Digital Skills at Divine Word University, Papua New Guinea

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Abstract

The purpose of the study was to investigate the level of digital skills within a group of university students in Papua New Guinea and their ability to meaningfully engage within the digital world. The study also aimed to explore whether the traditionally recognized digital divide continues between genders and place of origin, and between years of study and faculties. This study utilizes the framework defined by Van Deursen and Van Dijk who identify operational, formal, information and strategic skills. The study measured the internet skills of students by asking 289 participants to complete sixteen assignments on the internet. The results indicate that, on average, the tasks were completed as follows: 38% of operational skills, 13% of formal internet skills, 30% of information skills and 28% of strategic internet skills. Age and gender were not significant; however, performances were significantly different for students from the capital city as compared to those coming from a rural town or village environment, and performance improved as students moved through the four years of university training. Differences in groups from specific faculties are significant but require further study to explain. If operational and formal skills are a necessary (but not sufficient) condition for performance of higher-level information and strategic skills, then tertiary institutions, particularly those facing the effects of the digital divide, will need to ensure that those necessary skills are provided for. Having ensured digital competency at that level, further efforts can be made to develop information and strategic skills to ensure a meaningful and creative use of digital technologies.

Keywords: digital skills, digital literacy framework, university, developing country, Papua New Guinea

The internet provides an endless source of information and entertainment, and also has the potential to empower individuals to realize their educational and professional development. However, just having access to Information Communication Technologies (ICTs) does not mean people are making use of them. Many people have access to these technologies, but they lack the skills to use them properly or the motivation to engage with them. Realising the importance of the internet involves not simply monitoring the number of citizens subscribed to an internet plan, but also assessing the patterns behind usage and skills such as production of meaningful content, and engagement with technology or the benefits obtained from it (Fuchs & Horak, 2008; Godhe, 2019; Spante et al., 2018). Hence, digital skills are not simply functional technological skills, but also the ability to find and select digital information, and the knowledge essential for people to become "critical consumers" (Ameen & Gorman, 2009, p. 99) of that information.

Research for this paper began as a study of the so-called "digital divide" whereby new technologies open a gap between those who can access these technologies and those who cannot. Societal digital divides are those between citizens with and without formal education and between rural and urban populations in their relation to technology. However, physical access alone, without proper skills and adequate policies, is not enough to achieve the full benefits of ICTs (Acilar, 2011; Chetty, Qigui, et al., 2018; Halford & Savage, 2010; Jin & Cheong, 2008). For this reason, nowadays many researchers expand the initial area of research, based on access and hardware, and introduce the so-called "second divide", referring to the different level of skills that allow users not only to access technology, but to make a fruitful and effective use of it (Chetty, Qigui, et al., 2018; Lesame, 2013; Selvyn, 2004; van Deursen et al., 2014).

The second divide, goes hand in hand with the term "digital literacy", a new indispensable set of skills that allows users to take profit of and perform efficiently in digital environments (Eshet-Alkalai, 2004). It can be said that digital literacy is "as important as reading and writing were in earlier centuries" (Katz, 2007, p. 4). In 2009, the ICT Development Index was established with the intention that it become a tool to measure the level of ICT adoption and advancement of a country and to contribute to adequate policy-making (Ayanso et al., 2011). However, it has not been used uniformly and, for the purpose of our study, it does not provide data for the country of Papua New Guinea. In order to start developing a base of reliable data on the specific characteristics of the digital literacy in Papua New Guinea, our team decided to undertake a practical study to assess the digital skills of university students at the Madang campus of Divine Word University.

Measuring Digital Skills

Given the importance of the digital skills for success in higher education as well as future participation in the digitized world, substantial efforts have been made by researchers to develop methods of measuring what has been termed "digital literacy". Researchers approach the issue from various perspectives. Reynolds (2016) observes that digital literacy often relates to the extent of technology usage and thus measuring of digital literacy focuses on practical skills. However, with the fast-changing technology, as well as with more exposure of the young generation to technology and its practical application in everyday activities, measuring digital skills has evolved in new directions to capture more complex functions and uses of technology. The changing landscape of research done on digital skills is presented in Table 1, which gives the example of four different approaches to measuring digital skills.

Table 1: Four approaches to measuring digital skills

Four steps in digital inclusions (Livingstone & Helsper, 2007, p. 10)	**Six-skills of digital literacy model (Eshet-Alkalai, 2004, 2012)**	**Four types of digital literacy skills (van Deursen & van Dijk, 2008, p. 4)**	**Digital competencies framework (Alvarez-Flores, et al., 2017, p. 545)**
Information seeking: using the internet for information finding purposes	Photo-visual digital skill: ability to use graphical user interface	Operational skills – the skills to operate digital media	Information – competency in browsing and filtering data, evaluating and storing data and feedback
Games and emails: using the internet for information, entertainment and communication	Reproduction digital skill – ability to use, edit and manipulate different forms of files to produce new ones	Formal skills – the skills to handle the structures of digital media	Communication – competency in interaction and sharing through digital technologies, participation and collaboration through digital media and managing digital identities
Instant messaging and downloading music: using the internet for the purposes described in steps 1 and 2, and expanding use for peer-to-peer engagement	Branching digital skill – ability to navigate through hyperspace in both non-orderly and non-linear ways.	Information skills – the skills to locate information in digital media	Content creation – competency in developing, integrating and re-elaborating digital content, copyrights and licenses and in programming
Using the internet for all previous steps activities and for a wide range of interactive and creative uses.	Information digital skill – ability to critically evaluate online information	Strategic skills – the skills to employ the information contained in digital media towards personal (and professional) development	Safety – competency is protecting devises and data, protecting health, well-being and environment
	Socio-emotional digital skill - ability to communicate effectively to create and share knowledge online		Problem solving – competency in solving technical problems, creatively using digital technologies and identifying digital competence needs
	Real-time digital skill (added by Eshet in 2012) – ability to effectively execute different tasks simultaneously		

Although authors identified different stages in the process of engagement with technology, they all point out the gradual evolution of the skills from the simple use of graphical user interface and searching for information, to critical analysis of the information found, to more complex tasks of using this information in order to create new digital artefacts and share them with other online users.

While researching the digital divide among young people, Livingston and Helsper (2007) identified four steps in digital inclusions which led them to categorizing young online users into four categories: "basic users", "moderate users", "broad users" and "all-rounders" (p. 10). These categories of users reflect a staged process of going online: from simple information seeking (basic users), to using the internet for information, entertainment, and communication, to expanding online activities to peer-to-peer engagement. The final stage includes a broad variety of interactive and creative uses. The authors support the widespread assumption that "basic use makes for a narrow, unadventurous, even frustrating use of the internet, while more sophisticated use permits a broad-ranging and confident use of the internet that embraces new opportunities and meets individual and social goals" (p. 14).

Based on the notion that engagement with technology involves more than mere ability to use a digital device, Eshet-Alkalai (2004) proposes to evaluate digital skills through five-skills of a digital literacy model. To function effectively in the digital world, he observes, it requires a "variety of complex cognitive, motor, sociological, and emotional skills" (p. 93). Thus, he proposes a five-skills digital literacy framework, later (in 2012) extended into a six-skills literacy framework. The proposed list of skills (photo-visual; reproduction; branching; information; socio-emotional; and real-time) are claimed to be "survival skills" in a digitalized world (Eshet-Alkalai, 2012, pp. 268–272) including in the context of today's higher education (Komlayut & Srivatanakul, 2017).

In relation to measuring digital skills, Ilomäki, et al. (2016) observe that in policy related papers, the term "skills" has been replaced by the term "competencies" (p. 655). Various papers make an attempt to propose the digital competencies that are required from those who enter and function in the digital world (Gašová et al., 2018; Iordache et al., 2017). Included in Table 1 is a digital competencies framework developed by (Álvarez-Flores et al., 2017).

Van Deursen and Van Dijk (2008) observed that the models and framework available to measure digital skills were more on a conceptual level, which may contribute to a lack of consistency among researchers in their approaches to measuring digital skills. Thus, the authors have made an attempt to move from the conceptual to the operational level. In their description of the four types of digital skills they provided "operational definitions for operational, formal, information and strategic skills, the measurements, and sample procedures" (p. 5). For each of the type of skills, Van Deursen and Van Dijk provide measurement indicators. The first three types of skills are related to an effective use of the internet. The indicators for operational skills include skills in operating an internet browser, operating an online search engine and completing online forms. To measure formal skills, the indicators include skills in navigating the internet through hyperlinks, and maintaining a sense of location while navigating the internet. The information skills are measured by locating required information by choosing an appropriate search system, or website, ability to define search queries, selecting information from search results, and evaluating information for accuracy of data and the reliability of the sources. The strategic skills are related to the purpose of the internet use and therefore involve the skills to use the networks' sources to achieve a specific goal as well as improve one's status in the society. To measure the strategic skills, the set indicators are: Taking advantage of the

internet by setting a particular goal, making the decision and taking the appropriate action to achieve the goal, and gaining the benefits belonging to this goal (pp. 5–9).

The framework used by Van Deursen and Van Dijk was to measure the internet skills of Dutch citizens. The results show that although the Dutch population has a high level of operational and formal internet skills, the level of information and strategic skills is much lower. The authors concluded that surveys measuring only operational and formal skills may not reflect actual digital skills of the researched population.

Our study adopted Van Deursen and Van Dijk's framework. The main factors influencing our selection of the framework were the specificity and detailed indicators developed for each of the type of digital skills, and the practicality of the proposed research setup.

Digital Skills in the Papua New Guinea Context

For decades, the Papua New Guinea (PNG) Government has understood that command and control of ICT is one of the keys to successful participation in the global digitalized world. Thus, to ensure that the entire nation benefits from access to services provided through ICT, the government established a Department of Information and Communication in mid-1992. Since then, although a number of policies and regulations were put in place, many attempts to implement them were unsuccessful. Various barriers were identified, including the ad hoc way of mounting projects resulting in incompatible systems being installed (Vaa, 2003), the diversity of the cultural and linguistic landscape, and the difficult geographical terrain (Henao, 2004). However, the government remains committed to strengthening the capacity and accessibility of ICT across the entire country (Department of National Planning and Monitoring, 2010). In its vision, the government expects the higher education sector to be able to prepare a skilful workforce prepared for the 21st-century work market. In line with the PNG Development Strategic Plan 2010-2030, the Department of Education (2016) plans to provide ICT training for all school teachers and for teaching ICT skills in primary and secondary schools. The new curriculum for upper secondary schools (Department of Education, 2008) introduces a Computer Studies program. In addition, the Department envisions establishing and maintaining successful e-learning infrastructure. However, despite ambitious plans, a majority of the student population, especially in rural areas, has no or little access to ICT (Department of Education, 2019; Leh & Kennedy, 2004; Ravinder, 2011; Trucano, 2014).

The higher education sector in PNG has a longer history of technology presence. Already in 1990, when there were only 250 internet users in the country, the internet was accessed at the University of Technology in Lae (Kolodziejczyk, 2012). Since then, the application of ICT in higher education institutions varied with generally much higher exposure to technology at universities than at colleges. However, as found by Kolodziejczyk, staff and students at all institutions of higher education recognize technology as an important factor contributing to success in teaching and learning as well as for a future professional career. In the same line, the recent assessment of the PNG graduate labour market (Salonda et al., 2017) shows that digital competency is recognized as one of the most important skills of university graduates.

Understanding the importance of digital skills for successful learning at the tertiary level (Gazi, 2016; Jiménez-Cortés et al., 2017; Komlayut & Srivatanakul, 2017) as well as the demand for graduates equipped with digital skills (Chetty, Aneja, et al., 2018; Gašová et al., 2018; Ilomäki et al., 2016), this research focuses on measuring the current digital skills of students at one of the universities in PNG. Better understanding of the level of student digital competency may

advise teaching and learning strategies towards strengthening and developing skills that will prepare students to function in digitalized environments.

Research Design

The research was inspired by the study of Van Deursen and Van Dijk (2008) on internet skills and the digital divide of the Dutch population. The objective was to investigate the level of digital skills within a group of university students in PNG and their ability to meaningfully engage within the online world. The study also aimed to explore whether the traditionally recognized digital divide continues between genders and place of origin, and between years of study and faculties. For these reasons, the study was guided by two main research questions:

> Q1: What are the levels of operational, formal, information and strategic digital skills of undergraduate students at the Madang Campus of Divine Word University?
> Q2: Are there statistically significant differences among the categories of gender, age, faculty of study, year of study, and residency (capital city, town or village)?

For comparability reasons, our study employed a similar approach to Van Deursen and Van Dijk and used the quantitative method. Prior to the completion of internet-based assignments, the participants were required to fill in a short questionnaire which collected socio-demographic information such as gender, age, faculty, year of study, and former place of residence before joining the university. Residence was considered significant because PNG has only one city, the capital Port Moresby, with a population approaching half a million. There are provincial towns, varying in size. However, the majority of the population live in small villages, many of which are isolated, without electricity or modern amenities.

The tasks to be completed on the internet were prepared following the description of four types of digital skills as defined in the original study:

- Operational skills – the skills to operate digital media
- Formal skills – the skills to handle the structures of digital media
- Information skills – the skills to locate information in digital media
- Strategic skills – the skills to employ the information contained in digital media towards personal (and professional) development (van Deursen & van Dijk, 2008, p. 4).

A total number of 16 assignments were devised to measure various digital skills. Time was allocated to complete each of the assessments. It required a total of 88 minutes to complete all tasks. All activities done on the internet were screen recorded for coding and analysis using Active Presenter software.

For the purpose of the study a special computer lab was set up with 30 brand new laptops with the same setup to ensure that all students were given the same tools. All computers were connected to the university's network. To complete their tasks, students could choose from the three popular web browsers (Mozilla Firefox, Internet Explorer and Chrome). After each group completed the session, temporary files, browser history, favourites, cookies, and computer storage and passwords were deleted to ensure that the next group work was not affected by previous participants' actions.

In line with the quantitative nature of the study, appropriate sampling was used. To achieve a representative sample of the student population, the researchers randomly selected 12 groups from among three faculties. For randomization, all group names were written on a piece of paper and a lottery done in each of the faculties at different levels: year one, two, three, and four. Two departments from within the Faculty of Business Studies and Informatics were excluded from the selection process, Information Systems and Maths and Computing, as their extensive experience with technology compared to others may have affected the results. All selected groups were approached and invited to take part in the study. All were informed about the voluntary nature of participation; a few students declined participation and left the lab during a session. A total of 289 students took part in the study which is considered an adequate number for a population of approximately 1400 to ensure valid results for quantitative analysis.[1] More detailed socio-demographic information about participants is presented in Table 2.

Table 2: Socio-demographic profile of the study participants

Gender	Female	159 (55%)
	Male	129 (45%)
Faculty	Arts and Social Sciences	125 (43%)
	Business and Informatics	66 (23%)
	Health and Medical Sciences	97 (34%)
Year of study	First year	73 (25%)
	Second year	78 (27%)
	Third year	86 (30%)
	Fourth Year	51 (18%)
Place of origin	Capital city	67 (23%)
	Town	158 (55%)
	Village	63 (22%)

The study obtained ethical clearance on April 4, 2017 from the Faculty of Arts and Social Sciences Ethics Committee (ID# FASS/FS/3/2017).

Study results

As indicated earlier, the purpose of the study was twofold: to create a profile of digital skills level among tertiary students and at the same time to explore possible digital divides along five variables: gender, age, faculty, year of study, and residency. After the general overview of completion of tasks in each of the digital skills category, the following sections present more detailed analysis of each of the four categories measured.

General Overview

Different types of digital skills were measured in four categories: Operational skills (9 tasks completed); Formal skills (2 assignments); Information skills (3 assignments); and Strategic skills (2 assignments). The completion of tasks was recorded as: 1 = not completed; 2= partially completed; 3= completed. As expected, the highest percentage of task completion was in the lowest category – operational skills (38%). However, the most difficult for students to complete were tasks in the formal skills category with only 13% of all tasks completed (Table 3).

[1] We note the issues with the internet connection in the time students were involved in completing research tasks and periodic unavailability of one of the government websites. In such cases, the affected results were not included in statistical analysis.

Table 3: General summary of completion of tasks in four categories of digital skills

	Completion of tasks		
	Mean (M)	Standard Deviation (SD)	% of tasks completed
Operational tasks (9)	2.04	.814	38
Formal tasks (2)	1.64	.661	13
Information tasks (3)	1.68	.816	30
Strategic tasks (2)	1.64	.886	28

Operational Tasks

The results of a linear regression test indicate that faculty and year of study are the main predictors of the level of operational skills.

Table 4: Linear regression of results of the number of operational tasks completed

	Number of tasks completed		
	Beta	t	Sig.
Gender	.087	1.562	.120
Age	-.088	-1.537	.126
Faculty	.136	2.441	.015
Year of study	.386	6.783	.000
Place of residency	-.075	-1.341	.181
R^2 F		.154 11.449	p<.001

The ANOVA test[2] shows that among three faculties, students from the Faculty of Medical Sciences score highest in completion of operational tasks ($F(2)=4.66$, $p=.01$).

Table 5: ANOVA results for the operational skills category as completed by students in three faculties

	Number of tasks completed		
	M	SD	% of all tasks
Arts and Social Sciences	3.33	2.74	37
Business and Informatics	3.10	2.87	34
Health and Medical Sciences	4.22	2.18	47

When analysed by year of study, the ANOVA results (Table 6) show that students in the fourth year score highest on completion of operational skills with the lowest results for students in the first year of study ($F(3)=15.391$, $p<.001$).

[2] ANOVA test (or analysis of variance test) is used to decide whether the differences between means of observations is due to chance or whether there are systematic effects that have caused scores of observations in one or more groups to be statistically significantly different.

Table 6: ANOVA results for number of operational skills tasks completed by students at different levels of university study

	Number of tasks completed		
	M	SD	% of all tasks
First Year	2.34	2.40	26
Second Year	2.96	2.69	33
Third Year	4.52	2.27	50
Fourth Year	4.67	2.45	52

Formal Skills

The results of linear regression test indicate that three main predictors of the level of formal skills among participating students are year of study, place of residence and faculty.

Table 7: Linear regression of results of the number of formal tasks completed

	Number of tasks completed		
	Beta	t	Sig.
Gender	-.038	-.663	.508
Age	-.080	-1.380	.169
Faculty	-.163	-2.861	.005
Year of study	.239	4.110	.000
Place of residency	-.187	-3.275	.001
R^2		.133	
F		8.642	.000

The ANOVA test shows that among students at different years of study, students in the fourth year score the highest in completion of formal skills ($F(3)=7.905$, $p<.001$). The significance effect is caused by the group of first year students whose results significantly differ from the other three groups (Table 8).

Table 8: ANOVA results for number of formal skills tasks completed by students at different levels of university study

	Number of tasks completed		
	M	SD	% of all tasks
First Year	.05	.23	2.5
Second Year	.35	.53	17.5
Third Year	.27	.45	13.5
Fourth Year	.39	.49	19.5

The ANOVA test shows that among students who came from a different residential background (lived either in capital city, town or village prior to their study at university), students who lived in the capital city score the highest in completion of formal skills ($F(2)=8,614$, $p<.001$). The significance effect is caused by the group of students who lived in the village whose results significantly differ from the other two groups (Table 9).

Table 9: ANOVA results for number of formal skills tasks completed by students coming from different residential backgrounds

	Number of tasks completed		
	M	SD	% of all tasks
Capital city	.45	.530	22.5
Town	.23	.436	11.5
Village	.14	.353	7

The ANOVA test (Table 10) shows that among students in different faculties, students from the Faculty of Business and Informatics score significantly higher in completion of formal skills that from other faculties ($F(2)=14.038$, $p<.001$). The significantly lower scores were recorded among students in the Faculty of Health and Medical Sciences.

Table 10: ANOVA results for number of formal skills tasks completed by students in different faculties

	Number of tasks completed		
	M	SD	% of all tasks
Arts and Social Sciences	.26	.442	13
Business and Informatics	.47	.561	23.5
Health and Medical Sciences	.10	.306	5.1

Information Skills

The results of linear regression test (Table 11) indicate that the two main predictors of the level of information skills among participating students are year of study and place of residence.

Table 11: Linear regression of results of the number of information tasks completed

	Number of tasks completed		
	Beta	t	Sig.
Gender	-.017	-.299	.765
Age	-.044	-.734	.463
Faculty	-.016	-.275	.783
Year of study	.182	3.036	.003
Place of residency	-.193	-3.258	.001
R^2		.075	
F		4.564	.001

The ANOVA test (Table 12) shows that scores of information tasks completion differ significantly ($F(3)=4.727$, $p<.003$) among students at different levels of study with students from first year scoring significantly lower than other groups.

Table 12: ANOVA results for number of information skills tasks completed by students at different levels of university study

	Number of tasks completed		
	M	SD	% of all tasks
First Year	.59	.683	19.7
Second Year	.97	.772	32.3
Third Year	1.0	.826	33.3
Fourth Year	.98	.836	32.7

The ANOVA test shows that among students who came from different residential backgrounds (lived either in the capital city, town, or village prior to their study at university), students who lived in the capital city score the highest in completion of information skills ($F(2)=7.277$, $p<.001$). This effect is caused by the group of students who lived in the village whose results significantly differ from the other two groups (Table 13).

Table 13: ANOVA results for number of information skills tasks completed by students from different residential backgrounds

	Number of tasks completed		
	M	SD	% of all tasks
Capital city	1.0597	.73610	35.3
Town	.9430	.82357	31.3
Village	.5714	.68895	19

Strategic Skills

The results of linear regression test (Table 14) indicate that faculty is the only predictor of the level of strategic skills among participating students.

Table 14: Linear regression of results of the number of strategic tasks completed

	Number of tasks completed		
	Beta	t	Sig.
Gender	-.107	-1.814	.071
Age	-.042	-.687	.492
Faculty	-.135	-2.266	.024
Year of study	.069	1.135	.257
Place of residency	-.109	-1.820	.070
R^2		.057	
F		3.404	.005

The ANOVA test (Table 15) shows that students in the Faculty of Business and Informatics scored significantly higher in completion of strategic skills than from other faculties ($F(2)=9.234$, $p<.001$). This effect is caused by the group of students in the Faculty of Health and Medical Sciences whose results significantly differ from the other two groups.

Table 15: ANOVA results for number of strategic skills tasks completed by students in different faculties

	Number of tasks completed		
	M	SD	% of all tasks
Arts and Social Sciences	.57	.639	28.5
Business and Informatics	.80	.706	40
Health and Medical Sciences	.38	.509	19

Discussion

The study objective was twofold; firstly, to investigate the levels of operational, formal, information and strategic digital skills of undergraduate students at the Divine Word University in Madang Campus; secondly, to explore any statistically significant differences among the categories of gender, age, faculty of study, year of study, and residency.

As mentioned earlier, the study used the framework from a previous research study in The Netherlands (van Deursen & van Dijk, 2008). We note the completion rate in our PNG study of tasks across all four categories, operational, formal, information and strategic is 39, 13, 29 and 28 percent as compared with 80, 72, 62, 22 percent respectively in The Netherlands study.

As reported, the highest percentage of completed tasks was in the lowest category – operational skills (38%). In this category students were expected to navigate an internet browser, operate an online search engine and complete an online form. Most of the students were able to complete successfully the two initial tasks while the latter task proved the most difficult with only 3% completing it. Van Deursen and Van Dijk (2008) pointed to a positive correlation between internet experience and operational skills. This may explain why students in PNG found it difficult to complete tasks in this category. Comprehensive study of e-government services in PNG conducted by Daniel (2020) concluded that the majority of the government websites operate on an emerging level with only basic one-way communication available to those who use their service; only one-third (about 34%) of the services provided were improved one-way (e.g. forms for manual completion) and simple two-way communication (e.g. contact forms and search facilities). Consequently, Daniel observed that the majority of citizens use services at an emerging level. The demonstrated pattern of internet skills reflects Daniel's observation: students were able to navigate websites successfully but only few were able to engage in some form of communication with the service provider.

In the formal skills category, the students were expected to navigate through internet websites by recognizing and using tabs and hyperlinks without getting disoriented and locating similar information in different website layouts. Unexpectedly, students did not perform well with only 13% completion across all tasks in this category. The most difficult task involved identifying physical addresses of four organizations in the capital city. It should be noted that there is no postal service to physical addresses in PNG. This may help explain why only students from the capital city, who knew the physical location of the organizations, were able to complete the task. None of the students from a rural village background completed the task successfully indicating that life experience could be a significant factor in their ability to complete the digital task.

The information skills category required students to choose appropriate websites to seek information. One-third (30%) of students were able to complete all the tasks successfully. The strategic skills category required students to define search queries and select proper resources. Almost one-third (28%) of students completed successfully all tasks in this category. We note that the results in these two categories were almost as high as in operational skills and much higher than in formal skills. The results in our study in these two categories show a different trend from The Netherlands study where higher level of skills showed a lower level of completion. The observed converse trend of successful completion of tasks in the two studies indicates that long exposure to the internet as in The Netherlands, may well contribute to the operational and formal skills but is insufficient for successful completion of information and strategic skills. In PNG, where the exposure to the internet is much shorter, students in the university setting were better able to complete tasks that require intellectual skills. Our observation remains in line with other studies, which found that the time spent on the internet has a weak relation with the level of internet skills and influences only operational and formal skills (van Deursen et al., 2011) while educational level shows a relevant impact on the ability to solve complex information and strategic tasks on the internet (Godhe, 2019; Gui & Argentin, 2011; Kim, 2019; Passey et al., 2018).

Considering the second objectives, whether there are statistically significant differences among the categories of gender, age, faculty of study, year of study, and residency, in both places The Netherlands and PNG there is no significant gender difference. Age did not feature in the significance tests for PNG, possibly because all the participants were between 18 and 29 years of age.

Considering the year of study, the results demonstrate that the year of study positively correlates with successful completion of tasks in three categories (Tables 4, 7, and 11). It was particularly obvious with only 2% of year one students completing formal skills tasks.

Turning now to the two remaining categories of residency and faculty we note how the PNG study distinguished between those who came from the capital city, Port Moresby, those who came from provincial or rural towns, and those from rural villages. This appears to be a significant predictor, at least for formal and informational skills. It follows that those from more isolated environments will have less exposure to the digital world and be on the disadvantaged side of the digital divide.

Similarly, of interest is the significance of Faculty as a predictor in three of four skills for the PNG students. It may be expected that students in the Faculty of Business Studies and Informatics might have better developed digital skills, but this was apparent only in formal and strategic skills (Tables 10 and 15). Further study may shed light on why Faculty of Health and Medical Sciences students should score so well in operational skills and so poorly on strategic skills.

Conclusion

Digital literacy is important in education, particularly tertiary education. Duncan-Howell (2012) has researched the nature of the digital competency exhibited by undergraduate students in an Australian University. She found that they had a high level of “digital comfort” but that did not necessarily translate from consuming content to creating content. She concluded that there is a strong need in higher education “for meaningful use of digital technologies as learning

tools and the development of digital professional skills within programs that is beyond the current practice of being limited to LMS use and email" (p. 838).

At a polytechnic tertiary institution in Singapore, students were found to be not well acquainted with a range of information search strategies and techniques that would enable them to search effectively for information (Laxman, 2009). Laxman proposes school programs that would enable students to become information literate and more able to fully utilize the educational computing potential of the internet in developing vibrant, independent learning environments.

The four levels of digital literacy skills from Van Deursen and Van Dijk (2008), provide ways of refining our understanding of digital competency so that we can identify and focus on skills that need attention. With only 38% of operational tasks and 13% of formal tasks completed in the PNG study, we cannot conclude as in The Netherlands that such skills will be learned simply by practice. Effects of the first digital divide mean that many first year students come to university with limited practice and consequently face a steep learning curve.[3] Our research points to the need for training and formal schooling right from the first year of tertiary education in PNG, since a good number of students will come with little prior experience. Divine Word University meets a felt need by giving a laptop to every new fully registered student and providing formal coursework in use of computers and the internet in their first semester at the university. The effect of such training may be seen in the relative improvement between first and second years shown in Table 8. If, as Van Deursen and Van Dijk (2008) conclude, that "operational and formal skills are a necessary (but not sufficient) condition for performance of information and strategic skills" (p. 19), then tertiary institutions, particularly those facing the effects of the digital divide, will need to ensure that those necessary skills are provided for. Having ensured digital competency at that level, further efforts can be made to develop information and strategic skills so as to make a meaningful and creative use of digital technologies.

[3] Since 2003, Divine Word University offers to all year one students a compulsory unit *Introduction to End-User-Computing and Word* that introduces students to the concept of the internet and usage of WWW, issues in end-user-computing, and basic and intermediate level skills in MS Word.

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