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High School Students' Use of Digital Technology as a Predictor of Measures of Academic Progress

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Abstract Digital technology is widely used by tech-savvy 'digital native' students in their learning. Research shows that this can have both positive effects, no effects and also negative effects on academic attainment. This study investigated whether high school students' use of digital technology in their learning positively predicted their academic attainment. Students use of digital technology was measured using the Tech-savvy Scale (α=.91) which consists of three factors, connection, adaptation and control. Academic attainment was measured using students Measures of Academic Progress (MAP) scores in math, language and reading (α=.74). Participants were 218 international school students of mixed gender and ethnicity aged between 15 and 17 years. The data were analyzed using structural equation modeling (SEM) and the proposed model had a fair fit (*RMSEA* .08; *CFI* .97). When taken as one factor, Tech-savvy scale score did not predict academic attainment ($p>0.05$). However, the connection factor of the Tech-savvy Scale positively predicted academic attainment in language ($p<0.05$) and the control factor negatively predicted academic attainment in language and reading ($p<0.05$). Results are discussed in light of the conflicting previous research, and have implications in understanding the complex of the relationship between students' use of digital technology and their academic attainment.

Keywords: technology, education, academic attainment, digital natives

Today's high school students have grown up with the use of digital technology permeating their social and academic lives. The use of digital technology is now central to the teaching and learning process, therefore research is needed to understand how students use of digital technology influences their academic attainment. Digital technology is defined as the use of hardware such as desktop and laptop computers, tablets, mobile phones, calculators and also the software students' use on these.

First, we must conceptualize what it means to be a tech-savvy high school student. These students are the 'digital natives', a generation of tech-savvy young people who are 'native speakers' in the language of computers are used to receiving and manipulating information using digital technology (Prensky, 2001). These students use digital technologies to communicate, do class work, and multitask (Dolezalek, 2003). They like being connected and are interactive in their use of digital technology (Sherry & Fielden, 2005). They also have

high levels of computer knowledge and literacy and they use digital technology fluently both inside and outside the academic contexts (Bennet & Maton, 2010; Craig & Stein, 2000).
The literature identifies several characteristics of tech-savvy students but does not clearly define and classify the construct. This study defines tech-savvy as a multi-dimensional construct consisting of three factors. The dimensions of the construct are *connection*, which is the use of digital technology to connect with information and other people when learning, *adaptation* is the ability to adapt digital technology to suit one's own learning needs and *control* is the ability to exercise control or self-regulation in ones use of digital technologies in learning.

Prensky (2001) suggested that there was a mismatch and division between the 'digital native' students and their 'digital immigrant' teachers who have not grown up with digital technology. Prensky argues that in order to educate this tech-savvy generation, digital technology must be increasingly integrated into teaching and learning. However, Bennet, and Maton (2010) believe that this is an overly simplistic portrayal of a complex situation, and a more nuanced understanding of exactly how students use digital technology in their learning is required, and this study aims to do this.

The findings of research in this area are contradictory results with positive, negative and no effects of students' use of digital technology on academic attainment. Research has identified several factors that play a role in whether students are successful in their use of digital technology. Students' computer self-efficacy and attitude towards computers are closely related to academic attainment because self-efficacy is a significant positive predictor of attitudes towards computers and academic attainment in a computer literacy course (Yalcinlap, 2005).

Self-regulation is an important factor in predicting success and satisfaction with the use of digital technology in an e-learning course (Lee, 2008). This may be because students who are more controlled in their use of digital technology are able to avoid its distractions. The quality of digital technology use is also a factor in academic attainment because spending quality time engaged in knowledge construction raises academic attainment, but too much time using digital technology has a negative impact (Lei & Zhao, 2007).

Digital technology can enhance academic attainment in reading, writing and math. Reading, language and math are core competencies that are widely used as benchmark measures of academic progress (Northwest Evaluation Association, 2012). Reading and writing achievement showed a consistent increase when students used digital technologies in their learning (Conyers, Kappel, & Rooney, 1999). Spellchecking, cutting and pasting tools increase academic attainment in writing. Using digital technology in learning develops students reading and language skills as they have to locate and extract information from the Internet (Jackson et al., 2006). Students who are less anxious using digital technologies have better language abilities because computer literacy is related to oral and written literacy (Rahimi & Yadollahi, 2010). Digital technology use by students has also been found to have positive effects on academic attainment in math, because scientific calculators and graphics software amplify students' cognitive abilities (Demir & Kilic, 2009).

Research also shows that students' use of digital technology has no effect or a negative effect on academic attainment. Learning oriented digital technology use may be unrelated to academic attainment, because the educational content of the internet is not used effectively by high school students (Young, 2006). A longitudinal study found that the use of digital technology had no effect on mathematics standardized attainment in students, this is because using the internet does not generally require mathematical skills (Jackson et al., 2006).

Furthermore, research has found no correlations among digital technology usage, self-regulation and academic attainment in students (YangKim, 2009). Students' attitude towards digital technologies has been found to be independent of their cognitive style and not a predictor of academic attainment (Altun & Cakan, 2006). Research has also shown that excessive use of digital technology in learning actually lowers grades because heavy use of digital technology isolates students from face to face social communication with their peers and they are susceptible to the many distractions present online (Austin & Totaro, 2011).

There are contradictory findings on students' use of digital technology and its relation to their academic attainment and a lack of clarity about the definition of tech-savvy as a construct. In light of this, the purpose of this study is to conduct a structural analysis to examine whether students' use of digital technology in their learning predicts their academic attainment. Despite some contradictory research, it is hypothesized that the effective use of digital technologies in learning, measured through the connection, adaptation and control factors of the Tech-savvy Scale positively predicts students Measures of Academic Progress (MAP) scores in math, reading and language.

Method

Participants

The participants were an opportunity sample of 218 high school students from an international school in Metro Manila, Philippines. There were 113 females and 105 males aged 15-17. Participants were from varied ethnic backgrounds, with 65 nationalities represented in the school. All had high socio-economic status, with the majority of students owning their own laptops and the school has a high level of digital technology resources.

Instruments

Students' use of digital technology in their learning. The Tech-savvy Scale was developed for this study to measure students' use of digital technology in their learning. Exploratory factor analysis (EFA) was used to determine the factor structure of the tech-savvy construct. Three hundred and thirty six high school students completed the 30 item; four-point forced choice Likert type Tech-savvy Scale. Students circled their answers to corresponding statements ranging from 'Strongly agree' (4) to 'Strongly disagree' (1).

Three factors were extracted using principal components analysis explaining 44% of the variance in the data (α=.91). Seven cross-loaded items were removed as well as two items that did not fit the factor labels, so the final scale had 21 items, 8 items for *adaptation,* 7 items for *connection* and 5 items for *control.* See Appendix A for factor loadings and communalities and Appendix B for the Tech-Savvy Scale.

Confirmatory factor analysis (CFA) was carried out to check the reliability and validity of the three factor Tech-savvy Scale. Three measures of goodness of fit were used, the Root Mean Squared Error of Approximation (*RMSEA*) which is a measure of the discrepancy per degree of freedom for the model, values below .05 indicate good fit. The Goodness of Fit Index (*GFI*) which accounts for the relative amount of variance in the model, and the Comparative Fit Index (*CFI*) compares fit to an independent model, for *GFA* and *CFI* values greater than .09 indicate good fit (Hooper, Coughlan, & Mullen, 2006). The three factor Tech-savvy Scale had a very good fit, with a *RMSEA* of .045, a *GFI* .916 and a *CFI* of .928

(*df*=186). This shows that the instrument is reliable and valid. See Appendix C for CFA path diagram.

Academic attainment. Academic attainment was measured using the Northwest Evaluation Association's (2012) Measures of Academic Progress (MAP) tests in math, reading and language. This is a widely used and reliable measure of academic attainment in international schools and North America. The theoretical framework for the scale construction is the Rasch Model (Rasch, 1961). MAP is a computerized adaptive assessment, this means that as student responds to questions, the test responds to the student, and the next question is either more or less difficult than the previous one. MAP produces an RIT Score (Rasch Unit) for the student in math, reading and language. The RIT Scale is an equal interval scale from high to low, and average scores all have the same meaning regardless of grade level (Northwest Evaluation Association, 2012). High reliability was established for students MAP RIT Scores in math, reading and language (α=.74).

Procedure

Data was gathered in high school classes on the 12th and 13th March 2012. Social studies teachers were contacted by the researcher to ask if they were willing to allow their students to take part in the study. The researcher then printed out the Tech-savvy Scale and distributed it among the teachers (see Appendix B). Teachers gathered data during regular class hours (7.30 am-2.30 pm) as a whole class, over the two days. Students were informed by the teacher that the scale was examining their use of digital technology in learning, and that all their answers were confidential. Teachers instructed students to read the instructions at the top of the Tech-savvy Scale and then fill out the items on the scale in pen. This was carried out in silence. After 5 minutes teachers collected the completed Tech-savvy scales and students were thanked for taking part. Teachers returned completed Tech-savvy scales to the researcher. Students MAP RIT Scores were provided by the high schools Assistant Principal, and had been gathered in testing three months earlier. Students MAP RIT Scores for math reading, and language were matched with their Tech-savvy Scores. Structural equations modeling analysis was carried out using PASW and AMOS data analysis software.

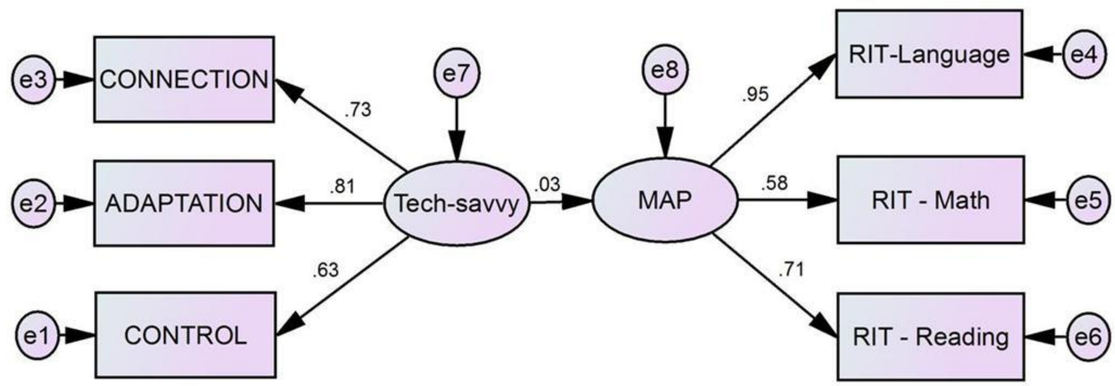
Results

The purpose of the study is to examine whether students' use of digital technologies in their learning predicts their academic attainment. Structural equation modeling (SEM) that examines causal relations between latent and manifest variables in a structural model, these are uncovered using regression equations and can be depicted pictorially (Byrne, 1998). Descriptive statistics for are presented in Table 1. Figure 1 is the SEM diagram and Table 2 is a summary of the regression equations between Tech-Savvy Scale scores and MAP RIT scores.

Table 1
Descriptive Statistics for Tech-savvy Scores and MAP RIT scores

	Tech-savvy Scores			MAP RIT Scores		
	Connection	Adaptation	Control	Math	Reading	Language
Mean	3.50	3.43	2.99	254.94	234.74	233.39
SD	.39	.52	.37	15.93	10.93	9.39

Figure 1
SEM diagram of Tech-savvy Scores and MAP Scores



Model fit was tested using Root Mean Squared Error of Approximation (*RMSEA*) and Comparative Fit Index (*CFI*) (for a description of these measures see Instruments section). The *RMSEA* was .08 and the *CFI* .97 indicating fair model fit (df=8). The regression equation of .03 between Tech-savvy and MAP was not significant (p>0.05).

Regression equations were then examined between the individual factors of Tech-savvy and MAP. The results are shown in Table 2 below.

Table 2
Standardized Regression Equations for Tech-savvy Scores and MAP RIT Scores

	Math	Reading	Language
Connection	.03	.12	.17*
Adaptation	-.08	.08	.03
Control	-.15	-.21*	-.18*

*p<0.05

The significant negative regression equations between control and reading and language shown in Table 2 do not support the hypotheses. However, the significant positive regression equation between connection and language supports the hypothesis.

Discussion

The hypothesis is partially supported. When examined as a one factor, Tech-savvy does not significantly predict academic attainment. This reflects the contradictory nature of previous research where positive, negative and no relationships between students use of digital technology and academic attainment. Examining the regression equations for the connection, adaptation and control factors of the Tech-savvy Scale and MAP RIT Scores for math, reading and language offers more insight into the predictive relationships between the variables.

Students' Tech-savvy Scores for connection significantly positively predicts their MAP RIT Scores for language. Students who rate themselves highly on their ability to connect with information and others using digital technology have higher academic attainment in language. The result of connection predicting academic attainment in language is consistent with previous research findings (Conyers et al., 1999; Rahimi & Yadollahi, 2010). Students who are tech-savvy or 'computer literate' in terms of connecting with information and others in their learning, also perform better in academic attainment tests of language. This suggests that literacy might be general ability that crosses contexts from language use in a traditional academic context and also in a digital context. These students are fluent in both of these domains, hence the positive regression equation between these two factors. Furthermore, using software such as word processors and carrying out internet based research does help students develop their academic attainment in language (Jackson et al., 2006).

The other significant result is the negative regression equations for Tech-savvy Scores for control and MAP RIT Scores for reading and language, which does not support the hypothesis. Unexpectedly, as students who rate their ability to control their use of digital technology highly have lower academic attainment in reading and language.

However, this finding supports Bennet and Maton's (2010) calling for a more nuanced understanding of students' use of technology in their learning. The control factor of the Tech-savvy Scale looks at how controlled or self-regulated students are in their use of digital technologies.

Students who score highly in reading and language tests have an increased awareness of the distractions of digital technology, hence they rate themselves lower on control. They have an accurate perception the limitations of digital technology and how it can potentially have negative effects on their academic attainment. This awareness in turn enables them to use technology more effectively in their learning, which is reflected in their higher academic attainment scores in language and reading.

This contrasts with Yalcinlap's (2005) and Lee's (2008) findings, because this study shows that high self-efficacy in terms of controlled self-regulated use of digital technology in students does not predict higher academic attainment. It also may be that the students who rate themselves lower on the control factor of the Tech-savvy Scale have a clearer understanding of intricacies of shifting between academic and non-academic contexts when using digital technology. It also may be that the academic attainment measure in this differs from those in the previous studies which focused on computer literacy and e-learning tasks.

The finding is also consistent with previous research showing how excessive use of digital technology in learning can have a negative impact on academic attainment (Lei & Zhao, 2007). The overuse of digital technology isolates students from connecting with other students and learning methodologies (Austin & Totoro, 2011). Similar to what Young (2009) proposes who rate themselves highly on control may over reliant on digital technology or not using it in an effective manner. These students perform less well on tests of academic attainment that require them to be disconnected to their usual digital technology.

However, there are some limitations to this study, the fair model fit suggests that the predictive relations between the variables are not yet clearly established. The insignificant regression equation between tech-savvy and academic attainment as one factor suggest that tech-savvy and academic attainment may be independent of each other, particularly in relation to academic attainment in math, which is what Jackson et al. (2006) also found. There may be other significant mediating factors that connect tech-savvy to academic attainment and these should be investigated.

The use of the self-report Tech-Savvy Scale meant that social desirability bias may have affected students' responses. The sample size of this study was limited to students who are from high socio-economic status and a school where digital technology use is highly integrated into their learning. Further research is required to see whether similar findings are observed in other contexts, for example with students who have less experience of the use of digital technology in learning.

In conclusion, the findings suggest that there is a need to move beyond viewing students as tech-savvy 'digital natives' who are extremely effective in their use of digital technology to enhance their learning. Students still need to be taught to be more self-regulated when learning using technology. Educators need to understand that even though students might have high self-efficacy in terms of being controlled users of digital technology, a continued effort is needed to improve the quality of their use of digital technology in learning. Students need to be encouraged to develop accurate perceptions of the strengths and limitations of digital technology in their learning and this will help their academic attainment.

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Appendix A

Factor loadings and communalities based on a principle components analysis with promax rotation for 21 items from the Tech-savvy Scale (N = 336)

	Connection	Adaptation	Control	Communality
I communicate using digital technology in order to enhance my learning.	.76			.34
I use digital technology to connect and collaborate with others when learning.	.72			.45
I prefer to learn using digital technologies than without them.	.71			.39
I find that using digital technology makes learning easier and more efficient.	.67			.52
I am eager to use new digital technologies in my learning.	.65			.35
I know that digital technology enables me to understand the topics I learn better.	.60			.26
I see digital technology as a useful tool to help me with my learning.	.53			.58
I ensure that digital technology allows me to be creative in my learning.	.38			.43
I navigate digital technology swiftly and easily when learning.		.87		.40
I understand that digital technology is constantly developing and I easily adapt to the changes.		.75		.39
I customize digital technology to suit my own learning needs.		.72		.35
I understand how to use the appropriate digital technology for different learning tasks.		.62		.55
I manipulate the format of the information using digital technology when learning.		.52		.44
I use digital technology to manage several tasks at once when learning.		.46		.34
I know how to find my own solutions to the problems I encounter using digital technology in my learning.			.81	.46
I ensure that digital technology does not distract me from my learning.			.68	.38
I know how to use digital technology in my learning without being distracted.			.68	.63
I think carefully about the most efficient way to use digital technology before engaging in a learning task.			.55	.36
I make decisions about which digital technologies are useful or not useful to me in my learning.			.54	.53
I conduct myself in an ethical and responsible manner when using digital technology in my learning.			.49	.57
I use digital technology to help me stay organized and monitor my learning.			.42	.52

Note. Factor loadings < .3 are suppressed

Appendix B
Tech-savvy Scale

Name:..................................**Grade:**.............**Gende**r: M / F

Instructions: The following items assess how you use digital technology in your learning. Read each item carefully and respond using the scale provided. Circle the number that most closely describes your use of digital technology.
While answering questions think about how you generally use digital technology in your day-to-day learning (PCs, laptops, tablets, etc).

ALL YOUR ANSWERS ARE CONFIDENTIAL

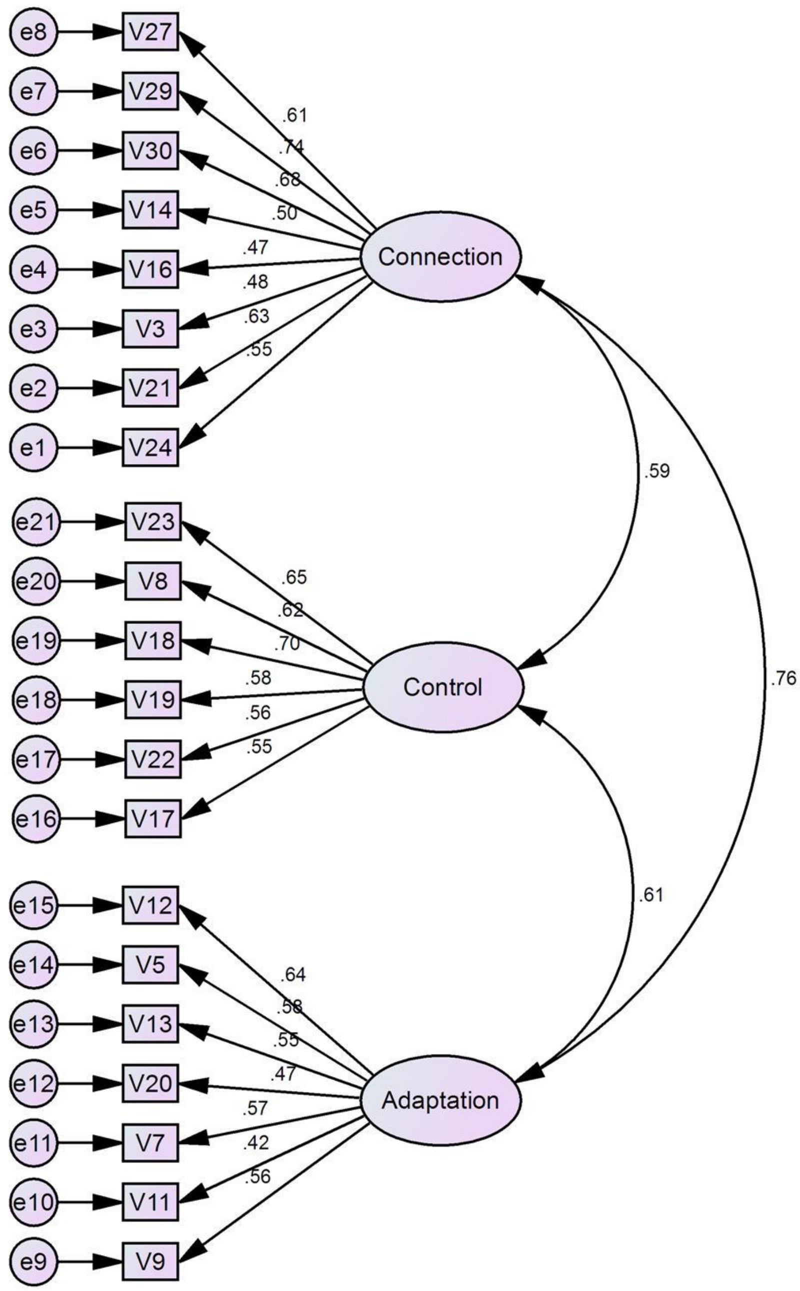
	Strongly Agree	**Somewhat Agree**	**Somewhat Disagree**	**Strongly Disagree**
1. I communicate using digital technology in order to enhance my learning.	4	3	2	1
2. I use digital technology to connect and collaborate with others when learning.	4	3	2	1
3. I prefer to learn using digital technologies than without them.	4	3	2	1
4. I find that using digital technology makes learning easier and more efficient.	4	3	2	1
5. I am eager to use new digital technologies in my learning.	4	3	2	1
6. I know that digital technology enables me to understand the topics I learn better.	4	3	2	1
7. I see digital technology as a useful tool to help me with my learning.	4	3	2	1
8. I ensure that digital technology allows me to be creative in my learning.	4	3	2	1
9. I navigate digital technology swiftly and easily when learning.	4	3	2	1
10. I understand that digital technology is constantly developing and I easily adapt to the changes.	4	3	2	1
11. I customize digital technology to suit my own learning needs.	4	3	2	1

Cont. Appendix B

12. I understand how to use the appropriate digital technology for different learning tasks.	4	3	2	1
13. I manipulate the format of the information using digital technology when learning.	4	3	2	1
14. I use digital technology to manage several tasks at once when learning.	4	3	2	1
15. I know how to find my own solutions to the problems I encounter using digital technology in my learning.	4	3	2	1
16. I ensure that digital technology does not distract me from my learning.	4	3	2	1
17. I know how to use digital technology in my learning without being distracted.	4	3	2	1
18. I think carefully about the most efficient way to use digital technology before engaging in a learning task.	4	3	2	1
19. I make decisions about which digital technologies are useful or not useful to me in my learning.	4	3	2	1
20. I conduct myself in an ethical and responsible manner when using digital technology in my learning.	4	3	2	1
21. I use digital technology to help me stay organized and monitor my learning.	4	3	2	1

Appendix C

Path Diagram for Standardized Estimates for the 21 Items of the Tech-savvy Scale (N=336)



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