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Construct Invariance of the Survey of Knowledge of Internet Risk and Internet Behavior Knowledge Scale

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Construct Invariance of the *Survey of Knowledge of Internet Risk and Internet Behavior* Knowledge Scale[1]

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Abstract

The wide use of the Internet has the potential for students to become victims of Internet sexual predators or other students who engage in inappropriate cyberbullying behaviors. The key for educational programming efforts targeted for students, teachers and parents is instrumentation that provides meaningful and reliable data assessing students' knowledge of Internet risk and their actual Internet behaviors. The *Survey of Knowledge of Internet Risk and Internet Behavior* (*SKIRIB*) was developed for this type of assessment. Construct invariance of the *SKIRIB* Knowledge scale regarding gender and grade level is examined for *N*=2621 middle school and *N*=1594 high school students using multi-group confirmatory factor analysis and Rasch rating scale modeling techniques. Implications for future score interpretations are discussed.

Purpose and Framework

School superintendents report that Internet safety and related bullying have become major issues for school districts (K. L. List, M. J. Frechette, P. A. Streifer, A. W. Distasio, R. J. Siminiski, personal communication, August, 2010). Victims of social media bullying feel unsafe; have trouble focusing on school work, which leads to lower classroom achievement levels; and often do not know whom to talk to about their negative experiences. We note the recent tragic suicide by the Rutgers University student. Students' own judicious Internet use and online behaviors, as well as an understanding of the consequences of their online choices, can mean the difference between safe and unsafe use of the Internet. Only when students are armed with the knowledge of these risks can they begin to make smart choices.

The key for educational programming efforts targeted for students, teachers and parents is instrumentation that provides meaningful and reliable data assessing students' knowledge of Internet risk and their actual Internet behaviors. The *Survey of Internet Risk and Internet Behavior* (*SIRIB*) was developed for this type of assessment.

Analysis of data for a previous sample of *N*=1366 middle school students indicated that the 7 statements defining the Knowledge scale successfully defined a unidimensional, hierarchically ordered scale assessing knowledge of Internet risks (Gable, Ludlow, McCoach, & Kite, 2011). The purpose of this paper is to further examine the construct validity of the Knowledge scale interpretations for a new sample of male and female middle school and high school students. To accomplish this, we examine construct invariance across the gender and grade level groups. The research question addressed is: Does the *SIRIB* Knowledge scale function in a similar manner for these gender and grade level groups?

Methodology

Sample/Data Collection

Data from *N*=2621 grade 6-8 middle school and *N*=1594 grade 9-12 high school students from six school districts (urban, suburban, and urban ring) were included in the sample. Surveys were administered by teachers during the "common planning time period" included in all of the school schedules.

Instrumentation

Scales and scoring technique. The *SIRIB* contains 7 literature derived demographic items (Franek, 2005/2006; Lenhart, 2007; Ma, 2001; McKenna, 2007; Shariff, 2008) and 26 statements constructed to describe students' knowledge of risks and behaviors associated with using the Internet, as well as their experiencing or exhibiting specified attributes associated with Internet use. For this paper only the 7 items defining the Knowledge scale are analyzed.

Knowledge Scale**.** The Internet Knowledge scale was constructed according to the principles of Rasch measurement (Ludlow, Enterline, Cochran-Smith, 2008). These principles guided the development of the seven-item scale, where the statements were written to span a unidimensional continuum consistent with the Rasch measurement model (Gable, Ludlow & Wolf, 1993). In this context, an item parameter estimate represents the "difficulty" of eliciting an agree response to a statement. Thus, "easy" items were written that students would be expected to agree with relatively frequently (e.g., *Making threats online can get me into trouble with the police*.), and items that are more difficult were written that students would be expected to agree with less often (e.g., *An Internet predator could contact me based on what my friends have posted about me*.). A successful application of Rasch model principles results in meaningful interpretations of high and low scoring students across a well defined and continuous construct. As such, it was anticipated that simple factual Internet actions would be easier knowledge items than items requiring complex uses of Internet procedures and applications (Gable, Ludlow, McCoach, & Kite, 2011).

The remaining 19 items on the instrument were designed to identify whether or not students had experienced (e.g., Bully Victim, Parental Involvement) or exhibited specified attributes (e.g., Bully Behavior, Adult Notification, Internet Behavior). As presently constructed, research on the prior middle school sample of *N*=1366 students indicated that the 19 statements defining these attributes did not properly fit a Rasch model (i.e., continuous and hierarchical in nature), as they tended to summarize the presence or absence of the described behaviors into two clusters of people—those who experienced most or all of the behaviors and those who experienced few or none of them. Therefore, only the Knowledge scale items are analyzed in this paper.

Response format. Students were asked to "Agree" or "Disagree" with each of the Knowledge statements. Responses were scored "1" or "0" to reflect a high level of Knowledge. Appropriate agreeing or disagreeing with a statement received a score of "1" (e.g., agree with the statement: *Making threats online can get me into trouble with the police*.).

Validity. Content validity of the Knowledge items was supported through the literature (Franek, 2006; McKenna, 2007; Shariff, 2008) and judgmental review by *N*=5 middle school teachers and *N*=2 principals. The reviewers were given the definition of the targeted dimension and were asked to review each item in relation to the Knowledge construct. For the prior data gathered on *N*=1366 middle school students construct validity of the Knowledge scale was supported using confirmatory factor analysis and Rasch model analysis (Gable, Ludlow, Kite, McCoach, & Filippelli, 2009).

Data Analysis

The data analyses employed were designed to assess construct invariance of the Knowledge scale construct across grade levels (i.e., middle vs high school) and gender groups. These analyses assessed whether the groups responded in a similar manner to the items.

Rasch Model. The Rasch model analysis employed the WINSTEPS software (Wright & Linacre, 1998, version 3.68.0) to generate person and item location estimates Rasch, 1960; Wright & Masters, 1982). (See Gable, Ludlow, & Wolf, 1990; Gable & Wolf, 1993; Ludlow, Enterline, Cochran-Smith, 2008 for examples of variable maps.) In this paper variable maps indicating person and item locations along the Knowledge continuum are displayed for the middle vs high school and the male/female samples.

Multiple Group Confirmatory Factor Analysis. A MG-CFA of the 7 Knowledge items using Mplus6 was conducted (Muthen & Muthen, 2010). The items are dichotomous; therefore, we conducted the CFA for categorical data, or a categorical CFA. In a categorical CFA, although the observed indicators, y_i , are dichotomous or ordinal variables with a limited number of response categories, we assume that there are i underlying latent response variables, y_i^*, that are continuous in nature. Thus, categorical CFA models a linear relationship between the underlying latent response variables y_i^*, and the factor (Finney & DiStefano, 2006; Long, 1997). The scores on the observed variables, y_i , are a function of the level of the underlying latent response variable, y_i^*. For a dichotomous model, y_i =1 if $y_i^* > \tau$ and y_i =0 if $y_i^* \le \tau$ (Long, 1997). τ is the threshold or the cutpoint on the latent response variable. It can be thought of as the quantity on the latent response variable that it takes to observe a change in category on the observed ordinal (or dichotomous) variable. There are always k-1 thresholds, where k= the number of response categories. For models with dichotomous indicators, rather than utilizing standard maximum likelihood estimation, Mplus uses “weighted least square parameter estimates using a diagonal weight matrix with standard errors and means and variance adjusted chi-square statistics that use a full weight matrix” (Muthen & Muthen, 2007, p. 484) (WLSMV). This is the recommended approach for estimating models with categorical dependent variables (Finney & DiStefano, 2006). Because traditional chi-square difference testing is not available when using WLSMV, we conducted chi-square difference testing using the DIFFTEST procedure described in Muthen and Muthen (2010).

Results and Discussion

Reliability

Cronbach's alpha reliabilities for the data obtained from each gender and grade level group are listed in Table 1. Indices for the data from the various groups ranged from .70 to .75. The use of the binary (Agree, Disagree) response format most likely contributed to the lower than desired reliability level because of the resulting restriction on item and scale variance.

Descriptive Data

Table 2 contains the percents of students with "agree" or "disagree" responses for the 7 Knowledge items. The boxed percents indicate what could be considered the more appropriate or correct response. While reporting the item-level descriptive data is not the primary objective of this paper, a few of the responses will be pointed out since they suggest some concern for educators regarding the level of student knowledge of appropriate internet behaviors and use. For example, only 25% of the students indicated that: *An Internet predator could contact me based on what my friends have posted about me online* (item 25), and only 29% agreed that: *With the contact information I put on Myspace, it would be easy for an internet predator to contact me* (item 12). Readers interested in a descriptive breakout of the findings for the Knowledge items for middle vs. high school and male vs. female groups are referred to the paper by Kite, Gable, and Filippelli (2010).

Rasch Model - Knowledge Scale Structure

Grades 6-12. Figure 1 presents the Knowledge scale variable map for the total sample of *N*=4215 grades 6-12 students. The left side of the figure shows the location of the students on the logit "difficulty" scale. For this map, each of the # indicators shows the location for *n*=64 students. The students are ordered from the lowest level of Knowledge (bottom of the map) to the highest level of Knowledge (top of map). The right side of the map lists the item numbers, where items toward the top are "hard" items that are "difficult" to yield a correct response (for these 7 items "agree" was correct), and the items at the bottom are the items that are "easy" to offer a correct response. The total group overall mean for the 7 items is indicated by the M symbol located near the middle of the vertical map.

For these grade 6-12 students the listing of item difficulties for the Knowledge scale showed wide item spread with an excellent spread of the students across the entire scoring range. Starting at the bottom of the map and proceeding upwards, it is easiest to "agree" with V2 (*Making threats online can get me into trouble with the police.*), somewhat harder to "agree" with V7 (*An online predator could contact me using a social networking site like Myspace or Facebook if I posted my personal information on it.*), harder still to "agree" with V19 and V15 (Threats online that I carry out at school can get me into trouble; *An internet predator can easily use internet sites such as Google earth, MSN live or other programs to locate my school and house);.*), and the cluster of items V17, V12, and V25 are the hardest items to "agree" with (*An Internet predator could make contact with me based on the information I have posted online; With the contact information I put on Myspace or Facebook, it would be easy for an Internet predator to contact me; An Internet predator could contact me based on what my friends have posted about me*). This cluster of "hard" items addresses the important issue of knowing that contact by an Internet predator can be made through personal information listed online.

The crucial aspect of this variable map is the extent and manner in which the students and items are spread vertically across the map. Adequate variable definition and support for construct validity are present because the items are spread across the map indicating that we have spanned the Knowledge continuum. Along with students located across the map, this continuum of items contributes to meaningful score interpretations for high and low scoring students, and provides support for construct validity for the Knowledge scale data for the grade 6-12 students.

Table 3 contains the "item statistics and misfit order" for the 7 Knowledge items. Note that item v2 is identified on the far right side of the first row in the table. This item (*Making threats online can get me into trouble with the police.*) displayed evidence of misfit (Outfit MNSQ=2.61) due to large numbers of students giving a surprising "disagree" incorrect response to a relatively easy item to agree with. The difficulty location of item v2 is at the bottom of the variable map in Figure 1 or-2.52. In Table 3 the -2.52 logit is listed in the 4th column from the left labeled MEASURE. We note that this finding is consistent with the sample of *N*=1366 middle school students in our earlier sample (Gable, Ludlow, Kite, McCoach, & Filippelli, 2009). At a later time the students with these unexpected responses will be identified so their demographic characteristics include in the survey can be examined (i.e., school type, gender, grade level, having an older sibling, getting good grades, perception of popularity with friends, getting into trouble, and owning a cell phone). For this paper, the focus will be on whether item v2 continues to exhibit misfit for the other subgroups studied.

Males vs. Females. The Rasch model construct invariance evidence for grade 6-12 males (*N* = 2115) and females (*N* = 2008) is presented in Figure 2. Examination of the wide spread of student locations (males each # is 30 students; females # = 34) and the spread of items spanning the Knowledge continuum indicates that the maps, including the mean Knowledge level listed as *M* in the map, are very similar for the gender groups and similar to the total sample presented in Figure 1. Further, the same item misfit information found for the total grade 6-12 group is present for item v2 for males (2.59) and females (2.55). Overall, these findings indicate that the structure of the Knowledge is the same for males and females.

A plot of the pairs of the 7 item estimates for males and females is presented in Figure 3. Essentially, this plot indicates the location of each item for the male/female item estimates located in Figure 2. For example, the dot in the lower left section of Figure 3 represents the male/female data for item v2, which is located at the bottom of each variable map in Figure 2. The fact that the dot for item v2 and all the other dots for the remaining 6 items are very close to the line is because the regression line using female item estimates to predict the male item estimates results in a near perfect relationship ($r = .996$, $r^2 = .992$). This indicates that the items function in a similar way for males and females. We clearly have further support that the structure of the Knowledge scale is invariant across gender groups. We do note that the male estimates have a slightly smaller range than the female estimates. That is, the “hard” items are not quite as hard for the males while the “easier” items are not quite as “easy”.

Males vs. Females: Middle School and Males vs. Females: – High School.

Figures 4 and 5 present the variable maps for the middle and high school students by gender. Inspection of the maps for the four groups of students indicates that we have the same type of student variability, item spread across the Knowledge continuum, and the mean Knowledge level listed as *M* in the map. Thus, we have the same level of evidence of the invariant structure of the Knowledge scale as that described for the prior group breakouts. In addition, we continue to see the large numbers of students giving a surprising "disagree" incorrect response to a relatively easy item to agree with (v2), which results in evidence of misfit (Outfit MNSQ ranged from 2.10 to 2.72). We also examined the plot of the pairs of the 7 item estimates for male and female middle school students ($r = .992$, $r^2 = .984$) and male and female high school students ($r = .994$, $r^2 = .988$).

Summary – Rasch Model Construct Invariance

The findings presented in this section support the conclusion that the structure of the Knowledge variable is invariant when analyzed for grade 6-12 students, males only, females only, males in middle school, females in middle school, males in high school, and females in high school. In essence, all these groups have the same understanding of the items on the scale. It should be possible, therefore, to develop meaningful interpretations of high and low scoring students and comparisons of average levels of responding on the scale. We also note that these findings are consistent with what we found for the Rasch model analysis for the prior sample of *N*= 1366 middle school students (Gable, Ludlow, Kite, McCoach, & Filippelli, 2009).

Confirmatory Factor Analysis - Knowledge Scale Structure

Our multiple group CFA included 4 samples: middle school males, middle school females, high school males, and high school females. We used the delta parameterization available in MPLUS. Therefore, in testing full or partial invariance models, when the loadings and thresholds were allowed to vary across the groups, we fixed the scaling factor to be one across the groups. In Model 1, we estimated a model which constrained the factor loadings and thresholds for each of the items to be invariant across all four groups. Next, we estimated a model that allowed all factor loadings (except the marker variable – V19) to be freely estimated across groups. The fit of Model 2, which allowed all paths and thresholds to be freely estimated, was statistically significantly better than the fit of Model 1, which assumed measurement invariance (chi-square difference= 57.34

with 15 *df*, p<.0001). We then estimated a series of partial invariance models, in which we systematically constrained both loadings and thresholds for each of the items (then pairs of items, triads of items, etc.) to be equivalent across groups, and compared the fit of the partial invariance models to the model that allowed all paths and thresholds to be freely estimated. We considered the "best fitting model" to be the model that allowed us to constrain the greatest number of paths/thresholds across groups resulting in a statistically significantly higher chi-square than the model in which all paths and thresholds were freely estimated. Our best partial invariance model allowed the paths and thresholds for items 2, 7, and 25 to vary across the four groups, but constrained the paths and thresholds for items 12, 15, 17, and 19 to be equal across all four groups. The fit of this partial invariance model was not statistically significantly worse than the fit of the model in which all paths/thresholds were freely estimated (chi-square difference= 2.64 with 6 *df*).

Finally, to test the assumption that the items had equal discrimination parameters, we compared our partial measurement invariance model to a model that constrained all the factor loadings to be 1 across all four groups. The model that specifies equal factor loadings for all items across all four groups model is equivalent to a 1-parameter IRT (or a Rasch) model. In contrast, the model which allows the factor loadings to differ across items implies that some items are more highly related to the underlying factor than other items. In other words (or in IRT speak), the items have varying discriminations. Thus, this model is equivalent to a 2 parameter IRT model. The fit of the Rasch model was statistically significantly worse than the fit of the 2-parameter model (which allows factor loadings to vary across items) (chi-square difference= 374.84 with 15 *df*).

Summary – Multiple Group Confirmatory Factor Analysis

We chose the partial measurement invariance model**,** which allowed factor loadings to differ across items as our best and final model. The fit of this final model was less than optimal (chi-square (62) = 743.18; *CFI*=.94; *RMSEA*=.10). The largest contribution to the chi-square came from the high school male group (*n*=1272) (chi-square contribution = 221.68). Even though the middle school male group had a larger sample size (*n*=1345), its chi-square contribution was smaller (chi-square contribution = 175.31). This suggests that the model fits less well for high school males than it does for middle school males. But, overall, we are concerned with the true meaning of these findings as we know that the statistical significance of the chi-square statistic is greatly affected by our large sample sizes for all of our comparisons. The parameter estimates for this final model are included in Tables 4 and 5. Table 4 contains the unstandardized path coefficients or factor loadings for the 4 groups. Table 5 contains the threshold values. There are some interesting differences in the item parameters across groups. The factor loading for item 2 (.46) appears to be much smaller in the middle school female group than it is in any of the other 3 groups. Since this item was identified in the Rasch analysis as a "misfitting item" (i.e., unexpected response), we will look closer at the middle school female Rasch fit statistics in the future. The factor loading for item 2 is highest (1.204) for the high school female group. The factor loading for item 25 is lowest in the middle school female group (.96) and highest in the high school female group (1.77). The results of these analyses suggest that the Knowledge items do exhibit some non-invariance, as a function of gender, grade-level, and the interaction between gender and grade level.

Summary: Rasch Model Results vs. MG-CFA Findings

At this point we are trying to figure out why some non-invariance was identified by the MG-CFA, while the Rasch model variable maps provided strong support for invariance across the four groups. We suspect that our use of chi-square statistical tests for the very large sample sizes has likely contributed to the significant chi-square values. The MG-CFA literally tested the hypothesis that the parameter estimates were the same in all four groups, rather than running separate models in each of the four groups and then inspecting for differences. Exactly how "important" are the differences or the MG-CFA non-invariance that we found? It is true that the parameter estimates are somewhat different across the four samples, but we are now discussing what magnitude of difference is "practically significant".

Implications

The analyses reported provide important validity information regarding whether the construct associated with the knowledge of Internet risks is perceived or operationalized in a similar manner for middle and high school male and female students. While we did find some difference in the evidence provided by the Rasch model and MG-CFA analyses, we feel we have explained the reason for the differences and strongly support the construct invariance evidence presented with the Rasch model analyses. This information will assist the researchers in the future specification of meaningful score interpretations, the essence of instrument score validity.

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Table 1

Alpha Reliabilities for the Survey of Knowledge of Internet Risk and Internet Behavior: Knowledge Scale

Group	*N* [a]	Alpha
Middle School	2,621	.75
Males	1,345	.77
Females	1,272	.73
High School	1,594	.71
Males	770	.73
Females	816	.70
Total Males	2,115	.76
Total Females	2,008	.72
Total Group	4,215	.74

[a]Differences in group total due to missing gender codes.

Table 2

Survey of Knowledge of Internet Risk and Internet Behavior: Knowledge Items [a] **(*N* =4,215)**

	Knowledge Items	Agree	Disagree
2.	Making threats online can get me in trouble with the police.	81	19
7.	An on-line predator could contact me using a social networking site like myspace or facebook if I posted my personal information on it.	71	29
12.	With the contact information I put on myspace or facebook, it would be easy for an internet predator to contact me.	29	71
15.	An internet predator can easily use sites such as Google earth, MSN live or other programs to locate my school and house.	56	44
17.	An internet predator could make contact with me based on the information I have posted online.	30	70
19.	Threats online that I carry out at school can get me into trouble.	57	43
25.	An internet predator could contact me based on what my friends have posted about me.	25	75

[a]Boxed percents indicate "appropriate" response.

Table 3

Knowledge Scale Item Statistics and Misfit Order

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
1	3397	4215	-2.52	.05	1.15	4.8	2.61	9.9	.49	.56	83.3	85.4	V2
2	3005	4215	-1.61	.04	.92	-3.7	1.09	1.6	.61	.59	81.5	79.2	V7
3	1210	4215	1.61	.05	.96	-1.5	1.03	.5	.65	.65	82.4	82.3	V12
4	2356	4215	-.46	.04	.93	-3.7	1.00	.1	.64	.63	75.7	73.5	V15
5	1247	4215	1.53	.05	.82	-7.5	.86	-2.5	.69	.65	84.8	81.6	V17
6	2411	4215	-.55	.04	1.07	3.7	1.28	7.6	.60	.63	73.8	74.1	V19
7	1049	4215	2.00	.05	.93	-2.6	.96	-.5	.66	.64	86.2	85.1	V25
MEAN	2096.4	4215.0	.00	.05	.97	-1.5	1.26	2.4			81.1	80.2	
S.D.	869.1	.0	1.62	.00	.10	4.0	.56	4.2			4.3	4.5	

Table 4

Unstandardized Path Coefficients for Grade Level and Gender Groups

Knowledge Items	Male MS	Female MS	Male HS	Female HS
2. Making threats online can get me in trouble with the police.	.87	.46	.91	1.20
7. An on-line predator could contact me using a social networking site like Myspace or Facebook if I posted my personal information on it.	1.21	.84	1.19	1.29
12. With the contact information I put on Myspace or Facebook, it would be easy for an internet predator to contact me.	1.30	1.30	1.30	1.30
15. An internet predator can easily use sites such as Google earth, MSN live or other programs to locate my school and house.	1.29	1.29	1.29	1.29
17. An internet predator could make contact with me based on the information I have posted online.	1.53	1.53	1.53	1.53
19. Threats online that I carry out at school can get me into trouble.	1.00	1.00	1.00	1.00
25. An internet predator could contact me based on what my friends have posted about me.	1.43	.96	1.60	1.77

Table 5

Threshold Values for Grade Level and Gender Groups

Knowledge Items	Male MS	Female MS	Male HS	Female HS
2. Making threats online can get me in trouble with the police.	-.83	-.77	-.95	-.97
7. An on-line predator could contact me using a social networking site like Myspace or Facebook if I posted my personal information on it.	-.46	-.54	-.73	-.68
12. With the contact information I put on Myspace or Facebook, it would be easy for an internet predator to contact me.	.48	.48	.48	.48
15. An internet predator can easily use sites such as Google earth, MSN live or other programs to locate my school and house.	-.19	-.19	-.19	-.19
17. An internet predator could make contact with me based on the information I have posted online.	.48	.48	.48	.48
19. Threats online that I carry out at school can get me into trouble.	-.20	-.20	-.20	-.20
25. An internet predator could contact me based on what my friends have posted about me.	.50	.66	.67	.89