in the RSM-based instrument for measuring the relevance in the second empirical study

	Item08R	Item10R	Item15R	Item21R
xsi.item	−1.152	−0.777	−0.821	−0.766
B.Cat0	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000
AXsi.Cat1	4.435	4.060	4.104	4.049
AXsi.Cat2	5.226	4.475	4.563	4.453
AXsi.Cat3	6.531	5.405	5.537	5.372
AXsi.Cat4	6.807	5.305	5.481	5.262
AXsi.Cat5	6.965	5.089	5.309	5.034
AXsi.Cat6	6.913	4.662	4.925	4.596
Outfit	1.231	0.989	0.948	0.832
Infit	1.209	1.020	0.902	0.849

Table 59 shows the estimated parameters for the measurement instrument of *Satisfaction* in the second empirical study in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 59 – Estimated parameters in the RSM-based instrument for measuring the satisfaction in the second empirical study

estimated	Item13S	Item14S	Item17S
xsi.item	−0.415	−0.344	0.025
B.Cat0	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000
AXsi.Cat1	2.615	2.544	2.175
AXsi.Cat2	3.805	3.662	2.924
AXsi.Cat3	5.326	5.112	4.004
AXsi.Cat4	5.125	4.839	3.363
AXsi.Cat5	4.154	3.797	1.952
AXsi.Cat6	2.492	2.064	−0.151
Outfit	0.939	1.000	1.064
Infit	0.957	1.039	1.025

D.5.3 Level of Motivation as Latent Trait Estimates

Table 60 shows the latent trait estimates by the RSM-based instrument for measuring the *Level of Motivation* in the second empirical study.

Table 60 – Latent trait estimates and person model fit of the RSM-based instrument for measuring the level of motivation in the second empirical study

	Level of Motivation				Attention				Relevance				Satisfaction			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10169	−1.408	0.260	0.453	0.528	−1.957	0.419	0.224	0.269	−0.869	0.400	0.922	0.875	−1.982	0.611	0.042	0.044
10170	0.226	0.248	0.641	0.640	0.568	0.435	0.852	0.854	0.006	0.365	0.808	0.789	−0.348	0.554	0.362	0.361
10171	0.802	0.262	0.363	0.344	0.758	0.428	0.134	0.132	1.438	0.726	0.420	0.433	0.978	0.578	0.195	0.194
10172	0.288	0.249	1.043	1.056	0.758	0.428	1.437	1.471	0.265	0.389	0.309	0.295	−0.645	0.536	0.893	0.905
10174	−0.628	0.231	1.109	1.119	−0.952	0.357	0.786	0.796	−1.028	0.425	0.916	0.948	−0.348	0.554	2.933	3.002
10175	1.319	0.294	1.086	1.139	1.764	0.425	1.141	1.166	2.358	1.265	0.133	0.136	0.978	0.578	1.191	1.186
10176	−0.838	0.232	0.270	0.269	−1.070	0.353	0.022	0.020	−1.028	0.425	0.406	0.390	−0.910	0.524	0.408	0.412
10178	0.413	0.252	0.227	0.226	0.758	0.428	0.164	0.163	−0.114	0.359	2.052	1.945	−0.014	0.570	0.145	0.142
10179	0.103	0.246	0.289	0.284	−0.041	0.428	0.082	0.079	0.132	0.374	0.182	0.175	−0.014	0.570	1.042	1.040
10181	−0.248	0.238	1.060	1.074	−0.041	0.428	2.256	2.269	−0.351	0.358	0.286	0.287	−0.645	0.536	0.691	0.675
10183	−0.628	0.231	0.627	0.626	−0.952	0.357	0.855	0.868	−0.726	0.383	0.404	0.383	−0.348	0.554	0.041	0.043
10184	0.870	0.265	0.437	0.449	1.436	0.413	0.571	0.575	0.579	0.441	0.314	0.280	0.978	0.578	0.561	0.565
10185	−0.134	0.240	0.261	0.265	−0.041	0.428	0.531	0.538	−0.114	0.359	0.187	0.184	−0.348	0.554	0.041	0.043
10186	0.043	0.244	2.338	2.347	−0.829	0.364	3.208	3.043	0.006	0.365	0.997	0.981	1.292	0.594	0.773	0.749
10187	−0.191	0.239	1.134	1.102	0.367	0.439	0.732	0.732	−1.212	0.462	0.162	0.147	0.333	0.575	0.078	0.078
10188	0.043	0.244	0.427	0.424	−0.041	0.428	0.548	0.551	0.132	0.374	0.722	0.696	0.333	0.575	0.324	0.324
10189	−1.985	0.335	1.655	2.149	−3.114	0.777	0.617	0.577	−1.028	0.425	2.393	2.356	−4.308	1.561	0.157	0.161
10190	−0.522	0.233	2.803	2.767	−1.665	0.377	1.204	1.170	−0.114	0.359	2.233	2.246	1.628	0.631	1.793	1.868
10191	1.237	0.287	0.858	0.730	1.937	0.438	0.537	0.501	0.412	0.410	0.784	0.837	1.628	0.631	0.036	0.040
10192	1.702	0.340	4.317	3.505	4.367	1.348	0.085	0.086	0.412	0.410	2.788	2.952	1.628	0.631	1.793	1.868
10193	−0.628	0.231	0.731	0.720	−0.557	0.386	0.386	0.366	−0.233	0.357	1.303	1.295	−1.408	0.532	0.651	0.673
10196	−0.469	0.233	0.919	0.912	−0.557	0.386	1.244	1.252	−0.869	0.400	0.343	0.324	−0.014	0.570	0.192	0.189
10197	0.164	0.247	1.334	1.338	0.161	0.437	2.566	2.560	0.006	0.365	1.057	1.049	−0.014	0.570	1.042	1.040
10198	2.516	0.511	1.764	2.085	4.367	1.348	0.085	0.086	0.779	0.489	2.488	2.022	1.628	0.631	1.793	1.868
10200	0.226	0.248	0.470	0.460	0.367	0.439	0.240	0.239	−0.233	0.357	0.325	0.330	0.978	0.578	0.148	0.146
10201	0.670	0.257	0.289	0.293	0.568	0.435	0.240	0.238	0.132	0.374	0.701	0.640	1.628	0.631	0.036	0.040
10202	−0.248	0.238	0.185	0.187	−0.230	0.415	0.346	0.347	−0.726	0.383	0.711	0.779	−0.348	0.554	0.041	0.043
10203	4.338	1.368	0.043	0.045	4.367	1.348	0.085	0.086	2.358	1.265	0.133	0.136	3.664	1.437	0.164	0.171
10204	1.953	0.381	1.280	1.112	3.360	0.789	0.508	0.529	0.779	0.489	0.601	0.604	2.024	0.704	0.955	0.991
10206	0.043	0.244	0.499	0.496	−0.402	0.400	0.435	0.447	−0.114	0.359	1.308	1.267	0.333	0.575	0.371	0.371
10208	−0.469	0.233	0.553	0.543	−0.402	0.400	0.445	0.454	−0.595	0.370	0.464	0.455	−0.645	0.536	0.353	0.352
10209	−1.545	0.273	1.163	1.163	−2.357	0.510	1.388	1.668	−0.595	0.370	1.646	1.700	−1.408	0.532	1.341	1.382

Table 60 – *(continued)*

	Level of Motivation				Attention				Relevance				Satisfaction			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10210	−0.522	0.233	1.262	1.233	−0.952	0.357	0.765	0.744	−0.114	0.359	1.136	1.159	−0.645	0.536	2.513	2.444
10211	−1.700	0.292	0.547	0.564	−2.652	0.599	0.425	0.418	−0.351	0.358	0.929	0.932	−2.386	0.708	0.261	0.212
10212	−0.522	0.233	0.419	0.417	−0.829	0.364	0.405	0.408	0.006	0.365	0.131	0.129	−1.159	0.522	0.535	0.542
10213	0.350	0.250	0.675	0.682	0.367	0.439	1.132	1.129	0.006	0.365	0.125	0.124	1.292	0.594	0.391	0.389
10214	0.164	0.247	0.440	0.433	0.367	0.439	0.252	0.251	0.412	0.410	0.131	0.141	−0.645	0.536	0.353	0.352
10215	0.540	0.254	1.450	1.450	0.367	0.439	1.269	1.272	2.358	1.265	0.133	0.136	−0.014	0.570	2.171	2.202
10216	−0.134	0.240	1.427	1.454	−0.402	0.400	2.949	3.013	0.006	0.365	0.819	0.790	0.333	0.575	0.788	0.787
10217	0.540	0.254	0.328	0.332	0.758	0.428	0.535	0.530	0.412	0.410	0.131	0.141	0.663	0.574	0.451	0.451
10218	−0.134	0.240	0.852	0.870	−0.952	0.357	0.926	0.908	0.132	0.374	0.202	0.198	0.663	0.574	0.038	0.038
10219	−1.052	0.238	1.485	1.466	−1.301	0.353	1.751	1.756	−1.212	0.462	1.333	1.265	−0.910	0.524	0.911	0.914
10220	−0.248	0.238	4.191	4.152	−2.357	0.510	2.272	2.082	2.358	1.265	0.133	0.136	1.628	0.631	1.793	1.868
10221	−0.838	0.232	0.611	0.610	−0.698	0.373	0.440	0.452	−0.726	0.383	0.834	0.882	−1.408	0.532	0.346	0.347
10223	−1.475	0.266	0.513	0.456	−1.803	0.395	0.694	0.670	−1.212	0.462	0.388	0.391	−1.673	0.559	0.452	0.427
10224	0.870	0.265	0.829	0.794	1.274	0.413	0.875	0.876	0.579	0.441	1.065	1.082	1.292	0.594	0.391	0.389
10226	0.939	0.268	0.617	0.610	0.938	0.421	0.802	0.811	0.779	0.489	1.047	0.919	1.292	0.594	0.339	0.343
10227	1.159	0.281	0.246	0.270	1.764	0.425	0.483	0.490	0.579	0.441	0.038	0.038	1.292	0.594	0.089	0.090
10228	−0.076	0.242	0.136	0.134	−0.041	0.428	0.178	0.177	−0.114	0.359	0.115	0.117	−0.348	0.554	0.041	0.043
10230	1.159	0.281	1.190	1.158	2.124	0.459	0.627	0.640	0.579	0.441	0.625	0.616	0.978	0.578	2.064	2.074
10231	−0.575	0.232	0.964	0.953	−1.417	0.357	0.522	0.521	0.006	0.365	0.994	0.976	0.333	0.575	0.692	0.692
10232	1.010	0.271	0.297	0.276	1.109	0.416	0.067	0.068	1.040	0.568	0.452	0.442	1.292	0.594	0.339	0.343
10233	−0.785	0.232	2.458	2.444	0.161	0.437	3.419	3.431	−1.028	0.425	0.231	0.229	−3.014	0.910	0.539	0.552
10234	0.103	0.246	1.444	1.421	0.568	0.435	1.133	1.129	0.132	0.374	2.005	2.061	−0.348	0.554	0.883	0.908
10237	−0.076	0.242	0.527	0.517	−0.402	0.400	0.337	0.325	0.579	0.441	0.281	0.250	−0.645	0.536	0.691	0.675
10238	0.103	0.246	0.222	0.219	0.367	0.439	0.240	0.239	−0.351	0.358	0.176	0.177	0.333	0.575	0.078	0.078
10240	−1.475	0.266	0.147	0.166	−1.803	0.395	0.019	0.023	−0.869	0.400	0.024	0.024	−2.386	0.708	0.462	0.493
10242	−2.395	0.417	0.964	1.247	−4.171	1.373	0.085	0.087	−1.028	0.425	0.578	0.545	−4.308	1.561	0.157	0.161

D.6 RSM-based Instrument for Measuring the Intrinsic Motivation in the Third Empirical Study

D.6.1 Checking Assumptions

Test of Unidimensionality

Table 69 shows the results for the test of unidimensionality in which the goodness of fit statistics indicate strong multidimensionality ($DETECT > 1.00$) to measure the intrinsic motivation with a DETECT index of 6.096. Essential unidimensionality ($ASSI < 0.25$ and $RATIO < 0.36$) in the data structure is indicated for the intrinsic motivation by the ASSI and RATIO indices with values of 0.242 and 0.128, respectively. The index of $AGFI = 0.899$ in the unidimensional CFA indicates an acceptable fit for measuring the *Intrinsic Motivation*. The sub-scales of *Interest/Enjoyment*, *Perceived Choice*, *Pressure/Tension* and *Effort/Importance* have a good fit indicated by the AGFI index with values greater than 0.95. A good fit with the unidimensional CFA is indicated by the TLI and CFI indices for all the sub-scales. The ASSI index indicates essential unidimensionality in the data structure for the sub-scales of *Interest/Enjoyment* and *Pressure/Tension*, essential deviation from unidimensionality is indicated in the data structure of the scales: *Perceived Choice* and *Effort/Importance*. The Ratio index in all the sub-scales indicate essential deviation from unidimensionality.

Table 61 – Goodness of fit statistics related to the test of unidimensionality in the RSM-based instrument for measuring the intrinsic motivation in the third empirical study

	df	chisq	AGFI	TLI	CFI	DETECT	ASSI	RATIO
Intrinsic Motivation	9.598	54.026	0.899	0.156	0.226	6.096	0.242	0.128
Interest/Enjoyment	5.419	8.602	0.996	0.963	0.887	6.028	0.200	0.507
Perceived Choice	4.040	3.576	0.998	1.006	1.000	12.178	0.600	0.803
Pressure/Tension	1.765	1.113	0.999	1.014	1.000	17.469	0.000	0.644
Effort/Importance	0.000	0.000	1.000	1.000	1.000	17.820	0.333	0.776

df: degree of freedom; AGFI: Adjusted Goodness of Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index;

Test of Local Independence

Results from the test of local independence in the RSM-based instrument for measuring the intrinsic motivation in the third empirical study are summarized in Table 70. The Standardized Root Mean Squared Residual (SRMSR) indicates a good fit (< 0.10) for the sub-scales of *Interest/Enjoyment*, *Perceived Choice* and *Effort/Importance*. An acceptable fit (0.10s) has found for the sub-scale of *Pressure/Tension* with value of 0.189. The null condition of local independence is not rejected in the sub-scales of *Interest/Enjoyment*, *Perceived Choice* and *Effort/Importance*.

Table 62 – Item residual correlation statistics related to the test of local independence in the RSM-based instrument for measuring the intrinsic motivation in the third empirical study

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Intrinsic Motivation	169.797	0.738	0.276	0.274	0.000
Interest/Enjoyment	1034.187	0.329	0.147	0.096	0.339
Perceived Choice	180.200	0.316	0.113	0.054	0.284
Pressure/Tension	64.855	0.500	0.338	0.189	0.003
Effort/Importance	52.489	0.211	0.141	0.081	0.430

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

Test of Monotonicity

Table 71 summarizes the test of monotonicity in the RSM-based instrument for measuring the intrinsic motivation in the third empirical study. These results indicates that there are no one violation of monotonicity in the items at the significance level $\alpha = 0.05$.

Table 63 – Test of monotonicity in the RSM-based instrument for measuring the intrinsic motivation in the third empirical study

	ItemH	ac	vi	vi/ac	maxvi	sum	sum/ac	zmax	zsig	crit
Intrinsic Motivation.Item22IE	0.33	0	0		0.00	0.00		0.00	0	0
Intrinsic Motivation.Item09IE	0.33	0	0		0.00	0.00		0.00	0	0
Intrinsic Motivation.Item12IE	0.28	5	1	0.2	0.08	0.08	0.02	0.53	0	51
Intrinsic Motivation.Item24IE	0.18	0	0		0.00	0.00		0.00	0	0
Intrinsic Motivation.Item21IE	0.25	6	0	0.0	0.00	0.00	0.00	0.00	0	0
Intrinsic Motivation.Item01IE	0.29	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Intrinsic Motivation.Item17PC	0.33	0	0		0.00	0.00		0.00	0	0
Intrinsic Motivation.Item15PC	0.32	6	0	0.0	0.00	0.00	0.00	0.00	0	0
Intrinsic Motivation.Item06PC	0.38	0	0		0.00	0.00		0.00	0	0
Intrinsic Motivation.Item02PC	0.33	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Intrinsic Motivation.Item08PC	0.39	0	0		0.00	0.00		0.00	0	0
Intrinsic Motivation.Item16PT	0.16	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Intrinsic Motivation.Item14PT	0.27	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Intrinsic Motivation.Item18PT	0.28	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Intrinsic Motivation.Item11PT	0.11	0	0		0.00	0.00		0.00	0	0
Intrinsic Motivation.Item13EI	0.19	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Intrinsic Motivation.Item03EI	0.06	5	0	0.0	0.00	0.00	0.00	0.00	0	0
Intrinsic Motivation.Item07EI	0.14	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Interest/Enjoyment.Item22IE	0.76	0	0		0.00	0.00		0.00	0	0
Interest/Enjoyment.Item09IE	0.73	0	0		0.00	0.00		0.00	0	0
Interest/Enjoyment.Item12IE	0.66	0	0		0.00	0.00		0.00	0	0
Interest/Enjoyment.Item24IE	0.61	0	0		0.00	0.00		0.00	0	0
Interest/Enjoyment.Item21IE	0.69	0	0		0.00	0.00		0.00	0	0
Interest/Enjoyment.Item01IE	0.60	0	0		0.00	0.00		0.00	0	0
Perceived Choice.Item17PC	0.69	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Perceived Choice.Item15PC	0.63	0	0		0.00	0.00		0.00	0	0
Perceived Choice.Item06PC	0.71	0	0		0.00	0.00		0.00	0	0
Perceived Choice.Item02PC	0.69	0	0		0.00	0.00		0.00	0	0
Perceived Choice.Item08PC	0.69	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Pressure/Tension.Item16PT	0.64	0	0		0.00	0.00		0.00	0	0
Pressure/Tension.Item14PT	0.65	4	0	0.0	0.00	0.00	0.00	0.00	0	0

vi: number of violations; vi/ac: proportion of active pairs; maxvi: maximum violations;
sum: sum of all violations; zmax: maximum z-value; zsig: number of significant z-values; crit: critical value

Table 63 – *(continued)*

	ItemH	ac	vi	vi/ac	maxvi	sum	sum/ac	zmax	zsig	crit
Pressure/Tension.Item18PT	0.65	4	0	0.0	0.00	0.00	0.00	0.00	0	0
Pressure/Tension.Item11PT	0.44	0	0		0.00	0.00		0.00	0	0
Effort/Importance.Item13EI	0.63	0	0		0.00	0.00		0.00	0	0
Effort/Importance.Item03EI	0.53	5	0	0.0	0.00	0.00	0.00	0.00	0	0
Effort/Importance.Item07EI	0.60	0	0		0.00	0.00		0.00	0	0

vi: number of violations; vi/ac: proportion of active pairs; maxvi: maximum violations; sum: sum of all violations; zmax: maximum z-value; zsig: number of significant z-values; crit: critical value

D.6.2 Item Parameters

Table 64 shows the estimated parameters for the RSM-based instrument used to measure the *Interest/Enjoyment* in the third empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system of *Interest/Enjoyment* is not distorted or degraded by the items.

Table 64 – Estimated parameters in the RSM-based instrument for measuring the interest/enjoyment in the third empirical study

	Item01IE	Item09IE	Item12IE	Item21IE	Item22IE	Item24IE
xsi.item	0.912	0.615	0.570	0.080	0.615	0.797
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	0.877	1.174	1.219	1.709	1.174	0.992
AXsi.Cat2	1.646	2.241	2.331	3.311	2.241	1.876
AXsi.Cat3	1.780	2.672	2.808	4.278	2.672	2.125
AXsi.Cat4	−0.028	1.161	1.342	3.302	1.161	0.431
AXsi.Cat5	−2.330	−0.844	−0.617	1.833	−0.844	−1.755
AXsi.Cat6	−5.473	−3.690	−3.418	−0.478	−3.690	−4.784
Outfit	1.503	0.664	1.009	0.937	0.521	1.309
Infit	1.537	0.694	0.996	0.926	0.516	1.425

Table 65 shows the estimated parameters for the measurement instrument of *Perceived Choice* in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 65 – Estimated parameters in the RSM-based instrument for measuring the perceived choice in the third empirical study

	Item02PC	Item06PC	Item08PC	Item15PC	Item17PC
xsi.item	−0.210	−0.119	−0.393	0.192	−0.356
B.Cat0	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	2.122	2.031	2.305	1.720	2.268
AXsi.Cat2	3.359	3.177	3.725	2.555	3.652
AXsi.Cat3	4.097	3.824	4.645	2.890	4.535
AXsi.Cat4	3.435	3.071	4.166	1.826	4.020
AXsi.Cat5	2.634	2.178	3.548	0.622	3.365
AXsi.Cat6	1.261	0.714	2.357	−1.153	2.138
Outfit	1.005	0.955	0.873	1.267	0.937
Infit	1.028	0.917	0.911	1.240	0.991

Table 66 shows the estimated parameters for the measurement instrument of *Pressure/Tension* in the third empirical study in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 66 – Estimated parameters in the RSM-based instrument for measuring the pressure/tension in the third empirical study

	Item11PT	Item14PT	Item16PT	Item18PT
xsi.item	0.123	−0.009	0.113	−0.081
B.Cat0	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000
B.Cat5	5.000	0.000	0.000	0.000
B.Cat6	6.000	0.000	0.000	0.000
AXsi.Cat0	0.000	0.000	0.000	0.000
AXsi.Cat1	0.222	−0.022	−0.145	0.049
AXsi.Cat2	0.418	−0.072	−0.316	0.071
AXsi.Cat3	1.149	0.415	0.048	0.628
AXsi.Cat4	1.017	0.038	−0.451	0.322
AXsi.Cat5	−1.232			
AXsi.Cat6	−0.736			
Outfit	1.530	0.747	0.778	0.744
Infit	1.583	0.819	0.910	0.866

Table 67 shows the estimated parameters for the measurement instrument of *Effort/Importance* in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 67 – Estimated parameters in the RSM-based instrument for measuring the effort/importance in the third empirical study

	Item03EI	Item07EI	Item13EI
xsi.item	−1.278	−2.012	−2.309
B.Cat0	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000
AXsi.Cat1	8.240	8.975	9.272
AXsi.Cat2	9.465	10.933	11.527
AXsi.Cat3	10.365	12.567	13.458
AXsi.Cat4	9.821	12.758	13.946
AXsi.Cat5	8.680	12.351	13.837
AXsi.Cat6	7.667	12.072	13.855
Outfit	1.148	0.923	0.818
Infit	1.160	0.973	0.903

D.6.3 Intrinsic Motivation as Latent Trait Estimates

Table 68 shows the latent trait estimates by the RSM-based instrument for measuring the *Intrinsic motivation* in the third empirical study.

Table 68 – Latent trait estimates and person model fit of the RSM-based instrument for measuring the intrinsic motivation in the third empirical study

	Intrinsic Motivation				Interest/Enjoyment				Perceived Choice				Pressure/Tension				Effort/Importance			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10169	0.455	0.163	2.935	2.794	5.357	1.439	0.082	0.087	0.808	0.387	0.502	0.507	2.258	1.137	0.144	0.139	−1.073	0.572	1.960	1.819
10170	0.481	0.164	0.870	0.875	0.721	0.443	0.521	0.550	1.258	0.420	0.508	0.499	−0.345	0.363	2.636	2.908	−0.222	0.517	0.021	0.023
10171	1.203	0.219	0.256	0.237	2.448	0.432	0.483	0.493	1.630	0.478	0.173	0.149	−0.752	0.439	0.195	0.193	2.330	1.198	0.174	0.222
10172	−0.028	0.161	1.282	1.267	1.795	0.408	0.438	0.421	−1.085	0.424	0.263	0.263	0.498	0.411	0.878	0.972	−1.411	0.601	0.874	0.793
10174	0.124	0.160	0.770	0.753	1.116	0.430	0.972	0.972	0.087	0.394	0.204	0.204	0.498	0.411	0.878	0.972	−0.481	0.528	1.531	1.646
10175	0.857	0.183	0.700	0.702	0.512	0.443	0.056	0.057	2.181	0.619	0.786	0.940	−1.956	1.082	0.145	0.149	0.802	0.573	0.820	0.881
10176	−0.157	0.163	0.439	0.440	0.305	0.437	0.108	0.111	−0.572	0.411	0.598	0.594	0.674	0.445	0.545	0.580	−1.073	0.572	0.522	0.488
10179	0.250	0.160	1.246	1.264	0.109	0.427	1.898	2.006	−1.261	0.432	0.735	0.716	−1.244	0.630	0.355	0.367	1.124	0.635	0.419	0.328
10181	−0.264	0.166	0.870	0.907	−1.250	0.401	0.482	0.485	0.087	0.394	1.561	1.586	0.098	0.359	0.958	0.930	−1.776	0.641	0.547	0.523
10183	−0.210	0.164	0.492	0.501	−0.685	0.385	0.208	0.209	0.239	0.389	0.914	0.932	0.887	0.493	0.215	0.187	−1.073	0.572	0.919	0.864
10184	−0.002	0.160	0.269	0.265	0.305	0.437	0.212	0.212	−0.071	0.399	0.426	0.432	0.218	0.370	0.074	0.071	−1.073	0.572	0.023	0.023
10185	0.074	0.160	0.992	0.981	1.469	0.415	1.025	1.037	−0.572	0.411	1.788	1.777	0.498	0.411	0.292	0.281	−0.481	0.528	0.296	0.316
10186	0.200	0.160	1.326	1.329	0.305	0.437	3.062	3.146	0.385	0.386	0.850	0.869	1.152	0.567	0.537	0.601	2.330	1.198	0.174	0.222
10188	0.535	0.165	0.967	1.006	−0.543	0.389	0.755	0.787	1.630	0.478	0.878	0.864	−1.956	1.082	0.145	0.149	0.024	0.513	0.072	0.072
10189	−0.028	0.161	0.808	0.797	−1.405	0.416	0.537	0.560	−0.572	0.411	0.191	0.192	−0.597	0.401	0.637	0.671	0.523	0.538	0.454	0.415
10190	−0.291	0.166	0.595	0.593	−0.396	0.395	0.398	0.393	−0.912	0.418	1.482	1.470	0.674	0.445	1.164	1.371	−0.762	0.547	0.586	0.586
10191	0.023	0.160	0.952	0.964	−1.104	0.391	0.400	0.381	−0.742	0.415	0.211	0.212	−1.956	1.082	0.145	0.149	−0.222	0.517	0.323	0.344
10192	0.225	0.160	1.019	1.005	0.512	0.443	3.013	2.969	0.528	0.384	0.461	0.462	0.498	0.411	0.014	0.015	0.523	0.538	3.664	3.845
10193	0.200	0.160	2.406	2.445	−2.287	0.601	0.524	0.561	3.716	1.382	0.102	0.107	−0.233	0.355	2.258	2.442	0.024	0.513	2.149	2.043
10197	0.175	0.160	0.583	0.584	−0.072	0.416	1.626	1.626	0.668	0.384	0.926	0.923	0.098	0.359	0.473	0.459	−0.222	0.517	0.021	0.023
10198	0.074	0.160	1.088	1.079	0.512	0.443	2.179	2.148	−0.402	0.408	3.557	3.492	0.498	0.411	0.014	0.015	0.523	0.538	0.525	0.577
10199	−0.079	0.161	0.411	0.400	−0.543	0.389	0.639	0.666	−0.235	0.404	1.112	1.103	−0.014	0.353	0.212	0.207	−0.762	0.547	0.205	0.198
10200	0.326	0.161	0.902	0.869	1.116	0.430	0.521	0.497	0.528	0.384	1.087	1.095	0.887	0.493	0.390	0.351	1.542	0.765	0.184	0.130
10201	0.403	0.162	0.561	0.568	1.795	0.408	1.147	1.163	0.087	0.394	0.265	0.263	−0.124	0.351	0.208	0.204	0.024	0.513	0.258	0.245
10202	0.200	0.160	0.369	0.382	−0.543	0.389	0.077	0.071	0.808	0.387	0.845	0.861	0.098	0.359	0.153	0.164	0.523	0.538	0.021	0.020
10203	0.673	0.171	1.183	1.072	0.721	0.443	0.865	0.902	1.869	0.531	1.313	1.584	−0.014	0.353	1.566	1.531	2.330	1.198	0.174	0.222
10204	−1.007	0.205	1.102	1.272	−3.681	1.306	0.087	0.095	−2.752	0.671	0.419	0.418	2.258	1.137	0.144	0.139	0.024	0.513	1.477	1.543
10206	0.403	0.162	0.267	0.279	0.109	0.427	0.786	0.800	1.100	0.404	0.115	0.116	−0.124	0.351	0.081	0.081	0.523	0.538	0.021	0.020
10208	0.403	0.162	0.126	0.130	0.305	0.437	0.108	0.111	0.528	0.384	0.445	0.449	−0.465	0.378	0.035	0.037	0.523	0.538	0.021	0.020
10209	−0.237	0.165	1.597	1.644	−1.104	0.391	0.743	0.727	−2.752	0.671	0.419	0.418	−1.244	0.630	0.397	0.401	−0.222	0.517	0.435	0.409
10210	−0.780	0.188	1.937	2.140	−3.681	1.306	0.087	0.095	−2.752	0.671	0.419	0.418	2.258	1.137	0.144	0.139	2.330	1.198	0.174	0.222
10213	−0.079	0.161	2.095	2.075	0.305	0.437	3.401	3.535	−2.752	0.671	0.419	0.418	0.218	0.370	1.597	1.525	2.330	1.198	0.174	0.222

Table 68 – *(continued)*

	Intrinsic Motivation				Interest/Enjoyment				Perceived Choice				Pressure/Tension				Effort/Importance			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10214	−0.375	0.169	1.851	1.920	−2.722	0.762	0.275	0.329	−1.261	0.432	2.481	2.574	0.349	0.386	1.469	1.526	2.330	1.198	0.174	0.222
10215	0.377	0.161	1.305	1.319	0.512	0.443	1.219	1.216	0.951	0.394	1.433	1.442	−0.345	0.363	2.636	2.908	−0.481	0.528	2.122	2.112
10216	0.824	0.180	0.669	0.717	1.297	0.422	2.059	1.974	1.258	0.420	0.508	0.499	−1.956	1.082	0.145	0.149	0.523	0.538	0.455	0.438
10217	0.403	0.162	0.749	0.729	0.924	0.438	0.483	0.470	0.087	0.394	0.677	0.699	−1.956	1.082	0.145	0.149	−0.762	0.547	0.128	0.127
10218	−0.028	0.161	0.361	0.358	0.512	0.443	0.056	0.057	−0.402	0.408	0.301	0.299	0.349	0.386	0.621	0.685	−0.762	0.547	0.205	0.198
10219	−0.237	0.165	2.223	2.282	−1.574	0.438	1.936	1.702	−0.742	0.415	3.805	3.809	−1.956	1.082	0.145	0.149	−2.719	0.854	0.301	0.304
10220	0.562	0.166	1.539	1.641	−0.963	0.386	1.536	1.549	1.869	0.531	1.941	2.034	−1.956	1.082	0.145	0.149	0.802	0.573	0.820	0.881
10221	−0.131	0.162	0.539	0.554	−0.824	0.383	0.100	0.100	−0.912	0.418	0.933	0.923	−0.014	0.353	0.960	0.970	0.268	0.520	0.127	0.131
10223	0.275	0.160	0.574	0.546	1.634	0.410	0.165	0.162	0.087	0.394	0.204	0.204	0.098	0.359	0.463	0.438	−0.481	0.528	0.829	0.774
10224	−0.105	0.162	0.456	0.456	0.512	0.443	0.056	0.057	−0.402	0.408	0.176	0.177	0.887	0.493	0.363	0.325	−0.762	0.547	1.357	1.257
10226	−1.237	0.228	0.625	0.561	−1.994	0.519	1.113	1.469	−2.752	0.671	0.419	0.418	2.258	1.137	0.144	0.139	−2.719	0.854	0.301	0.304
10227	0.175	0.160	0.643	0.614	0.924	0.438	1.125	1.129	0.385	0.386	0.160	0.163	0.218	0.370	0.636	0.640	−0.762	0.547	0.949	1.009
10228	0.049	0.160	1.940	1.938	−2.287	0.601	0.351	0.333	1.869	0.531	0.406	0.381	0.098	0.359	1.548	1.637	0.024	0.513	2.322	2.252
10230	0.149	0.160	0.660	0.668	1.116	0.430	0.165	0.163	−0.071	0.399	0.641	0.645	0.349	0.386	1.326	1.429	−0.222	0.517	0.640	0.621
10231	0.703	0.173	1.179	1.084	1.116	0.430	0.934	0.913	1.869	0.531	0.438	0.479	−1.956	1.082	0.145	0.149	−1.073	0.572	0.700	0.652
10232	0.481	0.164	0.289	0.281	1.116	0.430	0.227	0.222	0.385	0.386	0.302	0.298	−0.233	0.355	0.496	0.538	1.124	0.635	0.408	0.398
10234	−0.613	0.179	1.334	1.408	−1.766	0.470	0.225	0.193	−2.093	0.524	0.271	0.262	−0.465	0.378	0.843	0.894	−2.719	0.854	0.301	0.304
10237	0.023	0.160	0.698	0.689	0.512	0.443	1.727	1.715	0.087	0.394	0.793	0.764	0.887	0.493	0.390	0.351	−0.222	0.517	0.323	0.344
10238	−0.105	0.162	0.666	0.673	0.305	0.437	0.108	0.111	−1.085	0.424	0.563	0.535	1.152	0.567	0.480	0.520	0.802	0.573	0.197	0.151

D.7 RSM-based Instrument for Measuring the Level of Motivation in the Third Empirical Study

D.7.1 Checking Assumptions

Test of Unidimensionality

Table 69 shows the results for the test of unidimensionality in which the goodness of fit statistics indicate a strong multidimensionality ($DETECT > 1.00$) for the *Level of Motivation* with a DETECT index of 6.634. Essential unidimensionality ($ASSI < 0.25$ and $RATIO < 0.36$) in the data structure is indicated for the level of motivation by the ASSI and RATIO indices with values of 0.242 and 0.279, respectively. The index of $AGFI = 0.980$ in the unidimensional CFA indicates an acceptable fit for measuring the *Level of Motivation*. The sub-scales of *Attention*, *Relevance*, and *Satisfaction* have a good fit indicated by the AGFI index with values greater than 0.95. A good fit with the unidimensional CFA is indicated by the TLI and CFI indices for all the sub-scales. The ASSI and RATIO indices indicate essential deviation from unidimensionality in all the sub-scales.

Table 69 – Goodness of fit statistics related to the test of unidimensionality in the RSM-based instrument for measuring the level of motivation in the third empirical study

	df	chisq	AGFI	TLI	CFI	DETECT	ASSI	RATIO
Level of Motivation	9.196	20.051	0.980	0.844	0.749	6.634	0.242	0.279
Attention	4.337	3.955	0.997	1.006	1.000	7.166	0.333	0.621
Relevance	1.762	1.090	0.997	1.063	1.000	14.903	0.333	0.529
Satisfaction	0.000	0.000	1.000	1.000	1.000	18.022	0.333	0.939

df: degree of freedom; AGFI: Adjusted Goodness of Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index;

Test of Local Independence

Results from the test of local independence in the RSM-based instrument for measuring the level of motivation in the third empirical study are summarized in Table 70. The null condition of local independence is not rejected in all the sub-scales. The Standardized Root Mean Squared Residual (SRMSR) indicates good fits (< 0.10) for all the sub-scales.

Table 70 – Item residual correlation statistics related to the test of local independence in the RSM-based instrument for measuring the level of motivation in the third empirical study

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Level of Motivation	138.794	0.601	0.201	0.213	0.002
Attention	282.594	0.335	0.139	0.086	0.284
Relevance	110.345	0.176	0.072	0.066	1.000
Satisfaction	62.109	0.282	0.188	0.073	0.144

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

Test of Monotonicity

Table 71 summarizes the test of monotonicity in the RSM-based instrument for measuring the level of motivation in the third empirical study. These results indicates that there are no one violation of monotonicity in the items at the significance level $\alpha = 0.05$.

Table 71 – Test of monotonicity in the RSM-based instrument for measuring the level of motivation in the third empirical study

	ItemH	ac	vi	vi/ac	maxvi	sum	sum/ac	zmax	zsig	crit
Level of Motivation.Item12A	0.53	0	0		0	0		0	0	0
Level of Motivation.Item19A	0.47	0	0		0	0		0	0	0
Level of Motivation.Item04A	0.47	0	0		0	0		0	0	0
Level of Motivation.Item20A	0.45	0	0		0	0		0	0	0
Level of Motivation.Item16A	0.51	5	0	0	0	0	0	0	0	0
Level of Motivation.Item01A	0.44	0	0		0	0		0	0	0
Level of Motivation.Item21R	0.24	0	0		0	0		0	0	0
Level of Motivation.Item10R	0.29	0	0		0	0		0	0	0
Level of Motivation.Item08R	0.12	0	0		0	0		0	0	0
Level of Motivation.Item13S	0.49	0	0		0	0		0	0	0
Level of Motivation.Item14S	0.52	3	0	0	0	0	0	0	0	0
Level of Motivation.Item17S	0.42	0	0		0	0		0	0	0
Attention.Item12A	0.68	5	0	0	0	0	0	0	0	0
Attention.Item19A	0.66	0	0		0	0		0	0	0
Attention.Item04A	0.66	0	0		0	0		0	0	0
Attention.Item20A	0.59	0	0		0	0		0	0	0
Attention.Item16A	0.66	4	0	0	0	0	0	0	0	0
Attention.Item01A	0.54	0	0		0	0		0	0	0
Relevance.Item15R	0.35	0	0		0	0		0	0	0
Relevance.Item21R	0.41	0	0		0	0		0	0	0
Relevance.Item10R	0.42	0	0		0	0		0	0	0
Relevance.Item08R	0.35	0	0		0	0		0	0	0
Satisfaction.Item13S	0.77	3	0	0	0	0	0	0	0	0
Satisfaction.Item14S	0.75	0	0		0	0		0	0	0
Satisfaction.Item17S	0.68	4	0	0	0	0	0	0	0	0

vi: number of violations; vi/ac: proportion of active pairs; maxvi: maximum violations;
sum: sum of all violations; zmax: maximum z-value; zsig: number of significant z-values; crit: critical value

D.7.2 Item Parameters

Table 72 shows the estimated parameters for the RSM-based instrument used to measure the *Attention* in the third empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system of *Attention* is not distorted or degraded by the items.

Table 72 – Estimated parameters in the RSM-based instrument for measuring the attention in the third empirical study

	Item01A	Item04A	Item12A	Item16A	Item19A	Item20A
xsi.item	0.321	0.340	0.303	−0.029	0.229	0.376
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	1.292	1.274	1.311	1.643	1.384	1.237
AXsi.Cat2	1.608	1.571	1.645	2.309	1.792	1.497
AXsi.Cat3	2.891	2.836	2.946	3.943	3.167	2.725
AXsi.Cat4	1.786	1.712	1.859	3.188	2.154	1.565
AXsi.Cat5	−0.044	−0.136	0.048	1.709	0.416	−0.320
AXsi.Cat6	−1.928	−2.038	−1.817	0.176	−1.375	−2.259
Outfit	1.231	0.856	0.781	0.795	1.244	1.013
Infit	1.207	0.838	0.824	0.806	1.294	1.105

Table 73 shows the estimated parameters for the measurement instrument of *Relevance* in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 73 – Estimated parameters in the RSM-based instrument for measuring the relevance in the third empirical study

	Item08R	Item10R	Item15R	Item21R
xsi.item	−0.953	−0.773	−0.539	−0.677
B.Cat0	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000	0.000
AXsi.Cat1	3.925	3.745	3.511	3.649
AXsi.Cat2	4.994	4.634	4.166	4.441
AXsi.Cat3	6.466	5.925	5.223	5.636
AXsi.Cat4	6.291	5.570	4.634	5.185
AXsi.Cat5	6.096	5.195	4.024	4.713
AXsi.Cat6	5.718	4.637	3.232	4.059
Outfit	1.124	0.896	1.014	0.945
Infit	1.142	0.898	0.986	0.960

Table 74 shows the estimated parameters for the measurement instrument of *Satisfaction* in the third empirical study in which the Infit/Outfit statistics of items indicate that no one item distorts or degrades the measurement system with mean-square greater than 2.0.

Table 74 – Estimated parameters in the RSM-based instrument for measuring the satisfaction in the third empirical study

estimated	Item13S	Item14S	Item17S
xsi.item	−0.267	−0.047	−0.378
B.Cat0	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000
AXsi.Cat0	0.000	0.000	0.000
AXsi.Cat1	2.315	2.095	2.426
AXsi.Cat2	4.032	3.592	4.253
AXsi.Cat3	5.337	4.677	5.669
AXsi.Cat4	4.692	3.813	5.135
AXsi.Cat5	3.596	2.496	4.149
AXsi.Cat6	1.602	0.282	2.266
Outfit	0.944	0.921	1.176
Infit	0.938	0.889	1.163

D.7.3 Level of Motivation as Latent Trait Estimates

Table 75 shows the latent trait estimates by the RSM-based instrument for measuring the *Level of Motivation* in the third empirical study.

Table 75 – Latent trait estimates and person model fit of the RSM-based instrument for measuring the level of motivation in the third empirical study

	Level of Motivation				Attention				Relevance				Satisfaction			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10169	2.348	0.490	2.109	1.238	4.278	1.300	0.087	0.088	0.527	0.414	0.808	0.827	3.858	1.474	0.162	0.165
10170	0.329	0.228	0.723	0.690	0.844	0.411	0.646	0.647	0.374	0.405	1.525	1.464	0.133	0.611	0.166	0.168
10171	0.820	0.243	0.388	0.375	1.167	0.395	0.342	0.338	1.074	0.501	0.152	0.122	1.115	0.573	1.097	1.090
10172	0.226	0.226	1.159	1.121	1.167	0.395	0.285	0.284	−1.153	0.469	0.028	0.029	0.817	0.574	0.534	0.532
10174	0.381	0.230	1.352	1.334	1.314	0.389	1.038	1.034	−0.761	0.437	0.810	0.808	0.817	0.574	0.744	0.752
10175	1.000	0.253	0.322	0.305	1.314	0.389	0.321	0.322	1.074	0.501	0.500	0.498	1.416	0.588	0.354	0.350
10176	0.025	0.222	0.287	0.288	0.470	0.421	0.296	0.296	−0.404	0.416	0.033	0.034	−0.292	0.620	0.016	0.016
10178	−0.168	0.219	0.329	0.327	0.095	0.402	0.019	0.019	−0.761	0.437	0.429	0.409	−1.049	0.571	0.940	0.943
10179	−0.073	0.220	0.504	0.507	−0.344	0.361	0.909	0.889	0.374	0.405	0.439	0.449	−0.292	0.620	0.717	0.712
10181	−0.263	0.218	1.243	1.244	0.276	0.415	0.362	0.363	−0.078	0.403	0.581	0.583	−2.532	0.669	1.000	1.031
10183	−0.876	0.228	0.138	0.148	−1.247	0.368	0.036	0.039	−1.153	0.469	0.268	0.261	−1.616	0.549	0.626	0.629
10184	−0.024	0.221	0.501	0.502	−0.068	0.387	0.788	0.786	0.075	0.400	1.426	1.410	0.499	0.588	0.888	0.897
10185	−0.168	0.219	1.030	1.007	−0.068	0.387	1.322	1.251	−0.761	0.437	1.270	1.272	0.499	0.588	0.274	0.273
10186	0.277	0.227	2.241	2.257	−0.344	0.361	2.834	2.891	0.527	0.414	1.947	1.952	2.142	0.706	1.615	1.556
10188	−0.073	0.220	0.845	0.818	−0.465	0.351	0.395	0.396	1.336	0.575	0.444	0.451	−1.343	0.553	0.021	0.021
10189	−0.927	0.231	1.131	1.219	−2.220	0.603	0.452	0.438	−0.579	0.425	3.434	3.448	−1.616	0.549	0.101	0.100
10190	0.025	0.222	0.989	0.992	1.011	0.402	0.801	0.787	−0.952	0.450	0.068	0.071	−0.704	0.599	0.282	0.285
10191	−0.216	0.218	0.673	0.648	−0.465	0.351	0.534	0.549	−0.238	0.409	1.454	1.492	0.133	0.611	0.166	0.168
10192	0.879	0.246	1.605	1.489	1.314	0.389	1.664	1.657	−0.078	0.403	1.499	1.489	2.705	0.876	0.441	0.438
10193	−0.876	0.228	2.397	2.606	−2.710	0.795	0.624	0.593	1.727	0.726	0.478	0.480	−3.028	0.827	0.650	0.632
10197	0.277	0.227	1.831	1.831	1.314	0.389	1.805	1.801	0.225	0.400	1.741	1.747	−1.049	0.571	1.104	1.087
10198	1.270	0.276	0.907	0.934	1.881	0.399	1.273	1.284	0.374	0.405	0.301	0.306	2.705	0.876	0.673	0.662
10199	−0.024	0.221	0.694	0.706	−0.344	0.361	1.124	1.177	−0.078	0.403	0.297	0.302	0.499	0.588	0.888	0.897
10200	0.762	0.241	0.348	0.343	1.167	0.395	0.295	0.296	0.374	0.405	0.052	0.050	1.745	0.628	0.774	0.741
10201	0.434	0.231	1.043	0.999	1.011	0.402	1.198	1.200	−0.761	0.437	0.892	0.883	1.416	0.588	0.126	0.128
10202	−0.121	0.220	0.530	0.531	−0.579	0.345	0.545	0.552	−0.078	0.403	0.558	0.558	0.817	0.574	0.019	0.019
10203	0.487	0.232	0.873	0.864	0.662	0.419	0.626	0.630	−0.404	0.416	0.174	0.172	2.142	0.706	1.419	1.418
10204	−1.149	0.249	1.634	1.851	−3.843	1.425	0.084	0.085	−0.238	0.409	2.292	2.289	−1.887	0.562	1.179	1.179
10206	0.434	0.231	0.250	0.253	0.662	0.419	0.572	0.566	0.075	0.400	0.058	0.057	1.115	0.573	0.141	0.140
10208	−0.541	0.218	0.598	0.605	−1.012	0.347	0.144	0.141	−0.761	0.437	0.862	0.877	0.133	0.611	1.194	1.209
10209	−0.728	0.222	0.750	0.775	−1.126	0.356	0.141	0.136	−0.238	0.409	1.818	1.867	−1.887	0.562	0.131	0.134
10210	−2.299	0.486	0.310	0.352	−3.843	1.425	0.084	0.085	−1.625	0.536	1.169	1.082	−4.077	1.394	0.168	0.171

Table 75 – *(continued)*

	Level of Motivation				Attention				Relevance				Satisfaction			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10213	1.198	0.269	1.590	1.767	1.596	0.387	2.625	2.640	1.727	0.726	0.418	0.432	1.745	0.628	1.948	2.012
10214	−0.681	0.220	0.506	0.500	−1.247	0.368	0.722	0.752	−0.952	0.450	0.663	0.675	−0.704	0.599	0.282	0.285
10215	−0.168	0.219	2.231	2.186	−0.689	0.341	1.659	1.682	1.074	0.501	1.300	1.425	−1.887	0.562	1.044	1.062
10216	0.434	0.231	0.834	0.844	−0.068	0.387	1.367	1.373	0.867	0.458	0.324	0.329	1.115	0.573	0.141	0.140
10217	0.025	0.222	0.121	0.123	−0.068	0.387	0.319	0.308	0.225	0.400	0.036	0.036	−0.292	0.620	0.016	0.016
10218	−0.121	0.220	0.456	0.461	0.095	0.402	0.774	0.760	−0.078	0.403	0.326	0.326	−1.049	0.571	0.217	0.213
10219	−1.211	0.255	0.704	0.677	−1.378	0.386	0.608	0.584	−0.761	0.437	0.300	0.302	−4.077	1.394	0.168	0.171
10220	−0.073	0.220	3.289	3.273	−1.919	0.507	2.147	2.032	1.074	0.501	1.300	1.425	1.745	0.628	1.948	2.012
10221	−0.587	0.218	0.671	0.671	−0.796	0.340	0.442	0.442	−1.625	0.536	0.836	0.861	−0.292	0.620	0.564	0.565
10223	0.075	0.223	0.247	0.239	−0.068	0.387	0.114	0.118	0.225	0.400	0.499	0.494	0.133	0.611	0.392	0.388
10224	0.277	0.227	0.211	0.208	0.470	0.421	0.180	0.179	−0.078	0.403	0.070	0.070	0.817	0.574	0.459	0.457
10226	−0.448	0.217	0.734	0.742	−0.344	0.361	1.402	1.306	−0.238	0.409	1.145	1.133	−1.616	0.549	0.101	0.100
10227	0.939	0.250	0.382	0.354	1.596	0.387	0.179	0.181	0.225	0.400	0.418	0.420	1.745	0.628	0.023	0.024
10228	−0.448	0.217	1.367	1.339	−1.247	0.368	1.180	1.209	0.075	0.400	1.960	1.968	−0.292	0.620	0.016	0.016
10230	0.226	0.226	0.999	0.997	0.844	0.411	1.057	1.058	0.075	0.400	0.174	0.174	−0.292	0.620	3.518	3.532
10231	0.226	0.226	0.479	0.468	0.095	0.402	0.019	0.019	−0.078	0.403	0.297	0.302	1.115	0.573	1.604	1.598
10232	0.820	0.243	0.334	0.338	1.011	0.402	0.632	0.630	0.689	0.431	0.604	0.609	1.416	0.588	0.126	0.128
10234	−0.402	0.217	2.340	2.335	−0.579	0.345	3.201	3.234	0.689	0.431	0.819	0.841	−2.532	0.669	0.353	0.353
10237	−0.024	0.221	0.495	0.488	−0.213	0.373	0.549	0.529	−0.078	0.403	0.297	0.302	0.133	0.611	1.562	1.586
10238	0.025	0.222	0.547	0.546	0.470	0.421	0.260	0.260	−0.078	0.403	0.207	0.210	−1.049	0.571	1.239	1.223

D.8 Stacking Procedure for Estimating Gains in Skill/-Knowledge of the Pilot Empirical Study

D.8.1 Checking Assumptions

Test of Unidimensionality

Table 76 shows the results for the test of unidimensionality in which the goodness of fit statistics indicate essential unidimensionality ($DETECT > 1.00$) for the *Pre-test* with a DETECT index of 0.009. Strong multidimensionality for the *Post-test* is indicated by the DETECT index with a value of 3.187. Essential unidimensionality in the data structure is indicated by the ASSI index in the *Pre-test*. The RATIO indices for the *Pre-test* and *Post-test* indicate essential deviation from unidimensionality. The index of $AGFI = 0.990$ in the unidimensional CFA indicates an acceptable fit for measuring the skill/knowledge obtained in the *Post-test*. The unidimensional CFA indicated by the TLI and CFI indices indicate unidimensionality.

Table 76 – Goodness of fit statistics related to the test of unidimensionality in the GPCM-based instrument for measuring the gains in skill/knowledge of the pilot empirical study

	df	chisq	AGFI	TLI	CFI	DETECT	ASSI	RATIO
Pre-test	2	2.591	0.548	0.912	0.971	0.009	0.167	0.998
Post-test	2	0.387	0.990	−1.852	1.000	3.187	0.333	0.582

df: degree of freedom; AGFI: Adjusted Goodness of Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index;

Test of Local Independence

Results from the test of local independence in the GPCM-based instrument for measuring gains in skill/knowledge of the pilot empirical study are summarized in Table 77. The null condition of local independence is not rejected in the *Pre-test* and *Post-test*. The Standardized Root Mean Squared Residual (SRMSR) indicates a good fit (< 0.10) in the *Pre-test* with value of 0.089, and the SRMSR index in the *Post-test* indicates acceptable good fit with value of 0.107.

Table 77 – Item residual correlation statistics related to the test of local independence in the GPCM-based instrument for measuring gains in skill/knowledge of the pilot empirical study

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Pre-test	5.639	0.225	0.086	0.089	1.000
Post-test	9.115	0.288	0.116	0.107	0.767

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

D.8.2 Item Parameters

Table 78 shows the estimated parameters for the GPCM-based instrument used to measure the pre-test skill/knowledge of the pilot empirical study. These parameters had been calculated

using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat*x*" and column "*i*" is the item slope $b_{i,x}$ of item *i* in the category "*x*", and the value in the row "AXsi.Cat*x*" and column "*i*" is the item intercept $a_{i,x}\xi$ of item *i* in the category "*x*". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system is not distorted or degraded by the items.

Table 78 – Estimated parameters in the GPCM-based instrument for measuring the pre-test skill/knowledge of the pilot empirical study

	P1s0	P2s0	P3s2	P4s0
xsi.item	−0.643	0.433	4.444	4.227
B.Cat0	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000
B.Cat2	0.000	0.000	2.000	0.000
B.Cat3	0.000	0.000	3.000	0.000
AXsi.Cat0	0.000	0.000	0.000	0.000
AXsi.Cat1	0.643	−0.433	−4.177	−4.227
AXsi.Cat2			−7.924	
AXsi.Cat3			−13.332	
max.Outfit	0.649	0.537	0.994	0.386
max.Infit	0.844	0.755	1.500	0.961

Table 79 shows the estimated parameters for the GPCM-based instrument used to measure the post-test skill/knowledge of the pilot empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat*x*" and column "*i*" is the item slope $b_{i,x}$ of item *i* in the category "*x*", and the value in the row "AXsi.Cat*x*" and column "*i*" is the item intercept $a_{i,x}\xi$ of item *i* in the category "*x*". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system is not distorted or degraded by the items.

Table 79 – Estimated parameters in the GPCM-based instrument for measuring the post-test skill/knowledge in the pilot empirical study

	PAs2	PBs3	PCs0	PDs0
xsi.item	−0.506	−0.040	−0.518	1.901
B.Cat0	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	0.000	0.000
B.Cat3	3.000	3.000	0.000	0.000
B.Cat4	0.000	4.000	0.000	0.000
AXsi.Cat0	0.000	0.000	0.000	0.000
AXsi.Cat1	2.044	1.341	0.518	−1.901
AXsi.Cat2	1.845	1.192		
AXsi.Cat3	1.518	0.708		
AXsi.Cat4		0.161		
max.Outfit	1.198	1.915	1.060	0.927
max.Infit	1.149	1.078	1.071	0.950

D.8.3 Gains in Skill/Knowledge as Latent Trait Estimates

Table 80 shows the latent trait estimates by the GPCM-based instrument for measuring the gains in skill/knowledge of the pilot empirical study.

Table 80 – Latent trait estimates and person model fit of the GPCM-based instrument for measuring gains in skill/knowledge of the pilot empirical study

	Pre-test				Post-test			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10116	3.666	0.940	0.160	0.129	0.259	0.639	0.814	1.117
10119	−1.876	1.955	0.099	0.226	−3.280	1.766	0.216	0.232
10120	4.987	1.035	0.121	0.112	−0.514	0.715	0.343	0.243
10121	3.046	1.280	0.167	0.355	−1.684	1.085	0.422	0.422
10122	3.046	1.280	0.167	0.355	0.310	0.659	1.253	0.704
10126	2.620	1.298	0.148	0.199	−1.090	0.831	0.163	0.108
10127	3.046	1.280	0.167	0.355	−1.684	1.085	0.422	0.422
10128	2.620	1.298	0.148	0.199	0.606	0.660	0.184	0.109
10129	−1.876	1.955	0.099	0.226	−0.094	0.656	0.351	0.368
10130	−0.103	1.443	0.394	0.567	−0.477	0.723	0.431	0.262
10131	−2.145	2.095	0.223	0.223	−0.052	0.668	0.581	0.226
10132	−1.876	1.955	0.099	0.226	0.606	0.660	1.016	1.429
10133	2.620	1.298	0.148	0.199	−1.921	1.050	0.377	0.405
10134	−1.876	1.955	0.099	0.226	−0.514	0.715	0.343	0.243
10135	2.620	1.298	0.148	0.199	0.259	0.639	1.477	1.865
10136	−1.876	1.955	0.099	0.226	0.606	0.660	0.482	0.531
10137	−1.874	1.962	0.131	0.228	−0.094	0.656	0.357	0.290
10138	−1.876	1.955	0.099	0.226	1.010	0.733	0.309	0.243
10139	−2.145	2.095	0.223	0.223	0.674	0.697	1.548	1.065
10140	−0.103	1.443	0.394	0.567	0.259	0.639	1.703	0.703
10141	−1.876	1.955	0.099	0.226	3.106	1.673	0.117	0.181
10143	3.046	1.280	0.167	0.355	−3.002	2.068	0.379	0.379
10144	4.271	0.903	0.300	0.360	0.606	0.660	1.102	0.605
10145	4.987	1.035	0.121	0.112	0.606	0.660	0.184	0.109
10146	−0.104	1.424	0.299	0.552	1.628	0.929	0.832	0.865
10148	−1.876	1.955	0.099	0.226	1.010	0.733	1.138	1.138
10149	−1.876	1.955	0.099	0.226	0.606	0.660	0.184	0.109
10152	4.987	1.035	0.858	1.461	−0.514	0.715	0.446	0.384
10153	−0.103	1.443	0.394	0.567	1.628	0.929	0.385	0.411
10154	−2.145	2.095	0.223	0.223	−3.002	2.068	0.379	0.379

D.9 Stacking Procedure for Estimating Gains in Skill/-Knowledge of the First Empirical Study

D.9.1 Checking Assumptions

Test of Unidimensionality

Table 81 shows the results for the test of unidimensionality in which the goodness of fit statistics indicate strong multidimensionality ($DETECT > 1.00$) for the *Pre-test* and *Post-test* with values of 33.268 and 27.559. Essential unidimensionality in the data structure is indicated

by the ASSI index in the *Pre-test* (with value of 0.056). The index AGFI in the *Pre-test* and *Post-test* indicate got fit with values greater than 0.95 A good fit with the unidimensional CFA is indicated by the TLI and CFI indices for the pre-test and post-test.

Table 81 – Goodness of fit statistics related to the test of unidimensionality in the GPCM-based instrument for measuring the gains in skill/knowledge of the first empirical study

	df	chisq	AGFI	TLI	CFI	DETECT	ASSI	RATIO
Pre-test	27	27.576	0.969	0.981	0.986	33.264	0.056	0.508
Post-test	14	16.087	0.997	0.875	0.917	27.559	0.333	0.528

df: degree of freedom; AGFI: Adjusted Goodness of Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index;

Test of Local Independence

Results from the test of local independence in the GPCM-based instrument for measuring gains in skill/knowledge of the first empirical study are summarized in Table 82. The null condition of local independence is not rejected in the *Pre-test* and *Post-test*. The Standardized Root Mean Squared Residual (SRMSR) indicates an acceptable fit (0.10s) in the *Post-test*.

Table 82 – Item residual correlation statistics related to the test of local independence in the GPCM-based instrument for measuring gains in skill/knowledge of the first empirical study

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Pre-test	51.415	0.370	0.126	0.251	0.176
Post-test	90.705	0.326	0.125	0.166	0.345

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

D.9.2 Item Parameters

Table 83 shows the estimated parameters for the GPCM-based instrument used to measure the pre-test skill/knowledge of the first empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system is not distorted or degraded by the items.

Table 83 – Estimated parameters in the GPCM-based instrument for measuring the pre-test skill/knowledge of the first empirical study

	An3	Ap1	Ap2	Ap3	Ev1	Ev2	P1s2	Un1	Un2
xsi.item	−0.224	−0.662	−0.573	−0.196	−0.177	−0.054	−12.260	−6.086	−0.093
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	0.000	2.000	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	0.000	3.000	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	0.000	4.000	4.000	4.000	0.000	4.000	4.000

Table 83 – *(continued)*

	An3	Ap1	Ap2	Ap3	Ev1	Ev2	P1s2	Un1	Un2
B.Cat5	5.000	5.000	0.000	5.000	5.000	5.000	0.000	5.000	5.000
B.Cat6	6.000	6.000	0.000	6.000	6.000	6.000	0.000	6.000	6.000
B.Cat7	7.000	0.000	0.000	7.000	7.000	7.000	0.000	7.000	0.000
B.Cat8	8.000	0.000	0.000	8.000	8.000	8.000	0.000	8.000	0.000
B.Cat9	9.000	0.000	0.000	0.000	9.000	9.000	0.000	9.000	0.000
B.Cat10	10.000	0.000	0.000	0.000	10.000	10.000	0.000	10.000	0.000
B.Cat11	11.000	0.000	0.000	0.000	11.000	0.000	0.000	11.000	0.000
B.Cat12	12.000	0.000	0.000	0.000	12.000	0.000	0.000	12.000	0.000
B.Cat13	13.000	0.000	0.000	0.000	0.000	0.000	0.000	13.000	0.000
B.Cat14	14.000	0.000	0.000	0.000	0.000	0.000	0.000	14.000	0.000
B.Cat15	15.000	0.000	0.000	0.000	0.000	0.000	0.000	15.000	0.000
B.Cat16	16.000	0.000	0.000	0.000	0.000	0.000	0.000	16.000	0.000
B.Cat17	0.000	0.000	0.000	0.000	0.000	0.000	0.000	17.000	0.000
B.Cat18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	18.000	0.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	−7.050	−5.831	0.573	−7.073	−5.761	−7.447	36.897	7.836	−2.079
AXsi.Cat2	−8.618	1.387		−6.930	−5.680	−8.616	36.897	17.905	−1.386
AXsi.Cat3	−8.489	1.096		0.587	−0.523	−7.518	36.779	31.574	1.417
AXsi.Cat4	−7.076	−4.816		1.526	−5.619	−0.337		45.698	−1.386
AXsi.Cat5	0.000	−4.747		−6.317	−7.055	−0.075		67.220	−2.079
AXsi.Cat6	0.001	3.970		−7.534	−7.059	−7.256		108.163	0.560
AXsi.Cat7	1.387			−6.345	−5.544	−8.887		100.994	
AXsi.Cat8	1.097			1.568	0.782	−8.856		99.267	
AXsi.Cat9	−5.125				−4.940	−7.238		99.338	
AXsi.Cat10	−6.509				−6.290	0.539		101.019	
AXsi.Cat11	−6.499				−4.913			109.081	
AXsi.Cat12	−5.251				2.124			110.243	
AXsi.Cat13	−0.007							103.017	
AXsi.Cat14	1.099							101.713	
AXsi.Cat15	2.197							102.736	
AXsi.Cat16	3.584							107.459	
AXsi.Cat17								110.838	
AXsi.Cat18								109.550	
max.Outfit	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.001	1.000
max.Infit	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.001	1.000

Table 84 shows the estimated parameters for the GPCM-based instrument used to measure the post-test skill/knowledge of the first empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system is not distorted or degraded by the items.

Table 84 – Estimated parameters in the GPCM-based instrument for measuring the post-test skill/knowledge in the first empirical study

	AnC	ApB	ApC	EvA	PAs3	ReB	UnB
xsi.item	−0.264	−40.922	−0.412	−0.659	−26.881	−7.149	−0.415
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table 84 – *(continued)*

	AnC	ApB	ApC	EvA	PAs3	ReB	UnB
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	0.000	5.000	0.000
B.Cat6	6.000	6.000	6.000	6.000	0.000	6.000	0.000
B.Cat7	7.000	7.000	7.000	0.000	0.000	7.000	0.000
B.Cat8	8.000	8.000	8.000	0.000	0.000	8.000	0.000
B.Cat9	9.000	9.000	0.000	0.000	0.000	9.000	0.000
B.Cat10	10.000	10.000	0.000	0.000	0.000	10.000	0.000
B.Cat11	11.000	11.000	0.000	0.000	0.000	11.000	0.000
B.Cat12	12.000	12.000	0.000	0.000	0.000	12.000	0.000
B.Cat13	13.000	0.000	0.000	0.000	0.000	13.000	0.000
B.Cat14	14.000	0.000	0.000	0.000	0.000	14.000	0.000
B.Cat15	0.000	0.000	0.000	0.000	0.000	15.000	0.000
B.Cat16	0.000	0.000	0.000	0.000	0.000	16.000	0.000
B.Cat17	0.000	0.000	0.000	0.000	0.000	17.000	0.000
B.Cat18	0.000	0.000	0.000	0.000	0.000	18.000	0.000
B.Cat19	0.000	0.000	0.000	0.000	0.000	19.000	0.000
B.Cat20	0.000	0.000	0.000	0.000	0.000	20.000	0.000
B.Cat21	0.000	0.000	0.000	0.000	0.000	21.000	0.000
B.Cat22	0.000	0.000	0.000	0.000	0.000	22.000	0.000
B.Cat23	0.000	0.000	0.000	0.000	0.000	23.000	0.000
B.Cat24	0.000	0.000	0.000	0.000	0.000	24.000	0.000
B.Cat25	0.000	0.000	0.000	0.000	0.000	25.000	0.000
B.Cat26	0.000	0.000	0.000	0.000	0.000	26.000	0.000
B.Cat27	0.000	0.000	0.000	0.000	0.000	27.000	0.000
B.Cat28	0.000	0.000	0.000	0.000	0.000	28.000	0.000
B.Cat29	0.000	0.000	0.000	0.000	0.000	29.000	0.000
B.Cat30	0.000	0.000	0.000	0.000	0.000	30.000	0.000
B.Cat31	0.000	0.000	0.000	0.000	0.000	31.000	0.000
B.Cat32	0.000	0.000	0.000	0.000	0.000	32.000	0.000
B.Cat33	0.000	0.000	0.000	0.000	0.000	33.000	0.000
B.Cat34	0.000	0.000	0.000	0.000	0.000	34.000	0.000
B.Cat35	0.000	0.000	0.000	0.000	0.000	35.000	0.000
B.Cat36	0.000	0.000	0.000	0.000	0.000	36.000	0.000
B.Cat37	0.000	0.000	0.000	0.000	0.000	37.000	0.000
B.Cat38	0.000	0.000	0.000	0.000	0.000	38.000	0.000
B.Cat39	0.000	0.000	0.000	0.000	0.000	39.000	0.000
B.Cat40	0.000	0.000	0.000	0.000	0.000	40.000	0.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	−6.026	63.868	−6.583	−5.856	107.842	9.246	−6.877
AXsi.Cat2	−7.906	127.595	−6.455	1.386	107.523	18.531	−7.055
AXsi.Cat3	−8.366	191.328	2.080	−5.439	107.390	27.833	−0.135
AXsi.Cat4	−7.959	258.331	3.044	−6.371	107.523	37.145	1.658
AXsi.Cat5	−6.265	329.662	−4.344	−5.216		46.459	
AXsi.Cat6	1.104	402.199	−5.207	3.951		55.736	
AXsi.Cat7	−0.006	487.428	−4.150			64.998	
AXsi.Cat8	−4.810	488.815	3.295			74.299	
AXsi.Cat9	−6.196	488.527				83.592	
AXsi.Cat10	−6.451	487.428				93.532	
AXsi.Cat11	−6.376	489.731				103.808	
AXsi.Cat12	−4.726	491.066				114.022	
AXsi.Cat13	2.491					124.364	

Table 84 – *(continued)*

	AnC	ApB	ApC	EvA	PAs3	ReB	UnB
AXsi.Cat14	3.696					136.479	
AXsi.Cat15						146.873	
AXsi.Cat16						159.515	
AXsi.Cat17						171.435	
AXsi.Cat18						182.746	
AXsi.Cat19						196.735	
AXsi.Cat20						217.437	
AXsi.Cat21						241.704	
AXsi.Cat22						282.662	
AXsi.Cat23						282.649	
AXsi.Cat24						281.939	
AXsi.Cat25						277.050	
AXsi.Cat26						275.453	
AXsi.Cat27						274.899	
AXsi.Cat28						274.735	
AXsi.Cat29						275.542	
AXsi.Cat30						277.779	
AXsi.Cat31						283.146	
AXsi.Cat32						284.024	
AXsi.Cat33						278.717	
AXsi.Cat34						276.796	
AXsi.Cat35						276.101	
AXsi.Cat36						275.699	
AXsi.Cat37						276.319	
AXsi.Cat38						278.569	
AXsi.Cat39						282.075	
AXsi.Cat40						285.947	
max.Outfit	1.007	1.000	1.000	1.000	1.000	0.000	1.000
max.Infit	1.007	1.000	1.000	1.000	1.000	0.000	1.000

D.9.3 Gains in Skill/Knowledge as Latent Trait Estimates

Table 85 shows the latent trait estimates by the GPCM-based instrument for measuring the gains in skill/knowledge of the first empirical study.

Table 85 – Latent trait estimates and person model fit of the GPCM-based instrument for measuring gains in skill/knowledge of the first empirical study

	Pre-test				Post-test			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10169	−0.039	0.116	1.010	1.069	−0.181	0.103	0.285	0.243
10170	−0.063	0.112	1.271	0.855	−0.121	0.108	0.182	0.121
10171	−0.170	0.100	0.913	0.843	0.235	0.300	0.172	0.222
10174	−0.063	0.112	0.403	0.547	−0.207	0.105	0.445	0.651
10175	0.335	0.240	0.219	0.242	0.016	0.160	0.267	0.256
10176	−0.084	0.108	0.596	0.238	−0.065	0.121	1.125	0.571
10178	−0.397	0.126	2.367	1.774	−0.105	0.110	0.511	0.189
10179	0.034	0.133	0.658	0.957	0.322	0.387	0.114	0.171
10181	0.034	0.133	0.270	0.271	−0.074	0.119	1.015	0.462
10183	−0.170	0.100	1.014	1.003	−0.076	0.117	0.625	0.533
10184	0.115	0.154	0.637	0.510	0.048	0.179	1.462	0.704
10185	−0.012	0.122	0.859	1.235	0.134	0.245	0.210	0.243

Table 85 – *(continued)*

	Pre-test				Post-test			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10186	0.002	0.125	0.857	0.868	0.322	0.387	0.114	0.171
10187	−0.115	0.104	0.706	0.760	−0.105	0.110	0.511	0.189
10188	0.277	0.211	1.107	1.299	0.844	0.727	0.114	0.249
10189	0.234	0.195	0.429	0.302	−0.007	0.147	1.102	0.540
10190	−0.215	0.100	0.730	0.636	−0.007	0.147	1.090	0.557
10191	0.281	0.216	0.455	0.578	0.322	0.387	0.114	0.171
10192	−0.105	0.105	0.492	0.428	−0.025	0.138	0.423	0.331
10193	0.035	0.132	0.884	0.986	0.016	0.160	1.381	0.617
10195	−0.085	0.108	0.437	0.629	−0.123	0.107	0.645	1.053
10196	−0.095	0.107	0.355	0.278	0.104	0.216	0.428	0.337
10197	0.052	0.138	0.942	0.530	−0.025	0.138	0.423	0.331
10198	−0.205	0.100	0.456	0.257	−0.040	0.131	0.391	0.354
10199	−0.026	0.119	1.178	0.578	−0.025	0.138	1.337	0.582
10200	0.115	0.154	0.657	0.440	−0.076	0.117	0.545	0.294
10201	0.140	0.162	0.883	0.774	−0.040	0.131	0.391	0.354
10202	−0.124	0.103	0.637	0.872	−0.074	0.119	1.017	0.560
10203	−0.040	0.134	0.785	0.444	−0.635	0.211	0.168	0.153
10204	0.335	0.240	1.075	0.693	−0.040	0.131	0.403	0.335
10206	0.140	0.162	0.559	0.742	−0.053	0.126	1.354	0.629
10208	−0.116	0.104	0.873	0.564	−0.025	0.138	0.423	0.331
10209	−0.026	0.119	0.702	0.738	0.322	0.387	0.114	0.171
10210	−0.084	0.108	1.296	0.899	−0.138	0.105	0.425	0.108
10212	0.404	0.273	0.298	0.362	−0.172	0.103	0.384	0.513
10213	0.200	0.184	0.584	0.883	0.235	0.300	0.172	0.222
10214	0.140	0.164	0.629	0.756	−0.007	0.147	1.130	0.548
10215	−0.038	0.116	0.264	0.311	0.048	0.179	0.440	0.313
10216	−0.026	0.119	0.490	0.655	0.844	0.727	0.114	0.249
10217	−0.025	0.119	0.792	0.816	0.235	0.300	0.172	0.222
10218	0.019	0.128	0.765	0.414	−0.086	0.114	0.686	0.293
10219	−0.039	0.116	1.280	1.535	−0.021	0.142	0.408	0.382
10220	0.034	0.133	0.403	0.217	−0.002	0.152	1.267	0.573
10221	−0.116	0.104	1.133	0.643	−0.189	0.104	1.693	0.575
10222	0.052	0.138	0.752	0.484	−0.180	0.103	0.416	0.600
10223	0.002	0.125	0.751	0.795	0.134	0.245	0.210	0.245
10224	−0.196	0.100	0.810	0.797	−0.156	0.103	0.720	0.958
10226	0.199	0.182	0.321	0.511	0.322	0.387	0.114	0.171
10227	−0.161	0.100	0.381	0.324	−0.121	0.108	2.351	0.526
10230	0.200	0.184	0.988	0.772	−0.121	0.108	0.117	0.089
10231	−0.096	0.107	1.160	0.923	0.048	0.179	0.490	0.325
10232	0.052	0.138	1.198	1.570	−0.065	0.121	1.010	0.813
10233	−0.085	0.108	0.804	0.612	−0.037	0.134	0.359	0.394
10234	0.140	0.164	0.681	0.703	−0.138	0.105	1.278	1.260
10237	0.154	0.177	0.366	0.513	−0.074	0.119	0.917	1.057
10238	0.052	0.138	0.279	0.290	−0.037	0.134	0.215	0.296
10240	−0.310	0.109	2.264	2.377	−0.040	0.131	1.168	0.595

D.10 Stacking Procedure for Estimating Gains in Skill/-Knowledge of the Second Empirical Study

D.10.1 Checking Assumptions

Test of Unidimensionality

Table 86 shows the results for the test of unidimensionality in which the goodness of fit statistics indicate strong multidimensionality ($DETECT > 1.00$) for the *Pre-test* and *Post-test* with values of 126.482 and 79.021. Essential unidimensionality in the data structure is indicated by the ASSI index in the *Pre-test* (with value of 0.2). The index AGFI in the *Pre-test* and *Post-test* indicates good fit with values greater than 0.95. A good fit with the unidimensional CFA is indicated by the TLI and CFI indices for the pre-test and post-test.

Table 86 – Goodness of fit statistics related to the test of unidimensionality in the GPCM-based instrument for measuring the gains in skill/knowledge of the second empirical study

	df	chisq	AGFI	TLI	CFI	DETECT	ASSI	RATIO
Pre-test	9	8.908	0.970	1.003	1.000	126.482	0.2	0.712
Post-test	5	7.052	0.931	0.813	0.907	79.021	0.4	0.515

df: degree of freedom; AGFI: Adjusted Goodness of Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index;

Test of Local Independence

Results from the test of local independence in the GPCM-based instrument for measuring gains in skill/knowledge of the second empirical study are summarized in Table 87. The null condition of local independence is not rejected in the *Pre-test* and *Post-test*.

Table 87 – Item residual correlation statistics related to the test of local independence in the GPCM-based instrument for measuring gains in skill/knowledge of the second empirical study

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Pre-test	336.290	0.399	0.132	0.349	0.051
Post-test	77.018	0.303	0.136	0.309	0.397

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

D.10.2 Item Parameters

Table 88 shows the estimated parameters for the GPCM-based instrument used to measure the pre-test skill/knowledge of the second empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement

system is not distorted or degraded by the items.

Table 88 – Estimated parameters in the GPCM-based instrument for measuring the pre-test skill/knowledge of the second empirical study

	An3a	An3b	Ap2a	Ap2b	P2s1	Un3
xsi.item	−0.079	−0.010	−1.966	−0.013	−22.124	−0.058
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	0.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	0.000	3.000	0.000	3.000
B.Cat4	4.000	4.000	0.000	4.000	0.000	4.000
B.Cat5	5.000	5.000	0.000	5.000	0.000	5.000
B.Cat6	6.000	6.000	0.000	6.000	0.000	6.000
B.Cat7	7.000	7.000	0.000	7.000	0.000	7.000
B.Cat8	8.000	8.000	0.000	8.000	0.000	8.000
B.Cat9	9.000	9.000	0.000	9.000	0.000	9.000
B.Cat10	10.000	10.000	0.000	10.000	0.000	10.000
B.Cat11	11.000	11.000	0.000	11.000	0.000	11.000
B.Cat12	12.000	12.000	0.000	12.000	0.000	12.000
B.Cat13	13.000	0.000	0.000	13.000	0.000	13.000
B.Cat14	14.000	0.000	0.000	14.000	0.000	14.000
B.Cat15	15.000	0.000	0.000	0.000	0.000	15.000
B.Cat16	16.000	0.000	0.000	0.000	0.000	16.000
B.Cat17	0.000	0.000	0.000	0.000	0.000	17.000
B.Cat18	0.000	0.000	0.000	0.000	0.000	18.000
B.Cat19	0.000	0.000	0.000	0.000	0.000	19.000
B.Cat20	0.000	0.000	0.000	0.000	0.000	20.000
B.Cat21	0.000	0.000	0.000	0.000	0.000	21.000
B.Cat22	0.000	0.000	0.000	0.000	0.000	22.000
B.Cat23	0.000	0.000	0.000	0.000	0.000	23.000
B.Cat24	0.000	0.000	0.000	0.000	0.000	24.000
B.Cat25	0.000	0.000	0.000	0.000	0.000	25.000
B.Cat26	0.000	0.000	0.000	0.000	0.000	26.000
B.Cat27	0.000	0.000	0.000	0.000	0.000	27.000
B.Cat28	0.000	0.000	0.000	0.000	0.000	28.000
B.Cat29	0.000	0.000	0.000	0.000	0.000	29.000
B.Cat30	0.000	0.000	0.000	0.000	0.000	30.000
B.Cat31	0.000	0.000	0.000	0.000	0.000	31.000
B.Cat32	0.000	0.000	0.000	0.000	0.000	32.000
B.Cat33	0.000	0.000	0.000	0.000	0.000	33.000
B.Cat34	0.000	0.000	0.000	0.000	0.000	34.000
B.Cat35	0.000	0.000	0.000	0.000	0.000	35.000
B.Cat36	0.000	0.000	0.000	0.000	0.000	36.000
B.Cat37	0.000	0.000	0.000	0.000	0.000	37.000
B.Cat38	0.000	0.000	0.000	0.000	0.000	38.000
B.Cat39	0.000	0.000	0.000	0.000	0.000	39.000
B.Cat40	0.000	0.000	0.000	0.000	0.000	40.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	−5.616	−7.424	1.966	−6.053	44.471	−5.448
AXsi.Cat2	−5.666	−8.141		−7.940	44.248	−7.656
AXsi.Cat3	−0.287	−7.619		−8.724		−8.036
AXsi.Cat4	0.813	−2.717		−8.077		−7.771
AXsi.Cat5	−4.826	0.127		−6.069		−5.950
AXsi.Cat6	−5.910	−0.762		0.123		−1.000
AXsi.Cat7	−4.711	−7.448		−1.682		−1.025
AXsi.Cat8	1.180	−9.296		−6.004		−4.663

Table 88 – *(continued)*

	An3a	An3b	Ap2a	Ap2b	P2s1	Un3
AXsi.Cat9	−4.363	−9.859		−7.451		−0.310
AXsi.Cat10	−4.494	−9.344		−7.985		−0.321
AXsi.Cat11	−0.709	−7.386		−7.488		−4.996
AXsi.Cat12	1.019	0.126		−6.370		−6.747
AXsi.Cat13	−4.583			−2.806		−7.436
AXsi.Cat14	−4.845			0.186		−7.448
AXsi.Cat15	−1.408					−6.499
AXsi.Cat16	1.265					−4.881
AXsi.Cat17						−0.865
AXsi.Cat18						0.981
AXsi.Cat19						−0.262
AXsi.Cat20						−4.141
AXsi.Cat21						−5.534
AXsi.Cat22						−6.731
AXsi.Cat23						−7.145
AXsi.Cat24						−7.113
AXsi.Cat25						−6.642
AXsi.Cat26						−5.970
AXsi.Cat27						−4.529
AXsi.Cat28						−1.038
AXsi.Cat29						0.694
AXsi.Cat30						0.459
AXsi.Cat31						−3.326
AXsi.Cat32						−5.734
AXsi.Cat33						−6.869
AXsi.Cat34						−7.189
AXsi.Cat35						−7.135
AXsi.Cat36						−6.650
AXsi.Cat37						−6.214
AXsi.Cat38						−4.356
AXsi.Cat39						−0.379
AXsi.Cat40						2.319
max.Outfit	1.008	1.000	1.000	1.005	1.000	0.613
max.Infit	1.008	1.000	1.000	1.005	1.000	0.613

Table 89 shows the estimated parameters for the GPCM-based instrument used to measure the post-test skill/knowledge of the second empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system is not distorted or degraded by the items.

Table 89 – Estimated parameters in the GPCM-based instrument for measuring the post-test skill/knowledge in the second empirical study

	AnC1	AnC2	ApB1	ApB2	PCs3
xsi.item	−0.119	−0.133	−2.175	−0.106	−15.226
B.Cat0	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000

Table 89 – *(continued)*

	AnC1	AnC2	ApB1	ApB2	PCs3
B.Cat2	2.000	2.000	0.000	2.000	2.000
B.Cat3	3.000	3.000	0.000	3.000	3.000
B.Cat4	4.000	4.000	0.000	4.000	4.000
B.Cat5	5.000	5.000	0.000	5.000	0.000
B.Cat6	6.000	6.000	0.000	6.000	0.000
B.Cat7	7.000	7.000	0.000	7.000	0.000
B.Cat8	8.000	8.000	0.000	8.000	0.000
B.Cat9	9.000	9.000	0.000	9.000	0.000
B.Cat10	10.000	10.000	0.000	10.000	0.000
B.Cat11	11.000	11.000	0.000	11.000	0.000
B.Cat12	12.000	12.000	0.000	12.000	0.000
B.Cat13	13.000	13.000	0.000	13.000	0.000
B.Cat14	14.000	14.000	0.000	14.000	0.000
B.Cat15	15.000	15.000	0.000	0.000	0.000
B.Cat16	16.000	16.000	0.000	0.000	0.000
B.Cat17	17.000	17.000	0.000	0.000	0.000
B.Cat18	18.000	18.000	0.000	0.000	0.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	−5.378	−6.301	2.175	−5.704	61.918
AXsi.Cat2	−0.701	−7.422		−5.752	61.311
AXsi.Cat3	−5.803	−6.199		−1.807	61.466
AXsi.Cat4	−5.661	1.386		−1.808	60.906
AXsi.Cat5	0.696	1.792		−4.963	
AXsi.Cat6	0.918	2.194		0.613	
AXsi.Cat7	−4.952	−3.722		−0.407	
AXsi.Cat8	−6.102	−5.093		−5.151	
AXsi.Cat9	−5.226	−5.264		−7.286	
AXsi.Cat10	−0.701	−3.726		−8.101	
AXsi.Cat11	0.700	2.074		−8.113	
AXsi.Cat12	1.951	2.299		−7.278	
AXsi.Cat13	−4.933	−3.907		−5.135	
AXsi.Cat14	−6.289	−5.710		1.478	
AXsi.Cat15	−5.946	−6.251			
AXsi.Cat16	−4.969	−5.876			
AXsi.Cat17	−0.702	−3.951			
AXsi.Cat18	2.149	2.392			
max.Outfit	1.007	1.000	1.000	1.009	1.000
max.Infit	1.007	1.000	1.000	1.009	1.000

D.10.3 Gains in Skill/Knowledge as Latent Trait Estimates

Table 90 shows the latent trait estimates by the GPCM-based instrument for measuring the gains in skill/knowledge of the second empirical study.

Table 90 – Latent trait estimates and person model fit of the GPCM-based instrument for measuring gains in skill/knowledge of the second empirical study

	Pre-test				Post-test			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10169	0.009	0.067	1.001	0.908	−0.236	0.135	2.199	0.736
10170	−0.040	0.060	0.628	0.356	−0.153	0.116	2.807	0.850
10172	0.053	0.082	0.575	0.424	0.411	0.301	0.360	0.250

Table 90 – *(continued)*

	Pre-test				Post-test			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10174	−0.119	0.077	2.530	0.879	−0.141	0.114	0.413	0.388
10175	0.141	0.118	0.499	0.489	0.286	0.207	0.163	0.207
10176	0.012	0.068	0.300	0.406	−0.028	0.109	1.031	1.270
10178	0.005	0.066	0.600	0.700	−0.098	0.110	0.594	0.757
10179	−0.007	0.063	0.529	0.778	0.047	0.117	0.177	0.185
10181	−0.020	0.061	0.834	0.347	0.024	0.113	0.259	0.299
10183	−0.204	0.112	0.616	0.784	−0.119	0.112	0.243	0.240
10184	0.053	0.082	0.492	0.393	0.069	0.120	1.157	1.131
10185	0.148	0.121	0.418	0.498	0.300	0.222	0.142	0.190
10186	−0.013	0.065	0.344	0.201	−0.165	0.119	0.530	0.728
10187	0.009	0.067	0.673	0.681	−0.038	0.109	0.117	0.114
10188	0.307	0.205	0.301	0.196	−0.018	0.110	0.401	0.480
10189	−0.093	0.068	1.485	0.165	−0.153	0.116	0.054	0.046
10190	−0.010	0.063	0.702	0.333	0.047	0.117	0.216	0.237
10192	0.005	0.066	1.455	0.382	−0.099	0.109	0.475	0.747
10196	−0.063	0.062	0.347	0.097	0.069	0.120	0.237	0.183
10197	0.012	0.068	0.589	0.568	−0.029	0.108	0.302	0.123
10198	−0.350	0.182	0.218	0.123	−0.029	0.108	0.631	0.698
10200	−0.082	0.065	0.388	0.222	−0.218	0.129	1.676	0.180
10201	0.025	0.072	0.762	0.655	0.057	0.118	1.146	1.711
10202	−0.078	0.065	2.116	1.299	−0.049	0.108	0.585	0.636
10203	−0.195	0.108	0.366	0.301	−0.584	0.257	1.201	0.305
10204	0.126	0.111	0.595	0.632	0.109	0.129	0.493	0.356
10206	0.016	0.069	0.549	0.225	−0.049	0.108	0.606	0.970
10208	0.216	0.151	0.335	0.257	0.139	0.138	0.205	0.265
10210	−0.063	0.062	0.249	0.063	−0.019	0.109	0.634	0.810
10212	0.016	0.069	0.369	0.380	−0.018	0.110	0.545	0.708
10213	0.105	0.103	0.436	0.467	0.059	0.119	0.664	0.882
10214	0.035	0.075	0.273	0.269	−0.019	0.109	0.531	0.485
10215	−0.033	0.060	0.488	0.271	0.139	0.138	0.373	0.594
10217	0.358	0.242	0.239	0.155	0.069	0.120	0.638	0.904
10218	−0.011	0.063	0.706	0.392	−0.153	0.117	0.657	0.765
10219	−0.062	0.062	0.150	0.061	0.059	0.119	0.172	0.177
10220	−0.119	0.077	0.353	0.190	0.144	0.141	0.236	0.271
10221	−0.119	0.077	0.832	0.905	−0.253	0.140	1.873	0.237
10224	0.035	0.075	0.354	0.282	−0.009	0.109	1.109	0.894
10226	−0.051	0.061	0.787	0.328	0.144	0.141	0.236	0.271
10227	−0.059	0.061	1.654	0.122	0.023	0.112	0.768	0.870
10228	−0.010	0.063	1.958	0.321	−0.130	0.113	1.394	1.609
10230	0.032	0.074	0.185	0.292	0.139	0.138	0.530	0.746
10231	0.216	0.151	0.335	0.257	0.250	0.186	0.489	0.322
10232	−0.119	0.077	0.245	0.518	−0.049	0.108	0.730	0.877
10237	0.005	0.066	1.148	2.103	0.300	0.222	0.142	0.190
10238	−0.021	0.061	1.840	0.381	0.036	0.115	0.674	0.874
10240	−0.033	0.060	0.968	1.356	−0.088	0.109	0.326	0.220

D.11 Stacking Procedure for Estimating Gains in Skill/-Knowledge of the Third Empirical Study

D.11.1 Checking Assumptions

Test of Unidimensionality

Table 91 shows the results for the test of unidimensionality in which the goodness of fit statistics indicate strong multidimensionality ($DETECT > 1.00$) for the *Pre-test* and *Post-test*. Essential unidimensionality in the data structure is indicated by the ASSI index in the *Pre-test* with value of 0.200. The index AGFI in the *Pre-test* and *Post-test* indicates good fit with values greater than 0.95. A good fit with the unidimensional CFA is indicated by the TLI and CFI indices for the pre-test and post-test.

Table 91 – Goodness of fit statistics related to the test of unidimensionality in the GPCM-based instrument for measuring the gains in skill/knowledge of the third empirical study

	df	chisq	AGFI	TLI	CFI	DETECT	ASSI	RATIO
Pre-test	9	8.664	0.964	1.036	1	194.158	0.200	0.457
Post-test	14	9.815	0.962	2.826	1	258.820	0.429	0.645

df: degree of freedom; AGFI: Adjusted Goodness of Fit Index; CFI: Comparative Fit Index; TLI: Tucker-Lewis Index;

Test of Local Independence

Results from the test of local independence in the GPCM-based instrument for measuring gains in skill/knowledge of the third empirical study are summarized in Table 92. The null condition of local independence is not rejected in the *Pre-test* and *Post-test*.

Table 92 – Item residual correlation statistics related to the test of local independence in the GPCM-based instrument for measuring gains in skill/knowledge of the third empirical study

	max.chisq	maxaQ3	MADaQ3	SRMSR	p.value
Pre-test	285.450	0.361	0.142	0.188	0.112
Post-test	6332.263	0.342	0.141	0.179	0.402

aQ3: adjusted correlation of item residuals; maxaQ3: maximum aQ3;
MADaQ3: Median Absolute Deviation of aQ3;

D.11.2 Item Parameters

Table 93 shows the estimated parameters for the GPCM-based instrument used to measure the pre-test skill/knowledge of the third empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement

system is not distorted or degraded by the items.

Table 93 – Estimated parameters in the GPCM-based instrument for measuring the pre-test skill/knowledge of the third empirical study

	An3a	An3b	Ap1	Ap3	Ev2	Un2
xsi.item	0.030	0.065	−0.013	0.019	0.073	0.006
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000	6.000
B.Cat7	7.000	7.000	7.000	7.000	7.000	7.000
B.Cat8	8.000	8.000	8.000	8.000	8.000	8.000
B.Cat9	9.000	9.000	9.000	9.000	9.000	9.000
B.Cat10	10.000	10.000	10.000	10.000	10.000	10.000
B.Cat11	11.000	11.000	11.000	11.000	11.000	11.000
B.Cat12	12.000	12.000	12.000	12.000	12.000	12.000
B.Cat13	13.000	13.000	13.000	13.000	13.000	13.000
B.Cat14	14.000	14.000	14.000	14.000	14.000	14.000
B.Cat15	0.000	0.000	15.000	15.000	15.000	15.000
B.Cat16	0.000	0.000	16.000	16.000	16.000	16.000
B.Cat17	0.000	0.000	17.000	17.000	17.000	17.000
B.Cat18	0.000	0.000	18.000	18.000	18.000	18.000
B.Cat19	0.000	0.000	19.000	19.000	0.000	19.000
B.Cat20	0.000	0.000	20.000	20.000	0.000	20.000
B.Cat21	0.000	0.000	21.000	21.000	0.000	21.000
B.Cat22	0.000	0.000	22.000	22.000	0.000	22.000
B.Cat23	0.000	0.000	0.000	0.000	0.000	23.000
B.Cat24	0.000	0.000	0.000	0.000	0.000	24.000
B.Cat25	0.000	0.000	0.000	0.000	0.000	25.000
B.Cat26	0.000	0.000	0.000	0.000	0.000	26.000
B.Cat27	0.000	0.000	0.000	0.000	0.000	27.000
B.Cat28	0.000	0.000	0.000	0.000	0.000	28.000
B.Cat29	0.000	0.000	0.000	0.000	0.000	29.000
B.Cat30	0.000	0.000	0.000	0.000	0.000	30.000
B.Cat31	0.000	0.000	0.000	0.000	0.000	31.000
B.Cat32	0.000	0.000	0.000	0.000	0.000	32.000
B.Cat33	0.000	0.000	0.000	0.000	0.000	33.000
B.Cat34	0.000	0.000	0.000	0.000	0.000	34.000
B.Cat35	0.000	0.000	0.000	0.000	0.000	35.000
B.Cat36	0.000	0.000	0.000	0.000	0.000	36.000
B.Cat37	0.000	0.000	0.000	0.000	0.000	37.000
B.Cat38	0.000	0.000	0.000	0.000	0.000	38.000
B.Cat39	0.000	0.000	0.000	0.000	0.000	39.000
B.Cat40	0.000	0.000	0.000	0.000	0.000	40.000
B.Cat41	0.000	0.000	0.000	0.000	0.000	41.000
B.Cat42	0.000	0.000	0.000	0.000	0.000	42.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	−6.608	−6.424	−6.249	−5.083	−6.162	−6.234
AXsi.Cat2	−7.773	−8.559	−8.205	−7.157	−7.963	−7.998
AXsi.Cat3	−8.053	−9.409	−8.939	−8.177	−8.692	−8.967
AXsi.Cat4	−6.692	−8.749	−9.472	−8.725	−9.030	−9.913
AXsi.Cat5	−3.028	−6.715	−9.537	−8.919	−8.693	−10.148
AXsi.Cat6	−1.045	−1.541	−9.387	−8.781	−6.938	−9.931

Table 93 – *(continued)*

	An3a	An3b	Ap1	Ap3	Ev2	Un2
AXsi.Cat7	−0.593	−2.375	−8.827	−8.305	−3.495	−9.579
AXsi.Cat8	−3.026	−3.577	−7.911	−7.450	−0.672	−9.065
AXsi.Cat9	−6.673	−7.170	−6.166	−5.841	−3.510	−7.907
AXsi.Cat10	−7.543	−7.541	−1.781	−0.760	−7.131	−5.895
AXsi.Cat11	−6.507	−6.311	−6.144	−1.604	−8.700	−0.628
AXsi.Cat12	−2.311	−3.585	−7.598	−3.588	−9.521	−0.688
AXsi.Cat13	−1.889	−2.883	−8.300	−5.826	−9.563	−0.369
AXsi.Cat14	−0.423	−0.905	−8.407	−7.696	−8.974	−0.056
AXsi.Cat15			−8.270	−8.421	−8.844	−5.141
AXsi.Cat16			−7.623	−8.996	−8.289	−6.966
AXsi.Cat17			−6.085	−9.055	−6.950	−7.980
AXsi.Cat18			−3.306	−8.914	−1.306	−8.589
AXsi.Cat19			−6.316	−8.382		−8.632
AXsi.Cat20			−7.231	−7.435		−8.486
AXsi.Cat21			−5.925	−5.716		−7.945
AXsi.Cat22			0.284	−0.417		−6.822
AXsi.Cat23						−5.445
AXsi.Cat24						−2.093
AXsi.Cat25						−1.456
AXsi.Cat26						−0.586
AXsi.Cat27						0.964
AXsi.Cat28						−0.138
AXsi.Cat29						−2.046
AXsi.Cat30						−6.085
AXsi.Cat31						−7.783
AXsi.Cat32						−8.824
AXsi.Cat33						−9.423
AXsi.Cat34						−9.713
AXsi.Cat35						−9.829
AXsi.Cat36						−9.526
AXsi.Cat37						−8.816
AXsi.Cat38						−7.746
AXsi.Cat39						−5.916
AXsi.Cat40						−1.936
AXsi.Cat41						−0.577
AXsi.Cat42						−0.258
max.Outfit	1.002	1.069	1.028	1.167	0.985	0.580
max.Infit	1.002	1.069	1.028	1.167	0.985	0.580

Table 94 shows the estimated parameters for the GPCM-based instrument used to measure the post-test skill/knowledge of the third empirical study. These parameters had been calculated using the MML method (BOCK; AITKIN, 1981), so that the value in row "B.Cat$x$" and column "i" is the item slope $b_{i,x}$ of item i in the category "x", and the value in the row "AXsi.Cat$x$" and column "i" is the item intercept $a_{i,x}\xi$ of item i in the category "x". According to the Infit/Outfit statistics of items, no one mean-square value is greater than 2.0 indicating that the measurement system is not distorted or degraded by the items.

Table 94 – Estimated parameters in the GPCM-based instrument for measuring the post-test skill/knowledge in the third empirical study

	AnC1	AnC2	ApA	ApC	EvB	PGs3	ReB
xsi.item	0.031	0.139	0.037	0.095	0.118	−16.012	−0.052
B.Cat0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
B.Cat1	1.000	1.000	1.000	1.000	1.000	1.000	1.000
B.Cat2	2.000	2.000	2.000	2.000	2.000	2.000	2.000
B.Cat3	3.000	3.000	3.000	3.000	3.000	3.000	3.000
B.Cat4	4.000	4.000	4.000	4.000	4.000	4.000	4.000
B.Cat5	5.000	5.000	5.000	5.000	5.000	0.000	5.000
B.Cat6	6.000	6.000	6.000	6.000	6.000	0.000	6.000
B.Cat7	7.000	7.000	7.000	7.000	7.000	0.000	7.000
B.Cat8	8.000	8.000	8.000	8.000	8.000	0.000	8.000
B.Cat9	9.000	9.000	9.000	9.000	9.000	0.000	9.000
B.Cat10	10.000	10.000	10.000	10.000	10.000	0.000	10.000
B.Cat11	11.000	11.000	11.000	11.000	11.000	0.000	11.000
B.Cat12	12.000	12.000	12.000	12.000	12.000	0.000	12.000
B.Cat13	13.000	13.000	13.000	13.000	13.000	0.000	13.000
B.Cat14	14.000	14.000	14.000	14.000	14.000	0.000	14.000
B.Cat15	0.000	0.000	0.000	15.000	15.000	0.000	15.000
B.Cat16	0.000	0.000	0.000	16.000	16.000	0.000	16.000
B.Cat17	0.000	0.000	0.000	17.000	17.000	0.000	17.000
B.Cat18	0.000	0.000	0.000	18.000	18.000	0.000	18.000
B.Cat19	0.000	0.000	0.000	0.000	0.000	0.000	19.000
B.Cat20	0.000	0.000	0.000	0.000	0.000	0.000	20.000
B.Cat21	0.000	0.000	0.000	0.000	0.000	0.000	21.000
B.Cat22	0.000	0.000	0.000	0.000	0.000	0.000	22.000
B.Cat23	0.000	0.000	0.000	0.000	0.000	0.000	23.000
B.Cat24	0.000	0.000	0.000	0.000	0.000	0.000	24.000
B.Cat25	0.000	0.000	0.000	0.000	0.000	0.000	25.000
B.Cat26	0.000	0.000	0.000	0.000	0.000	0.000	26.000
B.Cat27	0.000	0.000	0.000	0.000	0.000	0.000	27.000
B.Cat28	0.000	0.000	0.000	0.000	0.000	0.000	28.000
B.Cat29	0.000	0.000	0.000	0.000	0.000	0.000	29.000
B.Cat30	0.000	0.000	0.000	0.000	0.000	0.000	30.000
B.Cat31	0.000	0.000	0.000	0.000	0.000	0.000	31.000
B.Cat32	0.000	0.000	0.000	0.000	0.000	0.000	32.000
B.Cat33	0.000	0.000	0.000	0.000	0.000	0.000	33.000
B.Cat34	0.000	0.000	0.000	0.000	0.000	0.000	34.000
B.Cat35	0.000	0.000	0.000	0.000	0.000	0.000	35.000
B.Cat36	0.000	0.000	0.000	0.000	0.000	0.000	36.000
B.Cat37	0.000	0.000	0.000	0.000	0.000	0.000	37.000
B.Cat38	0.000	0.000	0.000	0.000	0.000	0.000	38.000
B.Cat39	0.000	0.000	0.000	0.000	0.000	0.000	39.000
B.Cat40	0.000	0.000	0.000	0.000	0.000	0.000	40.000
B.Cat41	0.000	0.000	0.000	0.000	0.000	0.000	41.000
B.Cat42	0.000	0.000	0.000	0.000	0.000	0.000	42.000
B.Cat43	0.000	0.000	0.000	0.000	0.000	0.000	43.000
B.Cat44	0.000	0.000	0.000	0.000	0.000	0.000	44.000
B.Cat45	0.000	0.000	0.000	0.000	0.000	0.000	45.000
B.Cat46	0.000	0.000	0.000	0.000	0.000	0.000	46.000
B.Cat47	0.000	0.000	0.000	0.000	0.000	0.000	47.000
B.Cat48	0.000	0.000	0.000	0.000	0.000	0.000	48.000
B.Cat49	0.000	0.000	0.000	0.000	0.000	0.000	49.000
B.Cat50	0.000	0.000	0.000	0.000	0.000	0.000	50.000

Table 94 – *(continued)*

	AnC1	AnC2	ApA	ApC	EvB	PGs3	ReB
B.Cat51	0.000	0.000	0.000	0.000	0.000	0.000	51.000
B.Cat52	0.000	0.000	0.000	0.000	0.000	0.000	52.000
B.Cat53	0.000	0.000	0.000	0.000	0.000	0.000	53.000
B.Cat54	0.000	0.000	0.000	0.000	0.000	0.000	54.000
B.Cat55	0.000	0.000	0.000	0.000	0.000	0.000	55.000
B.Cat56	0.000	0.000	0.000	0.000	0.000	0.000	56.000
AXsi.Cat0	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AXsi.Cat1	−6.016	−7.630	−6.477	−6.260	−6.520	64.180	−4.373
AXsi.Cat2	−7.797	−8.765	−7.520	−8.031	−8.764	63.710	0.942
AXsi.Cat3	−7.643	−7.791	−6.599	−9.035	−8.893	63.710	−4.505
AXsi.Cat4	−6.231	−3.055	−3.183	−8.561	−8.163	64.046	−6.208
AXsi.Cat5	−2.360	−1.946	−5.662	−6.585	−6.520		−7.275
AXsi.Cat6	−1.411	−0.336	−0.720	−2.792	−3.627		−7.471
AXsi.Cat7	−1.231	−2.351	−5.722	−3.472	−3.532		−7.537
AXsi.Cat8	−3.054	−3.051	−3.191	−1.023	−1.395		−7.057
AXsi.Cat9	−6.343	−8.386	−6.700	−3.552	−2.948		−6.357
AXsi.Cat10	−6.866	−9.280	−7.405	−7.056	−3.666		−4.146
AXsi.Cat11	−6.217	−8.264	−6.479	−8.584	−7.352		0.181
AXsi.Cat12	−3.074	−1.661	−3.165	−9.695	−9.256		−0.127
AXsi.Cat13	−2.980	−8.117	−5.683	−10.164	−10.319		0.008
AXsi.Cat14	−0.435	−1.946	−0.511	−10.467	−10.722		−4.277
AXsi.Cat15				−10.173	−10.519		−6.159
AXsi.Cat16				−9.278	−9.662		−6.911
AXsi.Cat17				−7.619	−7.857		−7.021
AXsi.Cat18				−1.702	−2.132		−6.176
AXsi.Cat19							−4.458
AXsi.Cat20							1.042
AXsi.Cat21							0.490
AXsi.Cat22							−3.616
AXsi.Cat23							−5.390
AXsi.Cat24							−6.193
AXsi.Cat25							−6.436
AXsi.Cat26							−6.284
AXsi.Cat27							−5.316
AXsi.Cat28							−3.471
AXsi.Cat29							0.672
AXsi.Cat30							−3.567
AXsi.Cat31							−5.196
AXsi.Cat32							−5.974
AXsi.Cat33							−6.083
AXsi.Cat34							−6.261
AXsi.Cat35							−5.425
AXsi.Cat36							−3.647
AXsi.Cat37							−0.202
AXsi.Cat38							1.827
AXsi.Cat39							0.003
AXsi.Cat40							−3.899
AXsi.Cat41							−5.746
AXsi.Cat42							−6.678
AXsi.Cat43							−6.958
AXsi.Cat44							−6.454
AXsi.Cat45							−5.064
AXsi.Cat46							−3.569
AXsi.Cat47							1.232

Table 94 – *(continued)*

	AnC1	AnC2	ApA	ApC	EvB	PGs3	ReB
AXsi.Cat48							0.582
AXsi.Cat49							−3.531
AXsi.Cat50							−5.357
AXsi.Cat51							−6.125
AXsi.Cat52							−6.413
AXsi.Cat53							−6.322
AXsi.Cat54							−5.461
AXsi.Cat55							−3.401
AXsi.Cat56							2.922
max.Outfit	1.008	1.000	1.004	1.205	1.166	1.000	0.674
max.Infit	1.008	1.000	1.004	1.205	1.166	1.000	0.674

D.11.3 Gains in Skill/Knowledge as Latent Trait Estimates

Table 95 shows the latent trait estimates by the GPCM-based instrument for measuring the gains in skill/knowledge of the third empirical study.

Table 95 – Latent trait estimates and person model fit of the GPCM-based instrument for measuring gains in skill/knowledge of the third empirical study

	Pre-test				Post-test			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10169	−0.083	0.058	0.414	0.320	0.074	0.062	0.458	0.359
10170	0.017	0.048	1.122	0.975	−0.020	0.043	0.436	0.215
10172	−0.026	0.049	1.002	1.593	−0.080	0.057	0.695	0.573
10174	0.110	0.680	1.375	1.965	−0.026	0.043	1.006	0.375
10175	0.034	0.049	1.066	0.894	0.210	0.085	0.834	0.913
10176	0.078	0.054	0.718	0.627	−0.016	0.053	0.790	1.114
10178	−0.023	0.055	1.477	1.851	0.011	0.048	0.492	0.313
10179	0.068	0.049	0.224	0.249	−0.011	0.043	0.395	0.399
10181	−0.059	0.053	0.479	0.647	0.015	0.049	0.850	0.642
10183	−0.026	0.049	1.056	1.013	−0.020	0.043	0.180	0.111
10184	0.055	0.051	0.618	0.482	−0.020	0.043	0.867	1.210
10185	0.021	0.048	1.222	1.580	−0.010	0.043	0.772	0.970
10186	0.013	0.048	0.217	0.185	0.007	0.047	0.672	0.260
10187	−0.023	0.055	1.477	1.851	−0.003	0.045	0.449	0.728
10188	0.007	0.048	1.188	0.961	0.161	0.073	1.386	1.198
10189	−0.110	0.066	0.177	0.150	−0.041	0.044	2.318	0.626
10190	−0.052	0.050	0.310	0.215	−0.088	0.061	0.475	0.428
10191	0.086	0.056	1.119	0.949	−0.021	0.043	0.732	0.247
10192	0.017	0.048	0.884	0.697	0.127	0.069	1.557	1.476
10193	0.011	0.048	0.375	0.319	−0.029	0.043	1.621	0.877
10197	0.021	0.048	0.678	0.582	−0.269	0.081	24.053	20.830
10198	−0.057	0.052	0.505	0.698	0.032	0.053	0.339	0.234
10200	−0.052	0.050	0.453	0.630	−0.012	0.045	0.534	0.426
10201	0.034	0.049	1.010	0.796	−0.015	0.043	0.890	0.286
10202	−0.077	0.056	0.616	0.885	0.113	0.067	0.631	0.796
10203	0.549	0.104	1025.437	224.121	−0.082	0.058	0.317	0.126
10204	−0.025	0.065	0.312	0.374	0.020	0.050	1.124	0.787
10206	0.015	0.048	1.215	0.961	0.003	0.046	0.572	0.199
10209	0.045	0.050	0.663	0.387	0.181	0.077	0.563	0.383
10210	0.017	0.048	0.943	1.178	0.023	0.051	1.055	0.601

Table 95 – *(continued)*

	Pre-test				Post-test			
UserID	theta	error	Outfit	Infit	theta	error	Outfit	Infit
10213	−0.003	0.048	1.373	1.118	0.003	0.046	0.597	0.732
10214	−0.110	0.066	0.686	0.674	0.002	0.046	1.450	1.251
10215	−0.101	0.262	2.793	3.233	0.536	0.138	926.235	194.704
10216	0.110	0.680	0.722	0.846	0.067	0.061	1.006	0.783
10217	0.041	0.050	1.181	0.970	0.128	0.069	0.449	0.316
10218	0.009	0.048	0.940	0.939	−0.015	0.043	0.911	1.083
10219	0.023	0.050	0.624	0.398	−0.012	0.045	0.863	0.319
10220	−0.052	0.050	0.831	0.846	−0.012	0.045	1.429	0.402
10221	−0.092	0.060	0.516	0.321	−0.205	0.070	5.678	11.765
10223	0.007	0.048	1.188	0.961	−0.011	0.043	1.210	0.812
10226	−0.049	0.051	0.406	0.324	0.004	0.046	0.493	0.643
10227	0.013	0.048	0.706	0.642	−0.264	0.075	9.201	6.981
10228	−0.149	0.082	0.787	0.551	−0.264	0.075	8.157	12.257
10230	0.060	0.052	0.525	0.478	−0.079	0.056	1.086	0.678
10231	0.477	0.083	144.754	74.848	0.036	0.054	1.624	1.293
10232	0.050	0.051	0.573	0.424	−0.024	0.043	0.171	0.061
10237	0.005	0.048	0.854	0.673	0.021	0.051	0.567	0.507
10238	−0.003	0.447	1.172	1.195	−0.015	0.043	0.662	0.259
10240	−0.003	0.447	0.677	0.614	−0.041	0.046	0.737	0.285