International Journal of Scientific Engineering and Science
Volume 4, Issue 5, pp. 46-51, 2020. ISSN (Online): 2456-7361

What Generation Z Knows About Emerging Technologies and Technological Risks: Views of Japanese and Filipino Students

Dave E. Marcial
College of Computer Studies, Silliman University, Dumaguete City, Negros Oriental, 6200 Philippines

***Abstract*—*This paper describes the views of Generation Z about emerging technologies and the associated risks. Specifically, it presents the level of familiarity with the twelve key emerging technologies among Japanese and Filipino students. Likewise, it presents the likelihood level of the emerging technologies to bring positive and severe adverse consequences within the next ten years as perceived by the respondents. The study was descriptive using random sampling. Fifteen students were selected in a Japanese school and 19 students in a Philippine school. An online survey questionnaire was utilized, which was based on The Global Risks Report 2017. The result shows that the Filipino respondents are better in terms of the aggregate mean of the familiarity level with the emerging technologies (moderately familiar, $\bar{x}$ = 3.60) than the Japanese respondents (somewhat unfamiliar, $\bar{x}$=2.81). The result shows that both groups of respondents have the same likelihood level of positive benefits of the technologies in the next ten years. It has an aggregate mean of 4.83 for Japanese and 4.84 for Filipino students, described as somewhat likely. The result shows that the Filipinos perceived a higher likelihood that these technologies would provide severe negative consequences to society in the next ten years, with a mean of 3.76. The study concludes that Filipino students have a better familiarity but have a higher regard for the negative consequences than the Japanese students. Both students have the same beliefs that technology can bring positive benefits within the next ten years. There should be an advocacy program on digital citizenship in both universities.*

***Keywords*—*ICT in education, computer ethics, technological risks, emerging technologies, eLearning*.

I. INTRODUCTION

Generation Z, as described by the Pew Research Center, are those who were born from 1997 onward [1]. This newest generation, after millennials, is known to be highly adept at technology and has been raised on the internet and social media [2]. This group of individuals is considered as the highest user of a smartphone [3]. They are also known as Gen Z, iGen, or centennials [2].

Generation Z, shortly called as Gen Z, is generally highly familiar with recent technologies. This generation "favors more personal, immediate social platforms like Snapchat rather than broadcasting their lives widely and publicly for all to see through the like of Facebook and Twitter," according to Austin-based research firm Center of Generational Kinetics (cited in [4]). In a global survey, 96% of this youngest group "owns a smartphone and spend around 6 hours a day online" [5]. In the same global survey (cited in [6]), result shows that a) 97% said that technology literacy matters, b) 98% experienced technology as a platform in their formal education, c) 91% said that technology offered by an employer a factor in taking the job, and d) 80% said that technology and automation would make work environments more equitable. Further, it reported that "Gen Z wants to work with cutting-edge technology" [6].

The 2017 Global Risks Report of the World Economic Forum [7] reported 12 emerging technologies. These are 3d printing, blockchain, and distributed ledger, neurotechnologies, new computing technologies, advanced materials and nanomaterials, space technologies, geoengineering, ubiquitous linked sensors, biotechnologies energy capture, storage and transmission, virtual and augmented realities, and artificial intelligence and robotics. The description of each technology is found in Table 1.

TABLE 1. Emerging Technology [1]

Technology	Description
3D printing	Advances in additive manufacturing, using a widening range of materials and methods, innovations include 3D bioprinting of organic tissues.
Advanced materials and nanomaterials	Creation of new materials and nanostructures for the development of beneficial material properties, such as thermoelectric efficiency, shape retention, and new functionality
Artificial intelligence and robotics	Development of machines that can substitute for humans, increasingly in tasks associated with thinking, multitasking, and fine motor skills.
Biotechnologies	Innovations in genetic engineering, sequencing, and therapeutics, as well as biological, computational interfaces and synthetic biology
Energy capture, storage, and transmission	Breakthroughs in battery and fuel cell efficiency; renewable energy through solar, wind, and tidal technologies; energy distribution through smart grid systems, wireless energy transfer, and more.
Blockchain and distributed ledger	Distributed ledger technology based on cryptographic systems that manage, verify, and publicly record transaction data; the basis of "cryptocurrencies" such as bitcoin.
Geoengineering	Technological intervention in planetary systems, typically to mitigate effects of climate change by removing carbon dioxide or managing solar radiation.
Ubiquitous linked sensors	Also known as the "Internet of Things." The use of networked sensors to remotely connect, track, and manage products, systems, and grids.
Neurotechnologies	Innovations such as smart drugs, neuroimaging, and bioelectronic interfaces that allow for reading, communicating, and influencing human brain activity.
New computing technologies	New architectures for computing hardware, such as quantum computing, biological computing, or neural network processing, as well as the innovative expansion of current computing technologies.
Space technologies	Developments allowing for greater access to and

	exploration of space, including microsatellites, advanced telescopes, reusable rockets, and integrated rocket-jet engines.
Virtual and augmented realities	Next-step interfaces between humans and computers, involving immersive environments, holographic readouts, and digitally produced overlays for mixed-reality experiences.

While it is reported that Gen Zers are technically adept, they are also highly exposed to technological risks. It was reported that "Gen Z cares about data security, but is unsure how to address it" [6]. This generation has high regard for privacy and confidentiality [8]. They are argued that when they enter the workplace, they could be the most self-aware and technologically risk-conscious workers [9].

Technological risk refers to any potential for technology failures to disrupt operations such as information security and service outrages [10]. It is described as "the repercussions of technology failure, or the potential for such a failure to disrupt business through software or hardware issues, security incidents, natural disasters, or simple human error" [11]. Among the many technological risks includes cyber-attacks, DoS attacks, security breaches, password theft, information security incidents, and others [12]. 2017 Global Risks Report of the World Economic Forum highlights four technological risks. These are a) adverse consequences of technological advances, b) breakdown of critical information infrastructure and networks, c) large-scale cyberattacks, d) massive incident of data fraud/theft. The description of each risk is found in Table 2.

This paper aims to explore the views of Generation Z on emerging technologies and technological risks. Specifically, this article presents the level of familiarity with the emerging technologies among students in the next ten years. It also describes the likelihood of these emerging technologies to bring significant benefits to the students. In the same manner, this paper describes the likelihood of these technologies to bring severe negative consequences to society. Further, this paper articulates the degree of awareness of technological risks as perceived by the respondents. The emerging technologies and technological risks presented in this paper are those listed by the World Economic Forum [7].

TABLE 2. Technological Risks and Its Description [7]

Technological Risks	Description
Adverse consequences of technological advances	Intended or unintended adverse consequences of technological advances such as artificial intelligence, geoengineering and synthetic biology causing human, environmental and economic damage
Breakdown of critical information infrastructure and networks	Cyber dependency that increases vulnerability to an outage of critical information infrastructure (e.g., internet, satellites, etc.) and networks, causing widespread disruption
Large-scale cyberattacks	Large-scale cyberattacks or malware causing large economic damages, geopolitical tensions or widespread loss of trust in the internet
Massive incident of data fraud/theft	Wrongful exploitation of private or official data that takes place on an unprecedented scale

II. METHODS

The study implemented a descriptive-correlative approach and utilized a survey method. The study was conducted in two private Christian universities in Japan and the Philippines. The Japanese school was selected primarily because this is the host school of the researcher while doing the fellowship program in Japan. On the one hand, the Philippine school was selected because it is the school where the researcher is teaching. There are 34 respondents in the study. Of the 34, 15 are Japanese students enrolled in the Sustainable Development course, and 19 are Filipino students enrolled in the Computer Fundamentals course. The respondents were randomly selected in the classroom. There are 13 (38%) males and 21 (62%) females.

An online survey questionnaire was formulated. The instrument comprised of close-ended questions were based on the 12th edition of the Global Risks Report of the World Economic Forum. The questionnaire has four parts. First, the respondents were asked to evaluate the level of their familiarity with the twelve (12) key emerging technologies based on the seven choices: 7 as extremely familiar and 1 as extremely unfamiliar. The second part is where the respondents were asked to evaluate the likelihood level of the emerging technology to bring positive benefits to society within the next ten years. Third, the respondents were also asked to evaluate the likelihood level of the emerging technology to bring severe negative consequences within the next ten years. Responses to both questions were according to the seven choices: 7 as extremely likely and 1 as extremely unlikely. The last part of the questionnaire is on the awareness level of the respondents of the four technological risks based on the seven choices: 7 as extremely aware and 1 as extremely unaware.

The data was collected in May 2017 in Japan and September 2017 in the Philippines. The levels of familiarity, likelihood, and awareness were measured using the weighted mean formula.

III. RESULTS

A. *Familiarity of Emerging Technologies*

The result shows that the Filipino respondents are better in terms of the aggregate mean of the familiarity level with the emerging technologies (moderately familiar, $\bar{x} = 3.60$) than the Japanese respondents (somewhat unfamiliar, $\bar{x}=2.81$), as shown in Figure 1. The result implies that Filipino students have 50% familiarity with the technologies. In comparison, Japanese students have 30% familiarity with the technologies presented. The most familiar technology among the Filipino respondents is the "Energy Capture, Storage and Transmission" and "Artificial Intelligence and Robotics" with a mean of 4.54. Notably, "Emerging Technologies" is one of the topics of the Computer Fundamentals course.

On the other hand, the Japanese respondents are moderately familiar with "Artificial Intelligence & Robotics" with a mean of 3.73, which is a little lower than with the familiarity mean level among the Filipino respondents. Surprisingly for a developed country like Japan, "Blockchain

and Distributed Ledger" is mostly unfamiliar among the students with a mean of 2.00. At the same time, "New Computing Technologies" is mostly unfamiliar among Filipino students ($\bar{x}$=2.68).

B. Positive Benefits vs. Negative Consequences of the Technologies in the Next 10 Years

As shown in Figure 2, the result shows that both groups of respondents have the same likelihood level of the perceived positive benefits of the technologies in the next ten years with an aggregate mean of 4.83 for Japanese and 4.84 for Filipino students, described as somewhat likely. The result implies that the students somewhat believed that the technologies would have a positive impact on society in the next ten years. The data shows that Japanese students viewed "Artificial Intelligence & Robotics" ($\bar{x}$=5.60), "Biotechnologies" ($\bar{x}$=5.40), and "Energy Capture, Storage and Transmission" ($\bar{x}$=5.53) as the emerging technologies that will provide considerable benefits to the society in the next decade. "Energy Capture, Storage and Transmission" ($\bar{x}$=5.37) and "Geoengineering" ($\bar{x}$=5.32) are the evolving technologies perceived by Filipino students to be highly constructive to humanity in the next ten years. On the contrary, "Geoengineering" and "Blockchain and Distributed Ledger" are the technologies that perceived by the Japanese students as least beneficial ($\bar{x}$=4.20). For Filipino students, "Artificial Intelligence & Robotics" ($\bar{x}$=4.11) is perceived to have the least benefits to society.

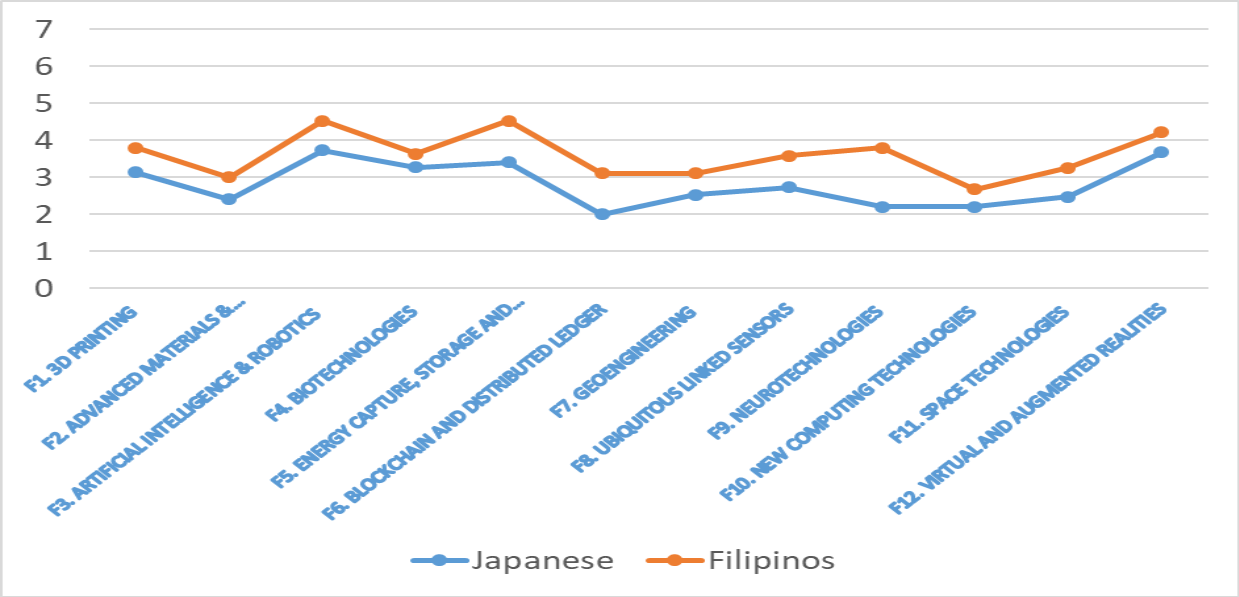

Figure 1. Level of familiarity of the twelve (12) key emerging technologies among the Japanese and Filipino students

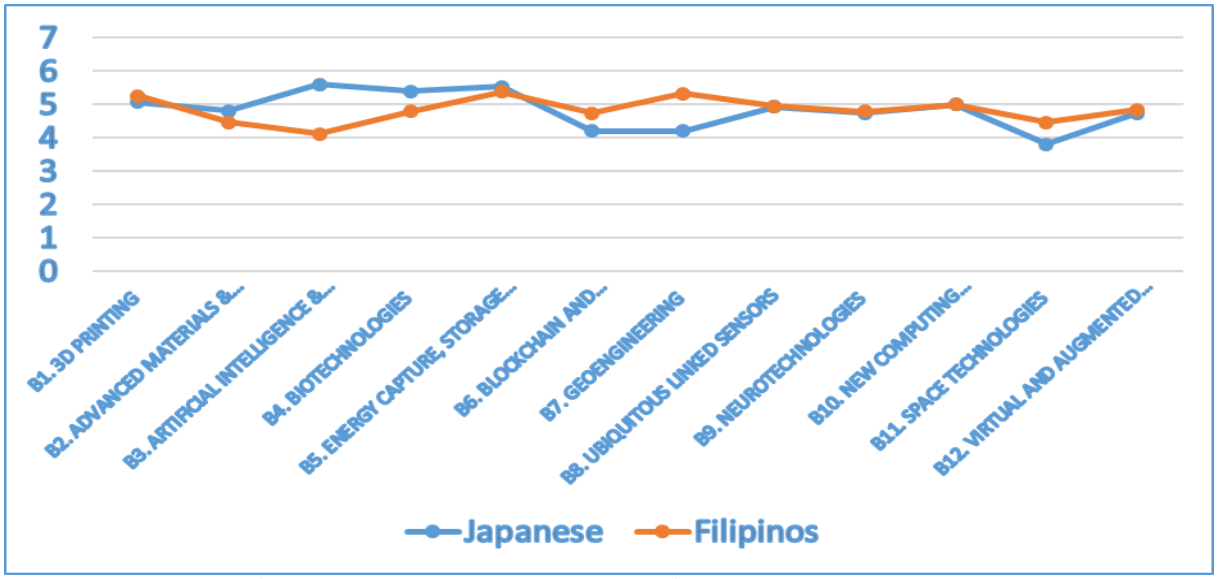

Figure 2. Likelihood level of the emerging technology to bring positive benefits to Japanese and Filipino students within the next ten years

In terms of the negative consequences of emerging technologies, as seen in Figure 3, the result shows that the Filipinos perceived a higher likelihood that these technologies would provide severe negative consequences to society in the next ten years, with a mean of 3.76. In contrast, the Japanese perceived that technologies would somewhat ($\bar{x}$=3.17) bring severe consequences to society in the next decade. The results imply that the Filipinos believe that in about 50% of the chances that the said technologies will bring severe negative consequences to the society in the next decade. Technologies like "Artificial Intelligence & Robotics" ($\bar{x}$=4.47) are perceived by Japanese students as the highest likelihood of negative consequences. For Filipino students, "Virtual and Augmented Realities" is the highest likelihood of negative consequences with a mean of 4.68. "3D Printing" ($\bar{x}$=2.67) and "Space Technologies" ($\bar{x}$=2.33) are perceived by the Japanese to have the least negative consequences. Half of the emerging technologies are perceived to be somewhat damaging to society. These technologies include 3D Printing ($\bar{x}$=3.42), advanced materials and nanomaterials ($\bar{x}$=3.47), energy capture, storage and transmission ($\bar{x}$=3.21), blockchain and distributed ledger ($\bar{x}$=3.42), geoengineering ($\bar{x}$=3.32), and new computing technologies ($\bar{x}$=3.37).

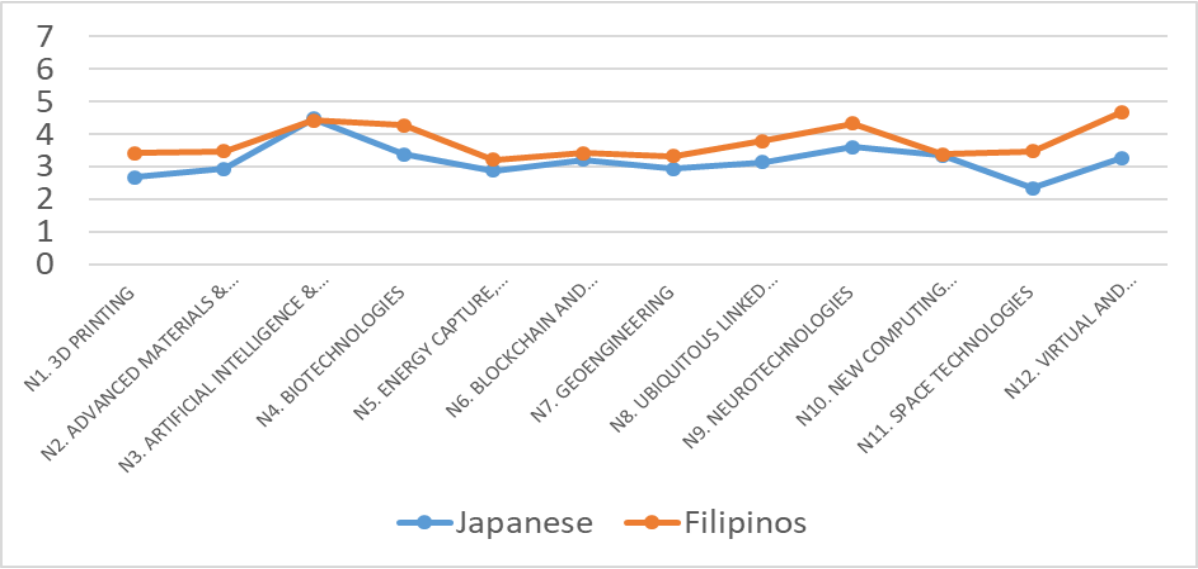

Figure 3. Likelihood level of the emerging technology to bring severe negative consequences to Japanese and Filipino students within the next ten years

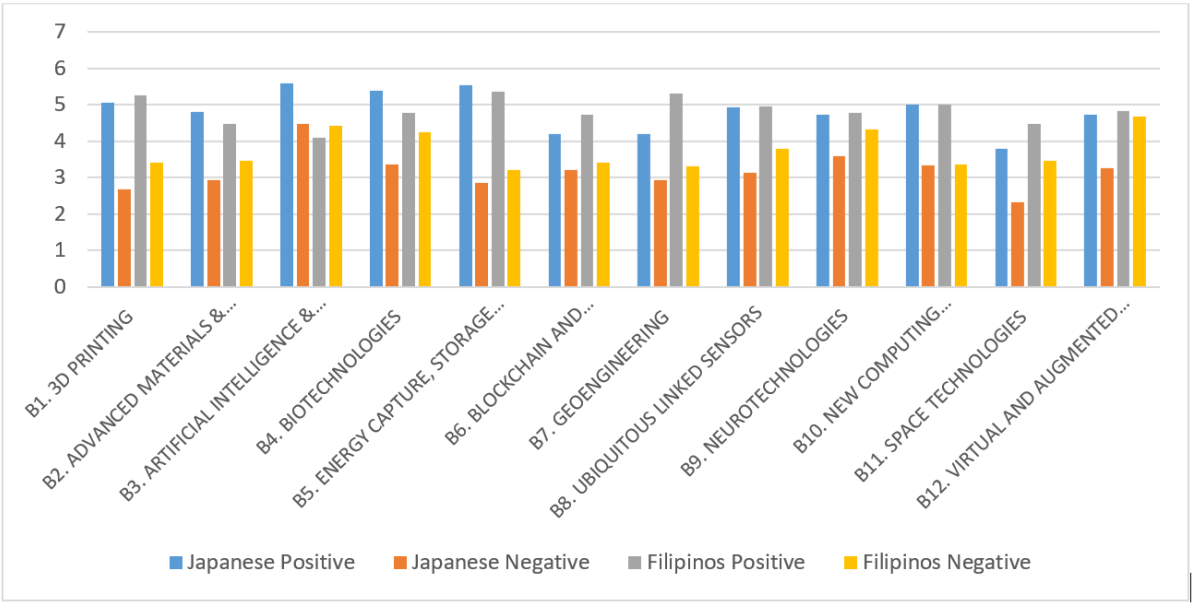

Figure 4. Likelihood Level of the Positive and Negative Effects of Emerging Technologies between Japanese and Filipino Students

Figure 4 visualizes the likelihood level of the positive and negative impacts of emerging technologies between Japanese and Filipino students. As shown, Filipino students have a higher degree of perception in terms of the negative consequences of emerging technologies compare to Japanese respondents. This result may imply that Filipino students have

a better understanding of the influences of these technologies on their lives as a student, as a child, or as a citizen.

C. Awareness of Technological Risks

Table 3 shows the degree of awareness of Japanese and Filipino students of technological risks. As shown, the respondents have the same level of awareness on the technological risks, which is described as somewhat aware. The data shows that Filipino students are somewhat aware of the technological risk with a mean of 5.09 and 4.48 for Japanese. This data implies that the students are slightly conscious and mindful of the risk that the technology would bring to society. The data shows that the respondents are mostly aware (Filipinos, $\bar{x}$=5.53, and Japanese, $\bar{x}$=5.20) on the massive incident of data fraud/theft. This may signify that the respondents are frequently attentive about the wrongful exploitation of private or official data that takes place on an unprecedented scale.

TABLE 3. Degree of Awareness of the Technological Risks

Technological Risks	Japanese		Filipinos	
	$\bar{x}$	Description	$\bar{x}$	Description
ADVERSE CONSEQUENCES OF TECHNOLOGICAL ADVANCES (Intended or unintended adverse consequences of technological advances such as artificial intelligence, geoengineering, and synthetic biology causing human, environmental, and economic damage).	4.55	Somewhat aware	4.87	Somewhat aware
BREAKDOWN OF CRITICAL INFORMATION INFRASTRUCTURE & NETWORKS (Cyber dependency that increases vulnerability to an outage of critical information infrastructure (e.g., internet, satellites, etc.) and networks, causing widespread disruption).	3.67	Moderately aware	4.74	Somewhat aware
MASSIVE INCIDENT OF DATA FRAUD/THEFT (Wrongful exploitation of private or official data that takes place on an unprecedented scale)	5.20	Somewhat aware	5.53	Mostly aware
LARGE-SCALE CYBER-ATTACKS (Large-scale cyberattacks or malware causing large economic damages, geopolitical tensions or widespread loss of trust in the internet)	4.20	Moderately aware	5.22	Somewhat aware
Aggregate Mean	4.48	Somewhat aware	5.09	Somewhat aware

D. Differences in Views

A one-way between subjects ANOVA was conducted to compare the familiarity level between Japanese and Filipino students. There was a significant difference in the familiarity of the emerging technologies at the p<.05 level for the two groups of students [F(1, 32) = 4.203, p = 0.049]. As mentioned, Filipino students have a higher familiarity with emerging technologies than Japanese students. The reason may be because the Filipino respondents are selected from a Computer Fundamentals class where trends and issues of information technology are discussed. Further, the likelihood of positive and negative benefits between Japanese and Filipino students were compared using one-way ANOVA. The likelihood of positive benefits of technology was not significant [F(1, 32) = 0.000, p = 0.983]. On the same manner, the likelihood of negative effects was not significant [F(1, 32) = 2.151, p = 0.152].

TABLE 4. One-way ANOVA Tests

		Sum of Squares	df	Mean Square	F	Sig.
Familiarity	Between Groups	5.228	1	5.228	4.203	.049
	Within Groups	39.806	32	1.244		
	Total	45.035	33			
Positive	Between Groups	.001	1	.001	.000	.983
	Within Groups	42.457	32	1.327		
	Total	42.458	33			
Negative	Between Groups	2.982	1	2.982	2.151	.152
	Within Groups	44.365	32	1.386		
	Total	47.347	33			

IV. Discussion

The result is consistent with the report that Gen Zers are conversant with cutting-edge technology [6]. Likewise, the result is consistent with the Pew Research [13] that stated: "views about the effects of technology are also largely positive." In a report cited in Davidson (2019), "statistics indicate that 33% of Gen Zers watch lessons over the internet, 20% read e-books, and 32% study with their classmates online". Gen Zers are aware of their privilege. Most of them are keen on learning new skill sets, and they educate themselves. Gen Zers are more committed to social causes [14]. Among the many social causes that are noticeable among Gen Zers are climate change, alternative energy, fair land use, pollution, water access, land conservation, animal rights, recycling, environmental discovery, environmental activism, and nuclear proliferation [15]. Other positive benefits that Gen Zers perceived about technology are better employment prospects in the future, and access to more information [14].

Low self-esteem, lack of confidence, exposure to inappropriate material, and risk of cyberbullying are among the harmful effects of technology that the Gen Zers are experiencing [14]. Studies also show that Facebook addiction among teenagers is alarming [16]. Because of social media, today's generation is known to have possessed behaviors that tend to be tied to narcissism [17]. Other damaging impacts of technology, according to Pew Research includes a) breakdown of communication and human interaction, b) degraded

society's morals and values, leading to a reliance on instant gratification and promoting negativity, c) inability to handle normal tasks and d) misuse of widely available information. Likewise, Emma (2016) listed five undesirable impacts of technology on Gen Zers. These are a) it is hard for them to communicate without technology, b) they come off entitled, c) they have uncertain future, d) they expect a quick and easy result, and e) they can come across as careless and rude.

V. Conclusion and Recommendations

Generation Z students have varying views and understanding of emerging technologies and their risks. Gen Z views more of the positive effects than the adverse effects of technology. In particular, Filipino students have a better familiarity with the 12 emerging technologies. Filipino and Japanese students have the same outlooks that emerging technology can bring positive benefits to society in the next decade. Filipino students have a higher regard for the negative consequences of emerging technology than Japanese students.

It is recommended to include or improve emerging technologies and their risk as part of the discussion in any general education courses. Classroom integration of ethical issues and concerns [18] must be reinforced. There must be active advocacy on digital citizenship, including responsible use of social media as well as green computing. Academic institutions must raise the level of their efforts concerning data privacy and security, as listed in [19]. Moreover, institutions must critically review basic IT infrastructure strategies [20] to provide a safe and sound learning community. Furthermore, conduct a thorough study to determine the factors that affect familiarity, the likelihood of positive and negative consequences, and the awareness of technological risk.

Acknowledgments

This research was conducted during the fellowship program funded by the United Board for Christian Higher Education. The assistance of my mentor Prof. Mark Langager is deeply appreciated. I want to thank the participants during the 1st International Research Conference on October 20, 2018, at Jose Maria College, Davao City, the Philippines, for the comments and suggestions of the first version of this article.

References

[1] M. Dimock, "Defining generations: Where Millennials end and Generation Z begins," 17 January 2019. [Online]. Available: https://www.pewresearch.org/fact-tank/2019/01/17/where-millennials-end-and-generation-z-begins/. [Accessed 2020].

[2] Business Insider, "Generation Z: Latest Characteristics, Research, and Facts," Business Insider, 2019.

[3] Kasasa, "Boomers, Gen X, Gen Y, and Gen Z Explained," Kasasa, LTD, 29 July 2019.

[4] CBS News, "How Generation Z is changing the tech world," CBS News, 10 March 2016.

[5] S. Datta, "Generation Z and Their Technology Consumption: What Companies Must Know," Read Write, 10 September 2019.

[6] T. Wright, "Gen Z Workforce: Education and Technology Considerations," In Focus - Dell Technologies, 26 November 2018.

[7] World Economic Forum, "The Global Risks Report 2017 12th Edition," World Economic Forum, 2017.

[8] N-Gen, "How Gen Z Uses Technology," N-Gen, 16 November 2017.

[9] L. Holman, "How Gen Z Will Lead Workers' Safety in Technology," OHS Online, 6 December 2019.

[10] J. Spacey, "What is Technological Risk," Simplicable, November 26 2015.

[11] A. Mancuso, "Redefining Technology Risk," RM Magazine, 1 November 2019.

[12] LexisNexis, "Monitoring and Managing Technological Risks," LexisNexis, 2020.

[13] C. Funk, B. Kennedy and E. Podrebarac Sciupac, "Public sees science and technology as net positives for society," Pew Research Center, 26 July 2016.

[14] B. J. Davidson, "Impact of Technology on Generation Z," Percento Technologies, 8 February 2019.

[15] D. Patel, "11 Environmental Causes Gen Z Is Passionate About," Forbes Magazine, 4 October 2017.

[16] D. E. Marcial, "Are you a Facebook Addict? Measuring Facebook Addiction at a Philippine University," Education, Research and Innovation III, vol. 66, pp. 12-15, 2013.

[17] D. Marcial, "What's on your Mind? Measuring Self-Promotional and Anti-Social Behaviors on Facebook among Tertiary Students," Information Technologies and Learning Tools, vol. 48, no. 4, pp. 199-208, 2015.

[18] D. E. Marcial, "Information and Communication Technology in Service-Learning: Some Ethical Issues and Concerns," Silliman Journal, vol. 56, no. 2, pp. 139-158, 2015.

[19] D. E. Marcial, "IT security in the higher education institutions," Jurnal Informatika, vol. 8, no. 1, pp. 1-14, 2012.

[20] D. E. Marcial, "IT Infrastructure in Higher Education Institutions in the Philippines.," Lumina, vol. 23, no. 2, 2012.

[21] Emma, "5 Pros & Cons About Being a Part of Generation Z," Play Buzz, 21 July 2016.