An initial development and validation of a Digital Natives Assessment Scale (DNAS)

Timothy Teo
University of Auckland
New Zealand

To be cited as:
Teo, T. (2013). An initial development and validation of a Digital Natives Assessment Scale (DNAS). *Computers and Education*, *67*, 51-57.

An initial development and validation of a Digital Natives Assessment Scale (DNAS)

Abstract

The purpose of this study is to address a gap in current research on digital natives by developing the Digital Natives Assessment Scale (DNAS). It is a self-report instrument designed to measure students' perceptions of the degree to which they are digital natives. Using three phases, the Digital Natives Assessment Scale (DNAS) was developed and validated with a total sample of 1018 students from three secondary schools. Results of the principal component and confirmatory factor analyses supported a 21-item, four-factor scale for use by students between 13 to 16 years of age. The four factors are: Grow up with technology, Comfortable with multitasking, Reliant on graphics for communication, Thrive on instant gratifications and rewards. Potential uses and applications of the DNAS by researchers and teachers are discussed. Suggestions for further research are provided.

Keywords: digital native; assessment; psychometrics; measurement; structural equation modeling

1. Introduction

"Digital native" is a concept introduced by Prensky (2001) to refer to the students who are "native speakers" of the digital language of computers, mobile phones, video gaming, and the Internet. However, although digital natives are defined by age, not all youths are digital natives. More than just their age, digital natives share similar attributes and experiences related to how they interact with technology, information, one another, other people, and institutions. In his discussion of digital natives, Prensky described digital natives as those who grow up with technology, are comfortable with multitasking, are reliant on graphics to communicate, and thrive on instant gratification and frequent rewards. These are the results of operating within a technology-rich environment that has caused a change in the brain structure, making young people think and process information in fundamentally different ways compared to older people. As learners, digital natives are those who are used to receiving information fast, like to parallel-process, multi-task, and prefer their graphics before their text. They also prefer random access and function best when networked. They thrive on instant gratification and rewards and, prefer games to 'serious' work' (Prensky, 2001).

Although Prensky's arguments are well-publicised and espoused by some, counter-positions have emerged in recent years. These emphasised the need for a more accurate portrayal of technology use among students (Bennett, Maton, & Kervin, 2008). In particular, although Prensky (2001) has emphasised on age in defining the digital natives, other researchers have advocated a consideration of experience with and exposure to technology (Tapscott, 1998). Helsper and Eynon (2010) argued that if age is the defining factor, then there is no hope of bridging the digital divide between the young and old and this has an impact on education because teachers will always be older than their students. On the other hand, if being digital natives is defined by their exposure to and experience in technology, age should not be an issue as older people can improve technology knowledge and skills when they collaborate and interact with the younger people.

In their study with more than 2000 British youths, Helsper and Eynon (2010) found empirical evidence to support the suggestion that age was not the only significant variable in explaining why people participate in activities that characterise digital natives. In addition to gender, education, experience with, and breadth of technology use being significant variables, the authors recognised that immersion in a digital environment (defined as the breadth of activities that people carry out online) may be the most important variable in predicting the behaviours of a digital native. This view was supported by Kennedy et al. (2008) who found that, while some digital natives have embraced a wide range of technologies, this was by no means universal. There appeared to be wide variations in the acceptance of technologies typically associated with digital natives. In his study, Cameron (2005) found that many first-year university students, despite being born at the same period as the digital natives, were ill-prepared to work with technology, including those enrolled in programs with a vocational focus on using digital tools. In addition, many of these students displayed resistance to online learning and unfamiliarity with some technology areas. Moving forward, researchers recommend that it may be more relevant for future discussions on digital natives to focus on understanding the attributes and behaviours exhibited by digital natives because these may have greater impact on teaching and learning (Bennett & Maton, 2010; Li & Ranieri, 2010).

2. Literature review

2.1. How do digital natives learn?

Since the introduction of the term, research on understanding how digital natives learn has gained momentum. In their review of the literature, Bennett, Maton, and Kervin (2007) found that digital natives have particular learning preferences or styles that differ from students in the past because of their upbringing and experiences with technology. In a learning situation, digital natives are active experiential learners, proficient in multitasking, and dependent on communications technologies (e.g., Internet) for accessing information and for interacting with others (Oblinger & Oblinger, 2005). They also appear technologically savvy, confident in the positive value of technology, and reliant upon technology, often to work on two or more tasks using two or more technology devices simultaneously (Jukes & Dosaj, 2006). Dede (2005) argued that advances in technology may have resulted in the new learning styles adopted by digital natives. These new learning styles are characterised by a greater use and fluency in multiple media and in simulation-based virtual settings, a communal learning expression through nonlinear, an associational webs of representations, and a co-designing of learning experiences to meet individual needs and preferences. Researchers have noted many digital natives are using or have used tools such mobile technology (for just in time information), social networks (to foster community of learners), and simulation tools (to provide experiential cognitive learning) to support their learning styles.

2.2 Determining who digital natives are

From the empirical studies on digital natives, researchers have relied heavily on questionnaires to gather data of interest. Kennedy et al. (2008) used a survey questionnaire to collect baseline data about key aspects of Australian university students' use of technology in their social life and for study purposes. Besides asking for demographic information, the authors asked questions relating to access to technology, use of technology in university study, and course-specific uses of technology were included. These questions were designed to gather data on the levels and nature of student access to computer software, hardware, mobile devices, games consoles and networks. In addition, there were self-report questions aimed at finding out more about the importance and frequency of student access to the Internet for social life and study, the locations of online access, their use of Web 2.0 tools, virtual worlds and games, as well their confidence levels in performing the most common ICT tasks. Administering the same questionnaire to South African university students, Thinyane (2010) sought to identify students' access to and use of technology. In addition, Thinyane added questions to survey students on their uses of technology that are prevalent in South Africa. Among university students in the United Kingdom, Margaryan, Littlejohn, & Vojt (2011) used a questionnaire to elicit information regarding student's use of technology on the course, technology used for learning in relation to the course (i.e. in addition to the technologies provided by the course), and technology used for socialising and recreation.

Students had to indicate the extent to which they used these technologies by indicating on a scale of daily, weekly, monthly, or never. From Austria, Nagler and Ebner (2009) surveyed a sample of University students to examine their technology use for both learning and socialising, focussing on patterns of internet access, use of hardware devices and students' preferences for and experiences with tools ranging from Virtual Learning Environments (VLEs) to Web 2.0 tools. Similar to other studies, Nagler and Ebner were interested to gather data on the types of technologies used and the extent to which their students have used these technologies.

Two observations are made from the above studies. First, university students who were born after 1980 were selected as participants. This type of sampling is predicated on the assumption that the selected participants would be representative of digital natives in the way they interact with technology as learners. At the same time, the authors did not find strong support for age as the determining factor to define digital natives in these studies. In other words, one's age did not make a person digital native. Second, the focus of the data collection was on the types of technology used (e.g., graphic tools, social networking tools), how they were used (e.g., studying, socialising), and how frequently these were used (e.g., daily, weekly). While data were relevant and useful for profiling students' interaction with technology, they did not provide information to help teachers to identify digital natives in the sample.

The studies reviewed above suggest that digital natives may have learning preferences and styles that are different from others and that using age as the only criterion to define digital nativity may not be tenable in the current educational environment. However, relative to the questionnaires described above, no self-report scale or inventory has been developed to provide a measure to identify the digital natives. Such a measure may be used to either complement the existing questionnaire for gathering data on the type of technology used or as a standalone instrument to assist teachers in obtaining an assessment of the extent to which their students may be considered digital natives. A self-report measure is easy to administer and scored manually or via the Internet. In addition, apart from understanding the frequency of and type of technology use, there is a need for a greater understanding of the attributes and behavioural characteristics of digital natives. This will allow a greater appreciation of the issues surrounding digital natives and how these could impact on teaching and learning.

2.3 Purpose of the study

The purpose of this study is to addresses a gap in current research on digital natives by developing the Digital Natives Assessment Scale (DNAS), a self-report instrument designed to measure students' assessment of the degree to which they are digital natives by responding to various attributes associated with digital natives. Theoretically, this study contributes to the current debates on defining digital natives by proposing several attributes and characteristics and testing these statistically. A practical contribution of this study is to produce a simple and useful tool to inform teachers on how their students interact and learn with technology. Such information will be useful to teachers for lesson planning, resource allocation, and lesson delivery, to align with their students' learning preferences. The development of DNAS will undergo three phases (1) item generation, (2) pilot test, and (3) validation.

3. Method

3.1. Phase One: Item Generation

The process of item generation began by reviewing the literature and empirical studies that discussed indicators of digital nativity (DN). To generate the initial set of items, information characterises aspects of digital native (e.g., "comfortable with multitasking" and "Short attention spans", or "Prefer bite-size chunks of content") were documented. From these, a total of 53 likert-type items were created. Some examples of these items are "I like to do things on the go” and “I expect quick rewards when I do something”, and “I use a lot of graphics and icons when I send messages.”

Following this, a focus group discussion (FGD) was held with 14 persons whose age ranged from 20 to 35 at the time this study was conducted. This age range was chosen because proponents of the digital native construct believed that digital natives are those born on or after 1980 (Prensky, 2001). The main goal of this FGD was to allow members to identify the statements which describe them, by using a number from 1 (strongly disagree) to 7 (strongly agree). From these, a list of 45 items was generated for the pilot test. In addition, members of the FGD were asked to group the items and suggest labels for each group. From their suggestions, four factors were proposed: (1) Comfortable with technology (12 items) (2) Able to multitask (13 items) (3) Reliant on graphics for communication (12 items), and (4) Thrive on instant gratifications and rewards (8 items).

A key step at the item generation stage was to ensure that the items could be understood by the potential respondents. For this purpose, the list of 45 items was presented to a group of ten secondary (aged 12 to 16) students for their feedback. Specifically, these students explained what they thought each statement meant to them. Thereafter, the items were revised for clarity, language, parsimony in sentence, and scale length. Items that were thought to be too complex, double-barrelled, or asking for the same thing were removed from the list. At the end of phase one, 35 items were retained. These 35 items were hypothesised to load on the above-mentioned four factors and were measured on a 7-point scale with 1=strongly disagree and 7=strongly agree.

3.2. Phase Two: Pilot Test

3.2.1. Aim and Participants

The aims of this study are to test and refine the 35 items proposed for the Digital Natives Assessment Scale (DNAS). These items were presented using a questionnaire and measured by a 7-point scale with 1= ‘strongly disagree’ and 7= ‘strongly agree’. A total of 333 students from a secondary school participated in this study. The mean age of the participants was 13.5 (SD= 1.03). All participants were invited to volunteer and they were briefed on the purpose of this study and informed that they could withdraw from the study at anytime during or after the data collection. On average, each participant took no more than 25 minutes to complete the questionnaire.

3.2.2. Results

The descriptive statistics showed the mean scores of all items to range from 4.65 to 5.95. The standard deviations ranged from 1.34 to 1.88 and the skew and kurtosis indices from -1.62 to -0.31 and -0.89 to 2.49 respectively. On the recommendations from Kline (2010), the data in this study were considered to be univariate normal.

An exploratory factor analysis using principal components analysis (PCA) with varimax rotation was conducted on the 35 items to explore the underlying structure of the Digital Native Learning Scale (DNLS). Principal Components Analysis (PCA) was chosen to determine the factorial structure because it is a data reduction method which attempts to explain as much total variance as possible in a set of observed variables using a smaller number of components. The criteria for determining the number of components to retain were Kaiser’s eigenvalues-greater-than-one (K1) rule, decrements in the scree plot, parallel analysis, and the interpretability of different factor solutions. The K1 rule retains all factors with eigenvalues greater than 1.0, whereas the scree test illustrates the plotted eigenvalues for drastic changes between adjacent pairs of plotted eigenvalues. In contrast, parallel analysis compares the initially extracted eigenvalues to random data sets that are the same size as the obtained data being evaluated. When the eigenvalue for a component in the random data exceeds the size of the component in the true data set, only the preceding factors are retained for further analysis (O'Conner, 2000). This approach to identifying the correct number of components to retain has been shown to be the most accurate, given that both Kaiser's K1 rule and Catell's scree test have a tendency to overestimate the number of components (Zwick & Velicer, 1986).

All of the extraction methods supported a four-factor solution for retention. The Kaiser's K1 rule, however, suggested seven factors should be retained. Hair et al. (2010) recommended a factor loading of +/- .50 to meet the minimal level of practical significance for interpretation. On this basis, five items were removed from further analysis. At this stage, four factors were retained. Researchers suggested that if the variables submitted to a PCA include a large amount of measurement error, the results will likely look very different from the results using the same data and other exploratory factor analysis (EFA) techniques (Benson & Nasser, 1998; Gorsuch, 1990). On the other hand, the results from a PCA and EFA will look similar only when either the observed variables are measured with little measurement error or a large number of observed variables are used as input into the analysis. To provide further checks on the factor structure, a second PCA and a Principal Axis Factor analysis with oblique rotations (promax: kappa=4) were conducted on the 30 item, four-factor solution and these yielded consistent results. Table 1 shows the results of the PCA with varimax rotated solution of the 30-item, four-factor scale.

--- Insert Table 1 here ---

3.2.3 Discussion

This pilot test resulted in four interpretable factors that accounted for 66.79% of the total variance explained. From the PCA, five items were removed and 30 items were retained for further analysis. Of the 30 items, factor 1 (Comfortable with technology) comprises six items, factor 2 (Able to multitask) comprises six items, factor 3 (Reliant on graphics for communication) comprises eight items, and factor 4 (Thrive on instant gratifications and rewards) comprises ten items. Using summated scores for each factor, a correlation matrix was obtained. All inter-factor correlation were positive, ranging from r=.57 to r= .65 and significant at the p <.01 level. This suggests that each factor was making a contribution to the overall structure and at the same time, was not related to the extent that no two factors were seen as one. The results of this phase indicate that the scores of the four-factor structure possess sufficient reliability to proceed to the next phase in the development of the DNAS.

3.3. Phase Three: Validation

3.3.1. Aim and Participants

The aim of this study is to assess the factorial validity of the 30-item, four-factor DNAS. Participants in this study were 380 students from a secondary school and their mean age was 13.46 years (SD=.99). All participants were volunteers and were not rewarded by money or in kind. The participants in this validation study did not participate in the previous studies.

3.3.2. Confirmatory factor analysis

In this study, AMOS 7.0 (Arbuckle, 2006) was employed as the computer software for the confirmatory factor analysis. The model tested in this study was estimated using maximum likelihood estimation (MLE) where all analyses were conducted on variance–covariance matrices. The four factors in this study (Grow up with technology, Comfortable with multitasking, Reliant on graphics for communication, and Thrive on instant gratifications and rewards) were assumed to be correlated and allowed to covary in the model. In addition, the measurement model was a congeneric model in that each indicator only loads on one of the four factor and all measurement errors were assumed to be uncorrelated.

Model fit was assessed by a number of indices. First, it was determined using the minimum fit function χ^2. As the χ^2 has been found to be too sensitive to sample size, the ratio of χ^2 to its degree of freedom (χ^2/df) was also used, with a range of not more than 3.0 being indicative of an acceptable fit between the hypothesized model and the sample data (Carmines & McIver, 1981). Because different indices reflect various aspects of model fit, researchers typically report the values of multiple indices. Two absolute fit indices are reported here: the standardized root mean square residual (SRMR) and the root mean square error of approximation (RMSEA) with values less than .06 and .08 respectively as acceptable fit. Finally, the comparative fit index (CFI) and Tucker-Lewis index (TLI), both incremental fit indices, were reported, with a recommended value of equal to or more than .90 to indicate an acceptable level of model fit (Hair et al., 2010).

3.3.3 Results

Because the reliability of results obtained by structural equation modelling is influenced by multivariate normality, the latter was assessed before proceeding with other analyses. The Mardia’s coefficient is a standard measure of multivariate normality and its value obtained in this study is 555.95. This value is less than the recommended value (($p(p+2)$ where p= total number of observed indicators; 30(32)=960) by Raykov and Marcoulides (2008) hence the requirement of multivariate normality was satisfied. On this basis, the data for this study was considered adequate for confirmatory factor analysis.

The results from the confirmatory factor analysis did not reveal an acceptable model fit [χ^2 = 1894.981; χ^2/df = 4.749, TLI =.797; CFI =.814; RMSEA= .099 [.095, .104]]. Hu & Bentler (1998) suggested that the CFI and the TLI are very sensitive to complex model misspecification, causing the inability to estimate the direct relationships between items and factors with precision. An inspection of the modification indices revealed that model fit may be improved by correlating several error variances but this recommendation was not accepted because the goal of this CFA was to establish a congeneric model without error correlations. Instead, the recommendation of Bryne (2001) was followed. She posited that if a model is correct, the absolute value of most standardized covariances of residuals will be expected to be less than three. An inspection of the standardized residual covariances matrix revealed that of the 465 standardized residual covariances, nine exceeded the absolute value of three. In addition to the standardized residuals, standardized regression weights and, square multiple correlations were also considered. Subsequently, a total of nine items were removed and the CFA was re-run on the remaining 21 items. The results showed an acceptable fit [χ^2 = 599.561; χ^2/df = 3.276, TLI =.907; CFI =.919; RMSEA= .077 [.071, .084]]. Table 2 shows the CFA results of the 21-item, four-factor scale.

As each indicator was specified to load on just one factor in the model, the standardized estimates were regarded as structure coefficients that estimate indicator-construct correlations (Kline, 2010). For each of the four sets of indicators, the standardized estimates were relatively large (.62 to .88), which provided support for convergent validity (Maruyama, 1998). Evidence for discriminant validity was also strong because the inter-factor correlations (r= .51 to .61) was moderately small enough to suggest that the four factors were sufficiently distinct. From Table 2, all standardized estimates were statistically significant at the $p < .001$ level and had exceeded the recommended value of 0.50 (Hair et al., 2010). The Cronbach alpha for each of the four factors met the recommended level for instrument development (Nunnally & Bernstein, 1994) and this provided support for the factorial and construct validity of the DNAS.

--- Insert Table 2 Here ---

3.3.4. Second confirmatory factor analysis

Researchers recommend subjecting a theoretical model to further validation once it has been obtained an adequate model fit, by using a separate sample (Schmacker & Lomax, 2010). On this recommendation, a second CFA was performed on the 21-item, four-factor model using a separate sample of 368 participants from a secondary school who did not participate in the previous phases in this study. Their mean age was 13.67 years (SD= 1.03) and all participants were volunteers who did not receive any rewards. The results revealed an acceptable model fit [χ^2 = 489.561; χ^2/df = 2.675, TLI =.900; CFI =.912; RMSEA= .068 [.060, .075]]. All item parameter estimates were also statistically significant at the $p < .001$ level. The standardized estimates for all items were larger than the recommended value of 0.50, ranging from .598 to .822. Together these results from the second CFA with a separate sample provided support for the four-factor structure of the 21-item Digital Natives Assessment Scale (DNAS).

3.3.5 Model comparison

In the development of a scale, Noar (2003) recommended examining alternative models to allow comparisons of different conceptualization of the factor structure of the proposed scale to be made. On this basis, three models with sound theoretical rationale were compared in this study. First, a null model (model 1) that assumes all the factors to be unrelated. Second, a one-factor model (model 2) that tests whether all the factors load on one overall factor. A support for the one-factor model suggests that the respondents had perceived all items to belong to a unidimensional construct. Third, a correlated factor model that tests whether the four factors are related to one another (model 3). Support for this model suggests that participants had discriminated among the four factors but they are intercorrelated with one another. A series of CFA was conducted to test the three models described above. Table 3 shows the results of the model comparisons, indicating that model 3 has better fit indices although the χ^2/df is slightly above the recommended values of 3.0. Figure 1 shows the graphic model of the 21-item, four-factor DNAS.

--- Insert Table 3 Here ---

--- Insert Figure 1 Here ---

4. General Discussion

The aim of this research was to develop a self-report instrument to assess the degree to which students perceived themselves possessing the attributes that are associated with digital natives. The 21 items in the Digital Natives Assessment Scale (DNAS) are measured using a 7-point scale, ranging from 7 for ‘strongly agree”, and 1 for ‘strongly disagree’. The scores from these items can be collectively summed (ranging from 21 to 147) to represent the degree of an individual’s perceptions of the four factors in DNAS, with a higher score indicating a level closer to being a digital native. The 21 items are shown in Table 2.

The DNAS complements existing measures of digital nativity which are mainly designed to gather data relating to the type of technology used, frequency of technology use, and contexts in which technology is used. Specifically, the DNAS measures respondents’ perceptions of the degree to which they (1) grow up with technology, (2) are comfortable with multitasking, (3) are reliant on graphics for communication, and (4) thrive on instant gratifications and rewards. The DNAS was developed and validated using three separate samples, totalling 1018 students from three secondary schools in Singapore. Results of the multiple CFAs indicate that the four-factor model has the best fit in comparison to two alternative models. All 21 items have good standardized loadings on the each of the four hypothesized factors, which are significantly but not highly correlated among them (i.e., < .8) and suggesting that the factors were related but distinct (Kline, 2005).

This scale can be readily used by educators as a cost-efficient research or assessment tool. For example, teachers may use the DNAS to gain a greater understanding of their students in relation to how they react to technology in learning, social and collaborative situations. Such information would enable teachers to better cater to their students' learning needs by employing more effective pedagogies and utilising resources with a focus on achieving specific outcomes. Most teachers teach different grade levels and could use the DNAS to obtain their student profiles in order to be more focused in their interaction with students, for example, for lesson delivery, resource utilization, and curriculum development. For example, if students in a class exhibit high levels in all four factors of the DNAS, it is clear that they are expressing their desire to use technology for learning in ways that characterize digital natives. Rather than guessing who their digital natives are, teachers could use the DNAS to obtain a reasonable assessment of their students.

Theoretically, this study contributes to the existing debates in defining digital natives. Instead of focusing on age, the amount of time spent in using technology, and exposure to the type of technology, this study proposes four attributes of digital natives as people who grow up with technology, are comfortable with multitasking, are reliant on graphics for communication, and thrive on instant gratifications and rewards. These are measured using a multi-item scale and found to be statistically valid and reliable. This study has the potential to enhance the current debate on digital natives by allowing a person's score on the above four attributes to be measured, a departure from the usual items on technology use that are reported in the digital native literature.

5. Conclusion and future research

Despite achieving statistical support for its construct validity, the DNAS is in need of further evaluation. First, the samples were taken from three secondary schools and this may have limited the generalizability of the findings to a larger population. Because the current research included only respondents aged between 12 to 16 years, future research should sample and examine the scale properties for individuals who are under 13 years or over 17 years old. This is particularly relevant given the growing support among researchers for not using age to determine who a digital native is.

Next, although the reliability estimates for the final set of 21 items was acceptable for exploratory and confirmatory analyses, future research should continue to refine and potentially add or remove items to increase the reliabilities of the subscales. An enhancement of the reliabilities will have a positive impact on the usability of the scale for research and practice. Some ways of examining the reliabilities include testing the consistency of the DNAS scores over time (e.g., test-retest reliability) or using the DNAS in longitudinal studies. In addition, the concurrent validity of the DNAS could be assessed by comparing its scores with teachers' perceptions of their students in terms of the behaviours measured in the DNAS.

Because this study has not differentiated the digital environments (computers, video games, intelligent phones, webcams, etc.) in the items, testing the DNAS in different types of digital environments should be undertaken. To ensure that the DNAS is usable and valid for different subgroups, tests of measurement invariance should be performed to ensure that the scores are comparable to ensure meaningful comparisons to be made. These subgroups include age, gender, school levels, and cultures. Beyond national boundaries, tests of invariance could be performed to facilitate comparative research across countries, allowing more discussions about digital natives to continued and be sustained. Finally, given that users' interaction with digital technologies will continue to evolve and change over time, the digital environments for work, play, and study would adjust itself to accommodate the emerging patterns of human interaction with technology. Hence, the theoretical constructs in the DNAS should not be taken as unchangeable but be further tested to be sharpened and refined with reference to the emerging attributes and characteristics of digital natives in order to remain relevant and valid for research and practice.

References

Arbuckle, J. L. (2006), *AMOS* (version 7.0), SPPS Inc, Chicago.

Bennett, S., Maton, K., & Kervin, L. (2008). The ‘digital native debate: A critical review of the evidence. *British Journal of Educational Technology*, *39*(5), 775-786.

Bennett, S. & Maton, K. (2010). Beyond the ‘digital natives’ debate: Towards a more nuanced understanding of students’ technology experiences. *Journal of Computer Assisted Learning*, *26*, 321-331.

Benson, J., & Nasser, F. (1998). On the use of factor analysis as a research tool. *Journal of Vocational Education Research*, 23, 13-33.

Byrne, B. M. (2001). *Structural equation modeling with Amos: Basic concepts applications, and programming*. Mahwah, NJ: Erlbaum.

Cameron, D. (2005). *The net generation goes to university?* Paper presented at the Journalism Education Association Conference, Surfers Paradise, Queensland, Australia.

Carmines, E. G., & McIver, J. P. (1981). Analyzing models with unobserved variables: Analysis of covariance structures. In George W. Bohrnstedt and Edgar F. Borgatta, (Eds.), *Social Measurement: Current Issues* (pp. 65-115). Beverly Hills, CA: Sage Publications.

Dede, C. (2005). Planning for neomillennial learning styles: Implications for investments in faculty and technology. In D. Oblinger & J. Oblinger (Eds.), *Educating the Net Generation* (pp. 15.1–15.22). Boulder, CO: EDUCAUSE.

Gorsuch, R. L. (1990). Common factor analysis versus component analysis: Some well and little known facts. *Multivariate Behavioral Research*, 25, 33-39.

Kline, R. B. (2010). *Principles and practice of structural equation modeling* (3rd ed.). NY: Guilford Press.

Hair, J. F. Jr., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). NY: Prentice Hall.

Helsper, E. J., Eynon, R. (2010). Digital natives: Where is the evidence? *British Educational Research Journal*, *36*(3), 503-520.

Hu, L., & Bentler, P. M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods, 3*, 424-453.

Jukes, I., & Dosaj, A. (2006). *Understanding digital children (DKs): Teaching & learning in the new digital landscape*. Retrieved May 16, 2007, from http://www.wright.edu/~marguerite.veres/786syl/growingupdigit.pdf

Kennedy, G. E., Judd, T. S., Churchward, A., Gray, K. & Krause, K.-L. (2008). First year students' experiences with technology: Are they really digital natives? *Australasian Journal of Educational Technology*, *24*(1), 108-122.

Li, Y., & Ranieri, M. (2010). Are 'digital natives' really digitally competent? A study on Chinese teenagers. *British Journal of Educational Technology, 41*(6), 1029-1042.

Margaryan, A., Littlejohn, A., & Vojt, G. (2011). Are digital natives a myth or reality? University students' use of digital technologies. *Computers & Education*, *56*(2), 429-440.

Maruyama, G. M. (1998). *Basics of structural equation modeling*. London: Sage Publications.

Nagler, W., & Ebner, M. (2009). *Is your university ready for the Ne(x)t-Generation*?. In Proceedings of 21st world conference on educational multimedia, hypermedia and telecommunications (EDMEDIA) (pp. 4344–4351), June 22–26, Honolulu, Hawaii, USA.

Noar, S. M. (2003). The role of structural equation modeling in scale development. *Structural Equation Modeling, 10*, 622–647.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). NY: McGraw-Hill.

Oblinger, D., & Oblinger, J. (2005). Is it age or IT: First steps towards understanding the net generation. In D. Oblinger & J. Oblinger (Eds.), *Educating the Net Generation* (pp. 2.1–2.20). Boulder, CO: EDUCAUSE.

O'Connor, B. P. (2000). SPSS and SAS programs for determining the number of components using parallel analysis and Velicer's MAP test. *Behavior Research Methods, Instrumentation, and Computers, 32,* 396-402.

Prensky, M. (2001). M. Digital natives, digital immigrants. *On the Horizon*, *9*(5), 1-6.

Raykov, T., & Marcoulides, G. A. (2008). *An introduction to applied multivariate analysis*. NY: Routledge.

Schumacker, R. E., & Lomax, R. G. (2010). A beginners guide to structural equation modeling. NY: Routledge.

Tapscott, D. (1998). *Growing up digital: The rise of the Net Generation*. NY: McGraw-Hill.

Thinyane, H. (2010). Are digital natives a world-wide phenomenon? An investigation into South African first year students' use and experience with technology. *Computers and Education*, *55*(1), 406-414.

Zwick, W. R., &Velicer,W. F. (1986). Factors influencing five rules for determining the number of components to retain. *Psychological Bulletin*, *99*, 432-442.

Figure caption:

Figure 1: Model of the 12-item Digital Natives Assessment Scale (DNAS)

Table 1. Results of the principal component analysis with varimax rotation

	Statement	1	2	3	4
1	I use the internet every day	.80			
2	I use computers for many things in my daily life	.63			
3	When I need to know something, I search the internet first	.64			
4	I use the computer for leisure every day	.80			
5	I keep in contact with my friends through the computer every day	.77			
6	I prefer reading from the computers to printed sources	.60			
7	I am able to surf the internet and perform another activity comfortably		.75		
8	I can check email and chat online at the same time		.70		
9	When using the internet for my work, I am able to listen to music as well		.75		
10	I am able to communicate with my friends and do my work at the same time		.77		
11	I am able to use more than one applications on the computer at the same time		.79		
12	I can chat on the phone with a friend and message another at the same time		.63		
13	I use pictures more than words when I wish to explain something			.66	
14	I use a lot of graphics and icons when I send messages			.79	
15	I prefer to receive messages with graphics and icons			.75	
16	I am able to understand pictures better than words			.70	
17	I use pictures to express my feelings better			.78	
18	I use graphics to say what I think			.77	
19	I use smiley faces a lot in my messages			.71	
20	I end every message with a smiley icon			.74	
21	When I receive a reply to something I post on the computer, I feel happy				.58
22	When I like to do something, I wish to do it straightaway				.51

23	I feel satisfied when I improve in my computer game scores				.66
24	I wish to be rewarded for everything I do				.73
25	I enjoy playing computer games because I want to earn more points				.64
26	I do not like to wait for too long for information to be given to me				.69
27	I expect quick access to information when I need it				.78
28	When I send out an email, I expect a quick reply				.61
29	I expect the websites that I visit regularly to be constantly updated				.72
30	When I study, I prefer to learn those that I can use quickly first				.67
	Total Eigenvalue	5.47	4.01	5.15	5.40
	Total Variance Explained	18.24	13.38	17.16	18.01

Note: 1= Grow up with technology; 2= Comfortable with multitasking; 3= Reliant on graphics for communication; 4=Thrive on instant gratifications and rewards

Table 2. Parameter estimates and reliability indices

Item	Statement	SE	CR	R^2	α
Grow up with technology					.89
1	I use the internet every day	.83	19.89	.69	
2	I use computers for many things in my daily life	.75	17.05	.56	
3	When I need to know something, I search the internet first	.68	14.79	.46	
4	I use the computer for leisure every day	.82	19.72	.68	
5	I keep in contact with my friends through the computer every day	.86	---	.74	
Comfortable with multitasking					.91
1	I am able to surf the internet and perform another activity comfortably	.75	---	.56	
2	I can check email and chat online at the same time	.83	16.50	.68	
3	When using the internet for my work, I am able to listen to music as well	.85	17.08	.73	
4	I am able to communicate with my friends and do my work at the same time	.80	15.87	.64	
5	I am able to use more than one applications on the computer at the same time	.85	16.93	.71	
6	I can chat on the phone with a friend and message another at the same time	.76	15.05	.58	
Reliant on graphics for communication					.87
1	I use pictures more than words when I wish to explain something	.66	12.56	.43	
2	I use a lot of graphics and icons when I send messages	.87	16.69	.75	
3	I prefer to receive messages with graphics and icons	.83	15.92	.68	
4	I use pictures to express my feelings better	.68	12.89	.46	
5	I use smiley faces a lot in my messages	.75	---	.56	

Thrive on instant gratifications and rewards					.87
1	I wish to be rewarded for everything I do	.62	---	.39	
2	I expect quick access to information when I need it	.79	12.25	.62	
3	When I send out an email, I expect a quick reply	.74	11.78	.55	
4	I expect the websites that I visit regularly to be constantly updated	.88	13.12	.78	
5	When I study, I prefer to learn those that I can use quickly first	.74	11.72	.55	

Table 3. Confirmatory Factor Analysis of Alternative Models

Model	χ^2	χ^2/df	TLI	CFI	RMSEA	SRMR	Model description
1	1068.70	5.65	.81	.83	.112	.312	Null model
2	2007.04	10.62	.61	.65	.159	.105	One-factor (21-item)
3	599.56	3.28	.91	.92	.077	.057	Four-factor, correlated

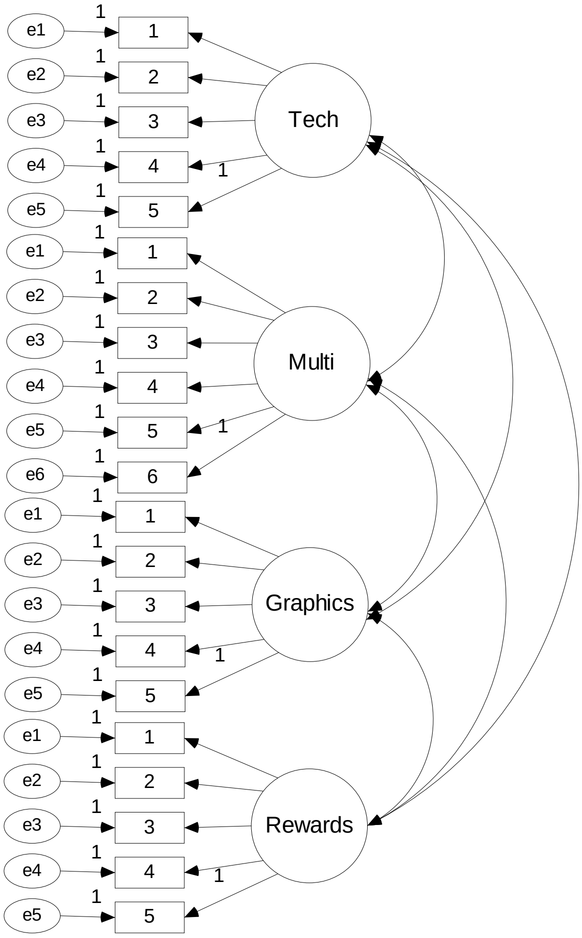

Figure 1: Model of the 12-item Digital Natives Assessment Scale (DNAS)

Tech= Grow up with technology; Multi= Comfortable with multitasking; Graphics= Reliant on graphics for communication; Rewards=Thrive on instant gratifications and rewards