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The Psychometric Properties of Dispositional Flow Scale-2 in Internet Gaming

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Abstract This study examined the psychometric properties of the Dispositional Flow Scale-2 (DFS-2; Jackson and Eklund in Journal of Sports and Exercise Psychology, 24:133-150, 2002). One thousand five hundred and seventy-eight secondary school students (One thousand and seventy four males, four hundred and eleven females, ninety-three missing) from six schools in Singapore completed the questionnaires. Confirmatory factor analysis (CFA) was used to evaluate the factorial structure of the DFS-2. A nine-first-order factor model was compared to a higher order model with a global flow factor. Support was found for the higher order factor. Multigroup analysis demonstrated invariance of the factor forms, factor loadings, factor variances, and factor covariances across age and sex. The DFS-2 subscales were found to have acceptable reliability estimates, and convergent validity. We conclude that DFS-2 is a valid instrument for assessing global flow experience in Internet gaming.

Keywords Dispositional flow · DFS-2 · Measurement model · Invariance factorial structure · Confirmatory factor analysis · Multigroup analysis

Flow was originally characterized by Csikszentmihalyi (1997) as an integration of the constructs of challenges-skills balance, action-awareness merging, clear goals, unambiguous feedback, concentration on the task, sense of control, loss of self-consciousness, time transformation, and autotelic experience. People can experience flow in a wide variety of activities in daily life, which including: sports and games, shopping, dancing, performing surgery and playing computer games.

Flow is an optimal psychological state that represents those moments where the individual is totally absorbed into the task, and where the experience is very rewarding in itself (Jackson and Eklund 2004). The construct of flow is popular to sport psychology researchers and practitioners as the occurrence of flow is

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associated with peak performance, peak experience and personal growth (Jackson and Csikszentmihalyi 1999). When athletes get into the flow state, the performance is usually effortless yet efficient. Given that the flow experience is highly desirable, investigation of flow in sport has received considerable attention.

In recent years, the flow theory has been applied to Internet usage and online gaming. For example, Wan and Chiou (2006) used the flow theory to examine the psychological motives of online games. They found that flow state in online games was negatively associated with addictive inclination to online games in a short term. On the other hand, Wang and his colleagues (Wang et al. 2008) found that flow was related to more positive motivational variables such as harmonious passion, more autonomous regulations, and positive affect.

Flow theory seems to be a crucial variable in online game players. However, the construct of flow is still not well-defined in the area of online gaming and Internet usage. In fact, Choi et al. (2007) claim that the construct of flow is too broad and ill-defined in computer-related area. One of the main problems is that no two researchers measure flow in the same way. Some researchers view flow as a second-order construct comprised of a series of first-order constructs (Huang 2006), while other view flow as an one-dimensional construct that could be measured using a six item inventory (Choi et al. 2000). There is a need to derive at a common measure of flow with strong psychometric properties.

One existing measure of flow is the Dispositional Flow Scale (DFS) developed by Jackson and her colleagues (Jackson et al. 1998) in sport and exercise settings. This scale is theoretically grounded in Csikszentmihalyi's (1990) nine dimensional concept of flow: challenges-skills balance, action-awareness merging, clear goals, unambiguous feedback, concentration on the task, sense of control, loss of self-consciousness, time transformation, and autotelic experience. Confirmatory factor analysis was used to compare a nine first-order factor and a single higher order flow, both models showed good reliability and validity. In another study, Jackson and Eklund (2002) came up with a revised version of the DFS and named it DFS-2. The psychometric properties of the DFS-2 were found to be stronger than the original DFS both conceptually and statistically. This measure is suitable for use in assessing dispositional flow. As with the original scale, both first order factor model and a higher order factor are suitable for use depending on the research questions (Marsh and Jackson 1999). Since the DFS-2 has demonstrated strong psychometric properties, it may be adopted into the gaming setting.

In summary, the measurement of flow in Internet gaming has been inconsistent and requires attention. Poor measurement technology may hamper the identification of important constructs and links. The purpose of this paper, therefore, is primarily to examine the psychometric properties of the DFS-2 in Internet gaming.

Method

Participants

One thousand five hundred and seventy-eight secondary school students (one thousand and seventy-four males, four hundred and eleven females, ninety-three missing) from six schools in Singapore took part in the study. The students ranged in age from twelve to seventeen years (M=13.2, SD=.80) and were attending Secondary One or Two levels.

Procedures

After securing permission from the head teachers, the teachers-in-charge were contacted for arrangement of the administration of the questionnaires. Pupils were informed that there were no right or wrong answers, assured of the confidentiality of their responses, and encouraged to ask questions if necessary. They were also informed that they were allowed to withdraw from taking part in the study any time they so chose. All pupils gave informed consent and took fifteen minutes to complete a battery of questionnaires administered in a quiet classroom. Research procedures for the study were cleared by the Ethical Review Committee of the university.

Measures

Dispositional Flow Scale (DFS-2). DFS-2 (Jackson and Eklund 2002) comprised of thirty-six items and is used for assessing individual's tendency in experiencing flow in sport. Wang et al. (2008) adopted the DFS-2 into Internet gaming. The respondent has to recall how he or she felt during previous involvement in a specific game. The Seven-point Likert scale was adopted, with response ranging from one "never" to seven "always." There are nine subscales including challenge-skill balance, merging of action and awareness, clear goals, unambiguous feedback, total concentration, sense of control, loss of self-consciousness, transformation of time and autotelic experience. The total score of all the items represents the global score for flow disposition. Higher scores correspond to stronger likelihood for experiencing flow in the same activity type.

Data Analysis

Confirmatory factor analysis (CFA) was conducted to examine the factorial validity of the DFS-2 using EQS for Windows 6.1 (Bentler and Wu 2006). Two different measurement models were compared. Model One tested a nine-first-order factor model. Model Two was a hierarchical model comprising nine first-order factors and one higher-order global flow factor.

The next phase involved testing the factorial invariance of the DFS-2 across sex and age through multigroup analyses. First, the data set was split by sex and school year. Model testing proceeded by fitting the acceptable measurement model of the DFS-2 to each subgroup separately. Next, the invariance of the model across sex and year group was tested by simultaneously fitting the model to the data for males and females, and subsequently to the data for the two year groups. Equality constraints were imposed on all the parameters to be estimated but not on the fixed parameters. These equality constraints included factor loadings, factor correlations, factor variances, measurement errors, factor patterns, and disturbances. The equivalency of the measurement model between sex and age was then assessed.

We used the following indices of fit provided by EQS were examined to evaluate the adequacy of the models: Satorra-Bentler scaled chi-square statistic with associated degrees of freedom; the non-normed fit index (NNFI); the comparative fit index (CFI); root mean square residual (RMSR); and root mean square error of approximation (RMSEA). The chi-square statistic estimates the fit between the sample covariance matrix and the estimated population covariance matrix. The NNFI evaluates an estimated model by comparing the chi-square value of the model to the chi-square value of the independence model, taking into account the degrees of freedom of the model under consideration. The CFI employs the non-central chi-square distribution with non-centrality parameters to compare a hypothesised model with the independence model. NNFI and CFI values close to 0.95 are typically taken to reflect acceptable fit to the data (Hu and Bentler 1999). The RMSR estimates lack of fit and represents the square root of the mean of the squared discrepancies between the implied and the observed covariance matrices. The RMSEA also assesses lack of fit in a model compared to the saturated model. Small values for RMSR are indicative of a good-fitting model; for RMSEA, a cut-off close to 0.06 is recommended (Hu and Bentler 1999).

Results

In the initial examination of the data, there was evidence of multivariate non-normality in the distribution. Although all the univariate statistics had skewness and kurtosis values between+2 and – 2, Mardia's coefficient was 805.51 and the normalized estimate was 258.26. Consequently, the Robust Maximum Likelihood method, which is best for controlling for the overestimation of chi-square, underestimation of adjunct fit indices, and underestimation of errors, was used (Hu and Bentler 1995).

The results showed that there was less support for the first-order factor model (Scaled χ^2=1925.49, df=558, NNFI=0.927, CFI = 0.936, RMSEA=0.047, 90% CI=.045, .049) compared to the hierarchical model (Scaled χ^2=1522.58, df=548, NNFI=0.947, CFI = 0.954, RMSEA=0.040, 90% CI=.038, .042).

Table 1 details the factor loadings and the measurement errors for each item with regard to Models One and Two. When comparing across different models, we examined the difference between the goodness-of-fit indexes (CFI, NNFI), the difference in the CFI between the two models is larger than .01, indicating that the hierarchical model was a significantly better fit model (Cheung and Rensvold 2002). All the first order factor loadings were higher than .66 and the error variance lower than .75, this provides support for the convergent validity of the measurement models.

The latent factor correlations with standard errors are shown in Table 2. We examined the confidence intervals of the correlation between each pair of factors (φ-coefficients) and found that twenty-two out of thirty-five confidence intervals exceeded 1.00. The high latent factor correlation provided additional support for the higher order measurement model.

Table 3 details the fit indices for the single group analyses for sex and level. The results showed acceptable fit for all groups. Table 4 presents the fit statistics for the simultaneous test of invariance across sex and level. These results provided strong support for the invariance of the DFS-2 hierarchical measurement model across sex and age.

Table 1 Standardized factor loadings and error variances for the DFS-2 measurement models

Factor	Model One		Model Two	
	Loadings	Error Variance	Loadings	Error Variance
F1 – Balance (Item 1)	.771	.630		
F1 – Balance (Item 2)	.807	.590		
F1 – Balance(Item 3)	.853	.520		
F1 – Balance (Item 4)	.842	.540		
F2 –Merging (Item 1)	.690	.720		
F2 –Merging (Item 2)	.660	.740		
F2 –Merging (Item 3)	.830	.550		
F2 –Merging (Item 4)	.810	.580		
F3 – Goals (Item 1)	.756	.650		
F3 – Goals (Item 2)	.830	.550		
F3 – Goals (Item 3)	.817	.570		
F3 – Goals (Item 4)	.842	.539		
F4 – Feedback (Item 1)	.790	.610		
F4 – Feedback (Item 2)	.845	.534		
F4 – Feedback (Item 3)	.864	.503		
F4 – Feedback (Item 4)	.868	.496		
F5 – Concentration (Item 1)	.754	.657		
F5 – Concentration (Item 2)	.663	.749		
F5 – Concentration (Item 3)	.833	.550		
F5 – Concentration (Item 4)	.846	.530		
F6 – Control (Item 1)	.743	.669		
F6 – Control (Item 2)	.756	.654		
F6 – Control (Item 3)	.820	.572		
F6 – Control (Item 4)	.818	.575		
F7 – Consciousness (Item 1)	.720	.694		
F7 – Consciousness (Item 2)	.813	.582		
F7 – Consciousness (Item 3)	.678	.735		
F7 – Consciousness (Item 4)	.790	.614		
F8 – Time (Item 1)	.792	.610		
F8 – Time (Item 2)	.845	.535		
F8 – Time (Item 3)	.785	.619		
F8 – Time (Item 4)	.671	.742		
F9 – Autotelic (Item 1)	.794	.608		
F9 – Autotelic (Item 2)	.801	.599		
F9 – Autotelic (Item 3)	.827	.562		
F9 – Autotelic (Item 4)	.803	.596		
F10 – Flow F1			.949	.316
F10 – Flow F2			.900	.436
F10 – Flow F3			.964	.266
F10 – Flow F4			.971	.239

Table 1 (continued)

Factor	Model One		Model Two	
	Loadings	Error Variance	Loadings	Error Variance
F10 – Flow F5			.986	.165
F10 – Flow F6			.933	.359
F10 – Flow F7			.778	.629
F10 – Flow F8			.736	.697
F10 – Flow F9			.938	.347

Table 2 Latent factor PLOC correlations and validity discriminant information

Variable	F1	F2	F3	F4	F5	F6	F7	F8
1. F1 Balance	1.00							
2. F2 Merging	.92*	1.00						
	.095							
	(.73, 1.11)							
3. F3 Goals	.91*	.85*	1.00					
	.087	.084						
	(.74, 1.08)	(.68, 1.02)						
4. F4 Feedback	.92*	.84*	.96*	1.00				
	.089	.086	.093					
	(.74, 1.10)	(.67, 1.01)	(.77, 1.15)					
5. F5 Concentration	.90*	.86*	.95*	.95*	1.00			
	.091	.089	.087	.089				
	(.72, 1.08)	(.68, 1.04)	(78, 1.12)	(.77, 1.13)				
6. F6 Control	.90*	.85*	.96*	.96*	.95*	1.00		
	.090	.088	.087	.089	.090			
	(.72, 1.08)	(.67, 1.03)	(.79, 1.13)	(.78, 1.14)	(.77, 1.13)			
7. F7 Consciousness	.69*	.71*	.67*	.67*	.71*	.72*	1.00	
	.088	.089	.080	.082	.087	.087		
	(.51, .87)	(.53, .89)	(.51, .83)	(.51, .83)	(.54, .88)	(.55, .89)		
8. F8 Time	.68*	.71*	.69*	.66*	.73*	.66*	.59*	1.00
	.088	.090	.082	.083	.089	.084	.090	
	(.50, .86)	(.53, .89)	(.53 .85)	(.49, .83)	(.55, .91)	(.49, .83)	(.41, .77)	
9. F9 Autotelic	.89*	.84*	.89*	.88*	.90*	.87*	.68*	.83*
	.089	.087	.083	.084	.087	.085	.084	.093
	(.71, 1.07)	(.67, 1.01)	(.72, 1.06)	(.71, 1.05)	(.73, 1.07)	(.70, 1.04)	(.51, .85)	(.64, 1.02)

* $p<.05$. In each cell, first row=latent factor correlation, second row=SE of latent correlation coefficient, last row=correlation confidence intervals within plus/minus 2 SE (in parentheses).

Table 3 Initial fit statistics for the DFS-2 by groups

Fit Statistics	Male	Female	Sec One	Sec Two
N	1071	409	916	657
χ^2 (544)	1057.70	880.72	1035.88	979.53
NNFI	.955	.945	.951	.950
CFI	.961	.952	.958	.957
RMSEA	.035	.045	.037	.042
90% CI of RMSEA	(.031, .038)	(.040, .050)	(.033, .040)	(.038, .047)

NNFI=Non-Normed Fit Index; *CFI*=Comparative Fit index; *RMSEA*=Root Mean Square Error of Approximation.

Discussion

The main purpose of the current study was to assess the psychometric properties of the DFS-2 (Jackson and Eklund 2002) in Internet gaming. Two measurement models were compared using confirmatory factor analysis. It was revealed that the hierarchical model with nine first-order factors and one global flow factor was best suited. Convergent validity and internal reliability estimates were demonstrated.

The findings of the present study contrasts with Jackson and Eklund's (2002) study, which found both the first-order and hierarchical measurement models to be satisfactory. One reason could be Jackson and Eklund (2002) were using 0.90 cutoff values for NNFI and CFI. In this study, we used 0.95 as the cutoff point recommended by Hu and Bentler (1999).

The latent factor correlations between the subscales were extremely high and most of the upper bound confidence intervals exceeded unity (1.00). The results presented here revealed extremely high latent factor correlations between each pair of factors in DFS-2 (ranging from .59 to .96), compared to Jackson and Eklund's (2002) study (ranging from .23 to .77). This shows that there are differences in flow experiences in Internet gaming environment and physical activity and sport setting. It could be that Internet gaming is less physically demanding than sport and therefore the cognitive aspects of flow are more salient (e.g., clear goals, action-

Table 4 Fit statistics for multi-group analyses of DFS-2

Fit Statistics	Sex	Age
χ^2	2417.03	2684.819
df	1205	1205
NNFI	.933	.927
CFI	.938	.932
RMSEA	.043	.047
90% CI of RMSEA	(.040, .045)	(.044, .049)

NNFI=Non-Normed Fit Index; *CFI*=Comparative Fit index; *RMSEA*=Root Mean Square Error of Approximation.

awareness merging, concentration on task at hand) and highly correlated. Therefore, there is clear evidence to support the higher-order factor measurement model to be better suited in the Internet gaming setting.

Results also supported the invariance of the higher order measurement model across two age groups and in both sexes. The DFS-2 appears to be suitable for use with children and adolescents to assess the global dispositional flow.

Internet gaming can provide flow experience and it could relate to other addictive orientations as well (Wan and Chiou 2006). It is therefore important to examine the measurement model of flow. This study has demonstrated a sequential and acceptable way for psychometric examination.

Future research needs to examine the concurrent and predictive validity of the DFS-2 with other variables, such as addictive behaviour, aggression, harmonious passion and obsessive passion, and achievement goals. In addition, future studies could examine the relationships between flow experience and the types of games played, and the game environment (massively multiplayer online vs. single player online).

In conclusion, the present investigation provides evidence of a valid DFS-2 measurement model for assessing dispositional flow among young people. Furthermore, the measurement models are similar with regard to factor structures and forms for males and females, as well as Secondary One and Two students.

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