Product Interest and Engagement Scale, Beta (PIES-beta): Initial Development

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Abstract

We report a work in progress: development and initial validation of the Product Interest and Engagement Scale (PIES), a short assessment instrument measuring consumer interest in technology products. PIES reflects an explicitly multidimensional, hierarchical, and extensible model of product interest. It assesses consumer product interest in terms of an overall interest scale plus three subscales assessing interest in features and choices, personal image as affected by a product, and interest in optimizing one's choice with regards to a product. We report factor structure in a sample of N=225 US consumers and replication with N=180 US consumers. The results establish reliability of the overall 12-item scale and subscales in a broad consumer sample (Cronbach's alpha = 0.89 overall, 0.82-0.88 for subscales). Validity measures in the validation sample demonstrate convergent and discriminant validity with product ownership and product involvement measures. We regard PIES as currently being in beta form (PIES-beta). It is suitable for usage now but will undergo further revision in 2009.

Keywords

Product interest, product involvement, evaluation, psychometrics, scale development.

ACM Classification Keywords

H.m. Information systems. Miscellaneous.
K.1. Computing milieu. Computer industry. Markets.

Introduction

An important factor in applied human-computer interaction (HCI) research is the degree to which users are interested in or engaged with a given product or service, i.e., the extent to which users are interested to think about a product, its capabilities, features, importance in their lives, and so forth. A traditional market research term is "product involvement," [3,9,10] although we adopt a more expansive view that may be described as "product interest and engagement" (PIE).

PIE is important for user-centered product design and development for several reasons. A product's audience is related to interest: more-interested consumers are more likely to use a product [3,11]. A high PIE product may have different user requirements than a low PIE product (for instance, rather than just deliver base functionality, it might support a consumer "image"). HCI practitioners may use an assessment of PIE to gain a better understanding of their customers, products, and the dimensions of product interest.

Existing product involvement measures are insufficient for HCI usage for several reasons. The problems include (a) respondent difficulty with concepts – for instance, one scale [10] rates products on a scale of "mundane … fascinating", which is a difficult conceptual pair; (b) potential construct problems in the technology space (e.g., pairs such as "mundane/ fascinating" may not be opposites for a product such as a PC interface device); and (c) concepts may be inapplicable – e.g., a product may be "needed" without being interesting (cf. scales [9,10]).

Most importantly, existing product involvement scales are generally unidimensional [9,10]. This reflects scale consistency and reliability, but excludes the opportunity to measure different *kinds* of product interest that are related yet distinct. A unidimensional scale gives little insight into *why* a user is interested in a given product.

We have designed a new product interest scale (PIE scale, or *PIES*) that is intended to be: (1) multi-dimensional and able to differentiate kinds of interest; (2) psychometrically strong and reliable; (3) consistent with expected validity measures; (4) useful across a range of technology products; (5) applicable to a broad consumer population. PIES does not replace traditional product involvement measures but extends them with a multidimensional framework that may be preferable for some products and research goals.

PIES is a work in progress. We report here on initial development comprising item selection, factorial modeling, subscale construction, validity measures, and replication with two products in two samples. Future efforts will include scale refinement and application to additional products, as discussed below.

Construct Definition and Item Generation

We began by defining the *product interest and engagement* (PIE) construct: PIE is the degree of interest that a consumer shows to think about and use products from a specific product category. PIE is related to product involvement and also includes other aspects of product interest. These include interest in features, in attributes important to product choice, and the contribution of a product to social interaction such as one's image. PIE is hierarchical; it is valid to consider both overall interest and discrete aspects of interest.

On the basis of literature review and construct brainstorming, the authors wrote 38 initial items that reflect 11 general areas of product interest. Each item refers to one potential aspect of product interest with a placeholder for a specific product. For example, item 12: "The differences among __ are very important."

The initial 38 items were piloted with N=13 consumer respondents in Redmond, WA. Following that review, several items were revised for clarity, 3 were cut, and 1 was added. This yielded a list of 36 items for initial testing: *PIES-0* (available from first author).

Development Samples 1 and 2

PIES-0 was administered online to a sample of N=405 adult consumer respondents in the US, with quotas to ensure broad sampling by age, gender and technology product ownership. The products assessed were "PC keyboards" and "iPods/MP3 players". Each PIES statement was presented in random order as a Likert-type agreement item with a 7-point scale including neutral, from "strongly disagree" to "strongly agree". PIES-0 was given twice to each respondent (once per product), along with the 10-item Zaichkowsky scale [10] for "iPods/MP3 players," in randomized order.

The N=405 sample was randomly sampled into N=225 "Sample 1" for model development and N=180 "Sample 2" for validation. The two PIES-0 product response sets, PIES-0-Keyboard and PIES-0-MP3, combine as 2 cases per respondent to give PIES-0-ALL. Data analysis was performed with R version 2.8.1 [2,5,6,7].

Factor Analysis

We initially investigated construct coherence through exploratory factor analysis (EFA) [8]. Our EFA approach comprised three iterated steps: (1) identifying the number of factors through parallel analysis, scree plot, and interpretability; (2) factor extraction followed by oblique rotation (oblimin [1]), consistent with the theorized hierarchical structure; (3) item selection based on factor loading and interpretability.

Space does not permit full description of the EFA, but we recap here. Parallel analysis [6,7,8] demonstrated 4 factors for PIES-0-ALL (36 items) in Sample 1. 2 items were removed due to negative loading, and 8 were removed for cross-loading. The trimmed PIES-0-ALL (26-item) dataset exhibited 4 clear factors in Sample 1. One of those factors concerned immediate purchase intent – orthogonal to PIE – so its items were removed.

The remaining three EFA factors represented clear factorial constructs: interest in the choices and features that are available ("choice interest"); interest in optimizing a choice rather than just selecting one that is "good enough" ("optimize"); and interest in a product's contribution to one's personal image ("image"). For each of those factors, 4 items were selected that maximized item-factor loading with content differentiation. These 12 items then underwent a new EFA with Sample 2 (holdout data). Consistent with Sample 1, EFA in Sample 2 yielded three factors with items loading in the same pattern as in Sample 1.

EFA loadings for Sample 2 are shown in Table 1. There were three relatively simple factors with high item-factor loading. Factor correlations were F1/F2: r=0.47

(p<0.01); F1/F3: r=0.28 (p<0.01); F2/F3: r=0.52 (p<0.01). Thus, the factors were related as expected.

Item	Factor 1	Factor 2	Factor 3
i8	0.677		
i9	0.240	0.610	
i12		0.597	
i13			0.783
i15			0.773
i20			0.780
i26		0.855	
i27		0.226	0.584
i28		0.875	
i33	0.818		
i34	0.896		
i35	0.869		

Table 1: Factor loadings for 12-item version in Sample 2 (validation sample). Loadings < |0.20| are not shown.

Subscale Construction and Reliability

Given the clear item-factor pattern, we proceeded to construct subscales. A subscale was defined for each factor comprising the four items with highest loadings in the 12-item EFA. Each subscale score is the sum of the individual items' 7-point scores (reversed for some items), while the overall score is the sum of all items. The scale and subscales are shown in Table 2.

Reliability was assessed by examining the EFA structure replication from Sample 1 to Sample 2 (as above) and by Cronbach's alpha reliability index [7]. For PIES-0-ALL in Sample 2, alpha=0.89 for the overall PIES scale, alpha=0.84 for the Choice Interest subscale, alpha = 0.82 for Optimize subscale, and alpha=0.88 for Image subscale. This demonstrates strong scale and subscale consistency in our consumer validation sample.

Choice interest scale (derived from Factor 2)
- I find some __ to be exciting products (i9)
- The differences among __ are very important (i12)
- There are some __ features that matter a lot to me (i26)
- In choosing a __ I would look for some specific features or options (i28)

Optimize scale (derived from Factor 3)
- It doesn't matter much which __ I might choose (i13R)
- When selecting a __ I would probably just choose the first one that was good enough (i15R)
- One __ is about as good as another (i20R)
- I don't care much about the specific features of __ (i27R)

Image scale (derived from Factor 1)
- It is important which __ a person owns (i8)
- When other people see my __ they form an opinion of me (i33)
- The __ that I use says a lot about me (i34)
- You can learn a lot about someone by seeing what kind of __ they use (i35)

Table 2. PIES-beta with subscales. Parentheses show item numbers (of 36 items). *R* indicates reverse scored items.

The result of this initial scale development process was a proposed 12-item measure with 3 subscales of 4 items each, which we term *PIES-beta*. The complete PIES-beta scale is shown in Table 2.

Construct Validity

Construct validity of PIES-beta was assessed first by looking at convergent and discriminant correlations among the PIES-beta results across products and with a standard product involvement scale. We used the 10-item Zaichkowsky product involvement scale [10] with MP3 players as the comparison (hereafter "Z-MP3"). In Sample 2, the correlation of PIES-beta-MP3 with Z-MP3 was r=0.63 (df=178, p<.01). This shows that PIES-beta is strongly related to product involvement but is not identical with it. PIES-beta-Keyboard correlated with PIES-beta-MP3 with r=0.50 (df=178, p<.01). This demonstrates that people high in interest for one technology product are likely to be interested in another. The correlation of PIES-beta-Keyboard with Z-MP3 was r=0.22 (df=178, p<.01), where the lower correlation shows discriminant validity for PIES-beta vs. product involvement when products differ.

People who have more interest in a product should be more likely to own it. We tested this for ownership of MP3 players and third-party (not original) PC keyboards. For MP3 players, PIES-beta-MP3 was higher for owners than non-owners, while for Keyboards, PIES-beta-Keyboard was higher for owners than non-owners. In both, PIES-beta for one product showed no significant difference for owners/non-owners of the other product. Results are shown in Table 3, indicating validity of PIES-beta with regard to product ownership.

Consistency of the hierarchical model of three factors and an overall second-order factor was assessed with a hierarchical structural equation model (SEM) [2,4,8] using Sample 2 data. The tested model and resulting path coefficients are shown in Figure 1.

Keyboard PIES	**Keyboard Ownership**	**MP3 Ownership**
Owner	KB PIES mean: 4.05	KB PIES mean: 3.74
Non-Owner	KB PIES mean: 3.51	KB PIES mean: 3.65
t-test	t=3.02, df=128, p<.01	t=0.50, df=148, p=.62
MP3 PIES	**Keyboard Ownership**	**MP3 Ownership**
Owner	MP3 PIES mean: 4.37	MP3 PIES mean: 4.55
Non-Owner	MP3 PIES mean: 4.11	MP3 PIES mean: 3.90
t-test	t=1.49, df=108, p=.14	t= 4.21, df=163, p<.01

Table 3. t-tests for PIES-beta scores by product ownership.

Briefly, the overall SEM model fit for the hierarchical model was good. Model chi-square=191, df=55; GFI=0.926 (good > 0.90); NFI=0.914 (good > 0.90); RMSEA= 0.083 with 90% CI=0.070-0.096 (good < 0.10); and SRMR=0.097 (good < 0.10). (See [4] for details on SEM measures and their interpretation.)

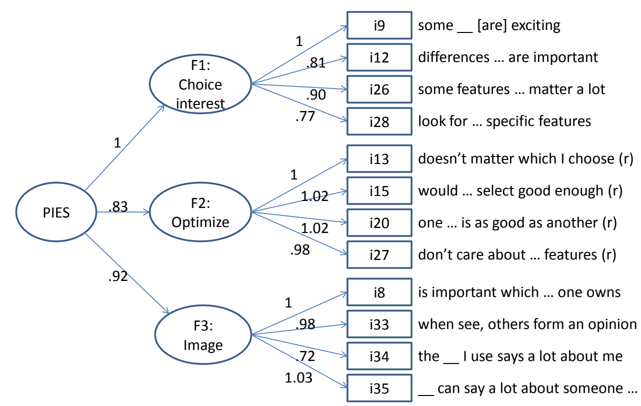

Figure 1. SEM confirmatory factor model for PIES-beta. Unstandardized coefficients are shown. Items are abbreviated.

Conclusion, Discussion and Future Directions

The proposed 12-item PIES-beta scale and subscales show strong reliability and validity in a broad consumer sample as a measure of the PIE construct. We believe that PIES-beta is suitable now for exploratory usage for some technology products. PIES-beta may assist HCI practitioners better to understand their products, customers, and dimensions of product interest.

There are areas for further development of PIES. Some items are perhaps unnecessarily confounded with product ownership (e.g., Image items in Table 2). Some items would benefit from rewording (e.g., item 35 uses a singular "they"). The Optimize subscale comprises entirely reverse-scored items; it would be preferable to reduce the potential confound with scoring direction by including positive items. Assessment with additional products would confirm the scale's breadth of applicability. We also plan to compare the proposed hierarchical factor model to alternative SEM models.

It is important to note that the PIE construct is intentionally non-exhaustive with regards to product interest and is intended to be extensible. PIES may be extended with new factors or subscales if warranted.

The next steps for PIES development, to occur in the first half of 2009, are to revise the existing items and add new potential items; to field the revised items with a new development sample; to revise the subscales as needed and confirm the model; and to validate the results in a final sample. In parallel with this scale development effort, the authors will begin to use PIES-beta in applied research. (For updates on PIES, address correspondence to the first author.)

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