

Do information and communication technologies influence skills, competencies, health and well-being of teenagers? Current evidence

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Abstract

INTRODUCTION: Information and Communication Technologies are deemed to be a significant influence on teenagers' development. It is important for studies to be conducted to assess the underlying influence of ICT on the teenager age group.

OBJECTIVES: The aim of this paper is to review whether ICT influences teenagers' skills, competencies, health and well-being based on previous studies.

METHODS: Articles from 2015 to 2020 were selected for analysis to identify the influences on teenagers.

RESULTS: Computer and mobile devices offer opportunities to improve literacy in digital skills and competencies. It is also evident that teenagers are prone to risks of getting musculoskeletal symptoms as a result of excessive use of such devices, and it also leads to unforeseen illnesses such as depression in the case of teenager's well-being.

CONCLUSION: Adopting ICT may have beneficial implications for teenagers, but it can pose more adverse effects on their development when used excessively.

Keywords: Information and communication technology, skills, competencies, health, well-being, influence, teenager.

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1. Introduction

The proliferation of ICT has become an essential medium for the young generation to learn about new tools in this interconnected world. The Digital revolution is prevalent and its influence is remarkable, which can be seen in how millennials or digital natives are already used to living with technologies. ICT offers teenagers learning opportunities and digital citizenship, as well as preparing themselves for future employment [1]. ICT tools are used extensively

among teenagers to enhance their overall learning experience. For instance, the internet and mobile phone are important to help teenagers in learning processes; these tools are essential for preparing for work as well as looking for school-related information [2]. The Internet has profoundly reshaped education as it offers more opportunities for students to improve their knowledge [3]. Learning activities supported by online learning tools provide the most effective learning domain in higher education [4], particularly during the current state of the COVID-19 pandemic, where all learning has been shifted to online. Online learning equips students with knowledge and

experience of the learning process that balances the development of times and technology used based on the ability of self-regulation [5]. Similarly, students who utilize online learning methods can improve their technical skills, which include performing in-depth research online, the ability to use new software and communicate effectively during online classes [6].

The adoption of mobile learning has enhanced students' digital skills, for example, searching for information to complete assignments and preparing written reports efficiently [7]. Moreover, Hamidi and Chavoshi [8] confirmed that mobile learning improves students' ability to communicate and access information through mobile devices. Around 77.2% of students stated that mobile devices provide flexibility for learning and 55.6% agreed that mobile learning increases their motivation to learn [9]. Despite the encouraging benefits, studies have shown the adverse effects of mobile phone usage among students. A study reported that teenagers turned their skills into illegal practices, such as using mobile phones for cheating by downloading online sources and plagiarize others' work without acknowledgement [10]. Besides, in a study conducted in a local university in Malaysia, the authors expressed their concern with the fact that students are using their digital skills to conduct unethical activities, which are hacking (15%), movie piracy (67%) and gambling (7%) [11].

Social networking is prevalent among teenagers as a way to make connections, socializing, as well as for knowledge sharing and learning [12]. The emergence and intensive use of social networking sites has seen the growth of popular social networking sites (SNS) like Facebook, Instagram, and Twitter. According to the study, the majority of students from university use social networking sites as a common tool for chatting and discussions such that WhatsApp (92.5%), YouTube (82.8%) and Facebook (74.4%) [12]. Most students are using social networking sites for information sharing, discussions and collaboration to complete assignments. Similarly, an online survey conducted at a public university found that 65% of students use social networking sites for information gathering and 55% of students use them for sharing information and materials [13]. In fact, students in higher education acknowledge the advantages of social networking sites for educational purposes, including communicating with peers and instructors in addition to strengthening their critical thinking and self-management learning [14].

Additionally, teenagers spent most of their time engaging with ICTs on leisure and entertainment such as browsing the internet, listening to music and playing online games. However, many researchers have debated the disadvantages of online gaming, but teenagers can definitely benefit from it if used in a controlled manner. Tsappis [15] asserted that online gaming offers relief to teenagers who struggle with the transition to college by providing entertainment and enjoyment, a platform to demonstrate their gaming skills, resulted in a sense of competence and provide an opportunity for social connectedness. Besides, learning incorporated with game mechanics as an online puzzle-

based game has improved students' algorithmic thinking skills [16]. Dumrique and Castillo [17] found that playing online games does not affect the students' academic performance and the majority of students (73.5%) that do not engage in before-school play are unlikely to exhibit poor academic performance [18].

The ever-increasing growth of ICTs has proved to have benefits and positive influences along the path. Despite the encouraging signs on ICT use, there is still ongoing concern about whether the usage is detrimental as well, particularly related to well-being and health. The excessive use of electronic media in daily activities was associated with experienced discomfort in sore eyes, neck pain or musculoskeletal pain [19]. For instance, researchers reported that 74% of the students who used smartphones/tablets are experiencing neck or shoulder pain, while 80% have one or more visual symptoms [20]. Furthermore, social media has become an integral part of teenagers' lives and habitual usage will pose more harm than good. As a result, studies concluded that the risk of using social media is connected to the exposure to a harmful substance [21] and teenagers who are categorized as creative user – very high usage of social sites; 70% - 80% higher odds of using combustible tobacco [22].

This article aims to identify and analyse the current evidence on how different types of information and communication technologies will influence teenagers' development in terms of skills, competencies, health and well-being. Although there are reviews of both positive and negative influences of ICT usage on teenagers [23,24], they do not address the influence based on the four major components as a whole and they do not fit the aim of this review paper. In their review, Siddiq et al. [23] focuses on digital literacy and computer-based assessment, of which majority are targeting lower secondary students (aged 11 to 14 years old). In contrast, Wu et al. [24] touches on the circumstances of internet technology use on health and well-being, however, the study is focusing mainly on the positive side. Neither of these reviews has discussed on the effects of different ICTs on the four aspects. Therefore, this survey was conducted to increase knowledge, understanding and validate theories in which technologies can enhance or deprive teenagers' development. It is also meant to increase awareness of the public, especially among teenagers, on the benefits or drawbacks of adopting ICTs in their lives.

Due to the limited number of papers on influences of ICT on teenagers, study on adolescent and youth were also included for consideration in this review.

2. Influence of ICT on Teenager

2.1. Skills

In the modern world, ICT benefits are abundant and apparent, especially in offering opportunities to teenagers in skills development. Teenagers are active consumers of the

internet and gadgets that explore information either for leisure or academic purposes. The constant use of technologies had refined their digital knowledge to have a greater perception of online risk [25]. A similar finding from a study conducted in South Korea, where students who are often engaged on the internet, have a higher device and content literacy [26].

Besides, digitally skilled teenagers retain more benefits from digital technologies by using their skills effectively and can cope with online risk [27]. Furthermore, Vioria et al. [28] have investigated mobile devices among Spanish and Hispanic-Americans, showing that 9.35% of students are using digital skills for academic information search, studies and consultation. Also, the presence of ICTs in education institutions is the key factor for teenagers to improve their digital literacy and subsequently prepare themselves for job employability [29]. For instance, digitally literate teenagers have the ability to use or communicate through digital technologies effectively and practicing safe search without taking risks on the internet [30]. Additionally, digital technologies enrich students' digital skills and literacy to support their learning where, the study reported that the majority of the students (37.65%) perceived their digital literacy on the scale of "very good", that engage in online learning [31].

Moreover, Gioiosa and Kinkela [32] had a similar result in their survey conducted on college students in New York, in which 78% of students agreed on the blending of technologies in classes has improved their communication skills and facilitate information search on the internet. On the other hand, several studies deny the benefits of the internet on teenagers' skills where abusive usage was identified. Teenagers can facilitate technologies and explore the benefits of social interaction in their daily lives; however, uncontrolled use has risen to the extent of misusing to harm others. For example, a study was carried out in England shows that 1.9% of students are the perpetrator of cyberbullying in misusing their ICT skills to harm others [33].

Moreover, a study by Ugur and Koc (2015) reported nearly 80% of students are misusing their digital skills in the classroom by using mobile devices for phubbing and cheating, which are tallied with the findings from [35] that the prevalence of cheating happening in classrooms and it is indicated that male students are more likely to plagiarize compared to female students. However, the disparity in terms of ICT exposure between urban and rural areas is a point of concern as Asfar and Zainuddin [36] responded that students (15%) from rural areas in Selangor, Malaysia has lower ICT skills and self-directed learning readiness compared to students (85%) from urban areas.

Table 1. Studies on the influence of ICT on skills.

Publication	Scope	Region	Positive influence	Negative influence
Asfar & Zainuddin, 2015	ICT in self-directed learning	Asia (urban and rural areas in Selangor, Malaysia)		15% from rural areas has less ICT skills compared to 85% from urban areas
Cabello-Hut et al., 2017	Digital skills and online opportunities	America (Brazil)	Ability to use, communicate and avoiding taking risk from the internet	
Gioiosa & Kinkela, 2019	Technology and communication skills	America (New York, United States)	Using technology further improve the learning process	
Lareki et al., 2017	Perception on the impact of technology	Europe (Basque Country and Navarre, Spain)	Participants who use technologies are aware of the online risk	
McGuinness & Fulton, 2019	Digital skills on e-learning	Europe (Dublin, Republic of Ireland)	Digital technology enriches online learning opportunities	
Negre et al., 2015	Academic cheating	Europe (Spain)		Male students are more likely to conduct cheating in the classroom
Park et al., 2015	Digital media literacy	Asia (South Korea)	Participants who engaged in online activities have higher digital literacy	
Picatoste et al., 2018	Impact of ICT on teenager's development	Europe (Spain)	ICT is a key factor for teenagers to improve digital literacy	
Rodríguez-de-Dios et al., 2018	Impact of digital skills on online opportunities and risk	Europe (urban and rural areas, Spain)	Digital literacy provides more benefits from digital technologies and may avoid risk or harm	
Ugur & Koc, 2015	Mobile phones usage	Asia (Sakarya, Turkey)		80% of students are distracted, phubbing.

Publication	Scope	Region	Positive influence	Negative influence
				and cheating during an exam.
Viloria et al., 2020	The use of mobile devices to carry out academic activities	America (Latin America)	Mobile devices are used for academic information search, studies and consultation	
West, 2015	Prevalence of cyberbullying	Europe (England, UK)		7.9% of students are victims of cyberbullying

2.2. Competencies

Teenagers that use the internet are mostly technology savvy and this indicates that teenagers who understand the background of the internet and information findings can perform better in academic competence [37]. The following study carried out in Universities in the South-West of Nigeria has a similar outcome where a significant of 88.2% of female and 83.3% of male students agreed that having learning materials on mobile devices improves overall learning [38]. The authors confirmed that mobile devices' familiarity among students enhances their learning by instantly updating resources that are easily accessible through the internet [39].

Students use mobile phones to learn new things and indirectly increase their searching and learning skills, but overuse causes them to be unable to concentrate on studies and leads to poor performance in exams [40]. The study has a similar result that students with higher phone time usage have a lower GPA than the students who use it less, where the descriptive analysis concluded that females have higher

GPA (Mean = 3.09) compared to males (Mean = 2.88) [41] and Domoff et al. [42] believed that the decrease in academic performance causes by smartphone addiction especially during class lessons.

However, a survey was carried out among high school students in Malaysia to identify the association of gadgets uses and their academic performance has a differing result that both males and females shared the same academic competencies in which 57.5% of them has poor performance and spent more than 6 hours on gadgets [43]. Whereas, in terms of digital divide, students from rural areas have fewer competencies as they have limited access to ICT facilities [44]. Despite the bounded access to ICT, Thinakaran et al. [45] revealed that students from rural areas in Malaysia have a high computer self-efficacy for basic and advanced skills. In contrast, a study conducted on other rural areas in Malaysia showed a gender divide where males have higher digital skills than females [46].

Table 2. Studies on the influence of ICT on competencies.

Publication	Scope	Region	Positive influence	Negative influence
Ahmad et al., 2019	Digital skills level	Asia (urban and rural areas in Hulu Langat, Selangor, Malaysia)		Males have higher digital skills compared to females
Buabeng-Andoh & Issifu, 2015	ICT literacy of secondary school students	Africa (urban and rural areas in Ghana)		Lack of ICT facilities for learning
Domoff et al., 2020	Addictive phone use.	America (Northern Midwest, United States)		Addictive phone use caused a decrease in academic performance
Lepp et al., 2015	Effect of cell phone use on grade point average	America (United States)		High cell phone use had a significantly lower GPA
Othman et al., 2020	Impact of electronic gadgets on academic performance	Asia (Kuantan, Pahang, Malaysia)		Students spent the most time on electronic gadget has a poor academic achievement
Pagani et al., 2016	Effects of digital literacy on educational outcomes	Europe (Italy)	Digital skills have a positive relationship with higher academic performance for both math and reading	
Shonola et al., 2016	Impact of mobile	Africa (Nigeria)	Learning materials on	

Publication	Scope	Region	Positive influence	Negative influence
	device on learning		mobile devices improve overall learning	
Thinakaran et al., 2018	Perceived computer self-efficacy	Asia (rural areas in Malaysia)	Basic and advanced skills have a higher self-efficacy level	
Venkatapathy & Bhargavan, 2020	Usage of smartphone and academic performance	Asia (Puducherry, India)		Overuse of smartphones causing students unable to concentrate on their studies

2.3. Health

The advancement of ICT in the health sector is distinguishable between developed and underdeveloped countries; however, teenagers from rural areas have poor access to technologies in improving their health where the existing barriers like socioeconomic status and geographical location restrict their approach to ICT [47]. Therefore, the author introduced mHealth as one of the possible solutions to overcome these barriers; the study was carried out in Dhaka shows that perceived ease of use was a significant factor in the students' intention to use mHealth [48]. For example, CopeSmart, a telemental health application through self-monitoring, has the potential to encourage positive teenagers' mental health. 79% of the participants regarded the app as a medium to monitor their health and increase awareness of their emotions [49]. Harrer et al. [68] support the internet-based mobile health application is effective to reduce the consequences of college-related stress and might provide help for students who are suffering from depression.

However, a report from high school students in the United States shows that students who spent time on TV or other screen devices for more than 5 hours a day are linked

to obesity (78%), less physical activity (94%), and inadequate sleep (80%) [51] which is higher compared to the result reported from college students in China who are suffering from poor sleep quality (9.8%) [52] and (29.4%) from Pittsburgh, United States [53]. Simultaneously, a sedentary lifestyle among teenagers was more often contributes to the increase in weight and obesity [54] that may cause health complications [55]. According to the study, teenagers who spent more than 2 hours (36.8%) on digital devices in a single sitting were subjected to overweight (14.4%) and obese (11.9%) [56].

Besides, the study found that the increase in musculoskeletal and visual symptoms is related to the increase in phone and tablet usage [57]. The consequences can be seen from the result gathered, where 8.3% (n=112) of the participants are categorized as obese and almost half of the participants 48.3% (n=653), reported experiencing musculoskeletal pain [58]. Also, Woo et al. [77] asserted that physical pain appears when the body and mind's movement is restrained, where their study revealed that 49.9% of students are having upper limb musculoskeletal discomfort.

Table 3. Studies on the influence of ICT on health.

Publication	Scope	Region	Positive influence	Negative influence
Bradbury et al., 2019	Sweet beverage intake and the use of electronic devices	America (United States)		A sedentary lifestyle contributed to the consumption of sugary beverages that may cause health complications
Cai et al., 2017	Screen-time viewing and overweight	Asia (Beijing, Shanghai, Tianjin, Chongqing, Mongolia, Xinjiang, Guangxi, Ningxia, Tibet, China)		14.4% were overweight, 11.9% were obese, 36.8% of teenagers exceeded daily screen-time of 2 hours
Goicolea et al., 2018	Health care access	Europe (Sweden)		Young people from rural areas have limited access to health technologies
Harrer et al., 2018	Efficacy of internet-based and app-supported stress	Europe (Germany)	Internet-based mobile health application is effective to reduce the	

Publication	Scope	Region	Positive influence	Negative influence
	intervention		consequences of college-related stress and depression	
Harris et al., 2015	Computer exposure to musculoskeletal pain	Oceania (Perth, Australia)		8.3% of the participants are categorized as obese and almost half of the participants 48.3% reported experiencing musculoskeletal pain
Hoque, 2016	mHealth adoption in a developing country	Asia (Dhaka, Bangladesh)	Perceived ease of use had a significant positive impact on the intention to adopt mHealth service	
Huang et al., 2020	Poor sleep quality from smartphone usage	Asia (Changsha, China)		Mobile phone addiction contributed to poor sleep quality and poor physical health.
Kenney & Gortmaker, 2017	Impact of screen devices and obesity risk factors	America (United States)		Participants that spent the most time on devices was associated with obesity, less physical activity and sleep disturbance
Kenny et al., 2015	CopeSmart, a telemental health app promote positive health outcomes	Europe (Dublin, Republic of Ireland)	79% of the participants regard the app as a medium to monitor their health and increase awareness of their emotions	
Levenson et al., 2016	Social media and sleep deprivation	America (United States)		Participants who use social media and devices had greater odds of having sleep disturbance
Puolitaival et al., 2020	The use of digital devices with poor eating habits and physical activity	Europe (Oulu, Finland)		Participants who spent time on video gaming (3h/d) had lower physical fitness, obese, and poor dietary habits
Straker et al., 2018	Impact of mobile technology	Oceania (Perth, Australia)		The increase in musculoskeletal and visual symptoms is related to the increased use of phones and tablets.
Woo et al., 2016	Musculoskeletal impacts of the use of devices	Asia (Hong Kong)		Participants who use gadgets has neck and shoulder pain

2.4. Well-being

The question of whether the use of ICT such as mobile devices, the internet and social media can benefit or detriment teenagers' well-being remains unclear. A study concerning teenagers' well-being and social media usage in the Netherlands found that 45.90 % of the participants felt better after using social media like Instagram and WhatsApp [60]. However, Meier et al. [48] denied that social media offer benefits for students and their analysis found that students often procrastinate in completing school tasks while using Facebook, which contributed to academic stress and negative well-being. Also, the extensive use of social media has raised concerns about the issue regarding cyber-

aggression resulting in mental health problems among teenagers [62].

Besides, mobile health application usage has reduced somatic anxiety by 18% and depression symptoms by 22%, to a manageable level, and improves students' quality of life [63]. On the other hand, the authors argue that prolonged mobile phone use for more than 2 hours per day among teenagers has significantly contributed to a higher risk of depression [64]. Meanwhile, social media use also posed a threat to teenagers' well-being as according to the study, 201 out of 225 Instagram post contains Non-suicidal self-injury (NSSI) hashtag which is associated to depression and self-harm [65]. Moreover, M. Liu et al. [53] and Wahyuni et al.

[54] agreed that exposure to digital technologies for more than two hours per school day shows a high risk of self-harm and psychiatric problems.

Furthermore, Chen et al. [55] asserted that the high frequency of mobile phone use is associated with suicidal and self-harm ideation. McDool et al. [56] voiced their concern on children's negative relationship between internet use and well-being, with their findings on girls having the most potent effect on feeling depressed about their appearance, social life and school work. Woods and Scott [57] responded that social media usage, especially at night, is linked to poor sleep quality and increased anxiety and depression levels.

Also, teenagers with excessive social media use show a higher risk of getting aggressive and conduct problems [71]. Wang et al. [59], in contrast, approximately 95% of students

used screen devices before sleep and between them, girls showed a higher chance of getting anxiety symptoms. The same outcome from the findings [73,74], where girls exhibit a higher level of depression. Interestingly, a study by Tangmunkongvorakul et al. [62] shows that 58.7% of excessive smartphone users are female students and they are more likely to suffer from psychological well-being. In 2015, the authors investigated the influence of ICT among urban youth in America and found that an increase in ICT usage related significantly to depression and hopelessness [76].

Meanwhile, a different study was conducted in a developing country, South Africa, discovered high computer usage on learning by working students (57%) but low prevalence of excessive use symptoms (7%) and medium loss of sleep (54%) because of work commitments [77].

Table 4. Studies on the influence of ICT on well-being.

Publication	Scope	Region	Positive influence	Negative influence
Beyens et al., 2020	Effect of social media on well-being	Europe (Netherlands)	46.90% of participants reported feeling better after using social media	
Chen et al., 2020	Relationship between mobile phone use and suicidal intention	Asia (Shenzhen, China)		High frequency of mobile phone use effect suicidal and self-harming actions
Coleman et al., 2015	ICT usage on psychological well-being	America (Southeastern United States)		Increased usage of ICT related significantly to depression and hopelessness
Demirci et al., 2015	Impact of smartphones on health	Asia (Isparta, Turkey)		The use of smartphone regularly exhibits a higher level of depression
George et al., 2020	Digital technology on well-being	America (North Carolina, United States)		High usage on social media was associated with conduct problems
J. Liu et al., 2019	Prolonged mobile phone use	Asia (Shandong, China)		Higher phone usage was connected to the increased risk of depression symptoms
M.Liu et al., 2016	Associations of digital screen with psychiatric symptoms and suicidal ideation	Asia (urban areas in China)		Exposure to digital technologies shows a high risk of self-harm and psychiatric problem
McDool et al., 2020	Use of internet and well-being outcomes in children.	Europe (England)		Girls having the strongest effect on feeling depressed about their appearance, social life and school work
Meier et al., 2016	Procrastination with social media impacted academic and well-being	Europe (Germany)		Procrastinating while using Facebook contributed to academic stress and negative well-being
Mishna et al., 2018	Cyber-aggression and mental health	North America (Canada)		Social media use has raised issues regarding cyberbully and mental health concern

Publication	Scope	Region	Positive influence	Negative influence
Moreno et al., 2016	Self-harm on social media			The intention of self-injury was found using certain hashtags on Instagram
Paul & Fleming, 2019	MindShift (m-health), alternative treatment for anxiety disorders	America (United States)	Mobile health has reduced somatic anxiety by 18% and depression symptoms by 22% to a manageable level and improve student's quality of life	
Tangmunkongvorakul et al., 2019	Smartphone use and psychological well-being	Asia (Chiang Mai, Thailand)		Females students had psychological well-being scores that were higher than males
Van Der Merwe, 2019	ICT use pattern and well-being of open distance learning students	Africa (South Africa)	Students have a low risk of overuse symptoms and sleep deprivation	
Wahyuni et al., 2019	Gadgets and mental health	Asia (Indonesia)		High-frequency use of digital gadgets affects mental-emotional health
Wang et al., 2019	Impact of smartphone dependence on sleep and health	Asia (Southern Taiwan)		95% of students who used screen devices before sleep have a higher chance of getting anxiety symptoms
Woods & Scott, 2016	Social media usage affected sleep quality, self-esteem, anxiety and depression.	Europe (Scotland, United Kingdom)		Social media use at night linked to loss of sleep, anxiety and depression
Zhao et al., 2017	Internet addiction and depression	Asia (Anhui province, China)		22.% of internet-addicted participants experienced depression

3. Methodology

In order to review the influence of ICT on teenagers, articles from the past five years were collected for analysis. To avoid possible selection bias, criteria for this review were developed with the intent of locating all relevant articles.

3.1. Data source and search strategies

Several databases had been thoroughly searched, including ScienceDirect, Scopus, ResearchGate, Google Scholar. Databases were searched for peer-reviewed articles in the English language and limited by years, range from 2015 to 2020 and open access articles. Besides, the search terms were used to retrieve many relevant studies for the review even though some keywords have low precision that returned many irrelevant articles to the study. However, some articles are collected from references within a research article. The search was mainly focusing on the four components, skills, competencies, well-being and health in teenagers.

The total articles recorded were 75, after Inclusion and exclusion (*refer to section 3.2*) has been applied. The search methods and results are described in *Table 5*.

Table 5. Search method to find relevant topic for review

Database	Search terms/keywords	Number of results	Relevant topics recorded
Filtered by (Research articles, Year: 2015 – 2020, Access type: Open Access)	("digital device" OR technolog?) AND (skills OR competent?) AND (student? OR teen? OR youth)	113	15
	"mhealth" AND intervention? AND "health" AND (student? OR "youth" OR teen?)	52	3
	"ICT" AND "well-being" AND ("youth" OR teen?)	71	2

Database	Search terms/keywords	Number of results	Relevant topics recorded
	OR student?)		
	"ICT" AND "well-being" AND "developing country" AND ("youth" OR "students")	17	0
	"ICT" AND ("health" OR "well-being") AND "rural areas" AND ("youth" OR "students")	64	2
Scopus <i>Limit to ("Open Access", Year: 2015 – 2020, Research article, Language: English)</i>	"ICT" AND "well-being" AND ("youth" OR teen* OR student*)	191	6
	"digital device" AND "health" AND ("youth" OR teen* OR student*)	157	5
ResearchGate <i>(Filtered to: Publications, Type: Article)</i>	ICT AND "rural areas" AND students		3
	ICT AND health AND youth		0
Google Scholar	ICT AND "learning" AND "students"		7
	technologies AND "Health OR well-being" AND teenagers		4
	Digital device AND skills OR competencies AND teenagers		9
	"social network" AND "learning" AND "students"		3
Total (Including references within a research article)			75

3.2. Inclusion and exclusion criteria

The initial search in the databases yielded a high number of results. Therefore, search results are filtered to select only peer-reviewed articles. Other document type has been excluded so that only articles based on the original findings are on the eligible list. To be included in this review, each research study must meet the criteria as described in *Table 6*.

Thus, studies were excluded if they did not meet those criteria listed.

Table 6. Inclusion and exclusion description

Criteria	Inclusion	Exclusion
Research theme	ICT, skills, competencies, well-being, health	Articles that do not cover these four components
Article publication date	2015 to 2020	Prior to 2015 and after 2020
Document type	Scholarly articles of original research and peer-reviewed	Conference paper, book, editorial or dissertations
Language	Article written in English	Other languages were not included
Access type	Only open access article was chosen	Other access type was eliminated

3.3. Data extraction and evidence synthesis

Pertinent information from each of the identified studies was extracted, including authors, year of publication, research scope, region and study results (positive and negative influence). The trend of publication was also determined to find the frequency of research articles published based on the study aim in past years.

Each reviewed article was scrutinized to find how other researchers applied different research methods in their studies. In order to analyse the influences of ICT, selected articles are read thoroughly to identify research focus based on the four aspects of this study (skills, competencies, health and well-being).

4. Findings

This section summarizes and discusses the main findings of the review. Based on the articles collected, we made the following observations:

4.1. Publication trends analysis

Bar charts were generated to analyse the frequency of research conducted on the effects of ICT on skills, competencies, health and well-being of teenagers for a period of five years, 2015 to 2020. As depicted in (Fig. 1), the total number of studies for each component for the past few years but lack in significance as the result collected was only based on research articles.

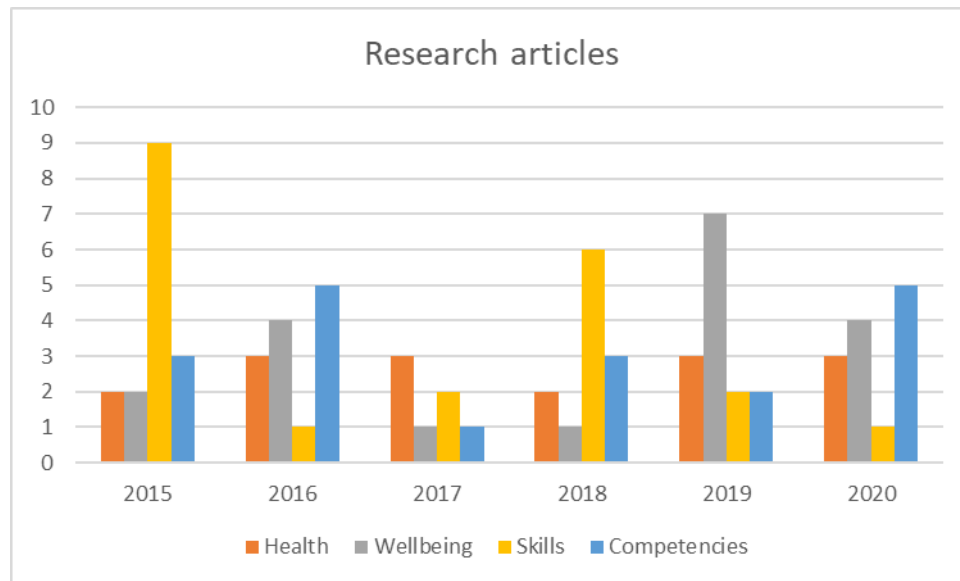


Figure 1. Number of Research Articles (2015-2020)

4.2. Research methodology and settings

The research methods used in the studies were classified into quantitative, qualitative and mixed methods. Table 7 below shows that more than half of the studies adopted the quantitative method (n = 51), followed by mixed-method (n = 16) and qualitative method (n = 8). According to the literature in Section 2, the vast majority of research used high school as the research setting. In addition, based on the findings in Section 2, it is also worth mentioning that the predominant investigation was conducted in several parts of Asia (n = 19) and Europe (n = 15). While, America (n = 13), Africa (n = 4) and Oceania (n = 2) respectively.

Table 7. Research components and methodology of previous studies

Component	Qualitative method	Quantitative method	Mixed methods
Skills	2	17	3
Competencies	1	14	1
Health	2	8	7
Well-being	3	12	5
Total	8	51	16

4.3. Study content focus and types of ICT

Each of the articles reviewed yielded findings relevant to the association between ICT and its influence on teenagers’ skills, competencies, health and well-being.

Skills

Previous studies that focused on teenagers’ skills found both positive and negative influences from ICT. The studies concluded several prominent influences on their skills and can be divided into different types of ICT that include the internet, mobile devices and computer.

Five studies found that teenagers who use mobile phones and computers to access the internet are more likely to have digital literacy improved that contributed to their awareness and perception of the risk related to the publication of data online [25–27,29,30]. Moreover, three studies examined the same technologies (internet, mobile phones, computer) influence their digital skills that facilitate learning experience [28,31,32].

In contrast, two studies identified that mobile devices are the main moderator for teenagers to use their skills to conduct academic cheating and that males are more likely to have such behaviour [34][35].

Competencies

Three studies agreed that computer and mobile devices have a significant influence on teenagers’ competencies. Teenagers who use such devices are more digital literate that enables them to be more competent in terms of academic settings [37,38,45].

However, studies also revealed that the influence of addictive smartphone uses is the main contributor to low academic competence [41–43] because the extended use of

smartphones caused teenagers to be unable to concentrate in studies [40].

Health

A number of studies discovered that mobile phones are an important technological tool to improve teenager health, especially, those who reside in rural areas. Such mobile phones used internet connection and application to effectively monitor teenagers' health [48–50].

On the other hand, numerous studies found that the use of computers excessively and that teenagers practicing sedentary lifestyle caused the increase in body weight [51,52,54–56] that connected closely to poor physical health and dietary habits [51,54,55]. Besides, the influence of mobile devices on teenagers with the increase of musculoskeletal and vision symptoms [57,58] has significantly increased. This includes pain and stiffness on the shoulder, neck and lower back area as well as vision loss [78]. In addition, addiction to mobile devices and social media also affects their sleeping hours [51–53].

Well-being

A recent study was conducted to investigate the use of social media in contributing to teenagers' well-being. The authors asserted that teenager who use social media to communicate with peers tends to feel better [60]. Furthermore, mobile devices are vital to help teenagers who are suffering from psychological disorders in monitoring their symptoms and to improve their overall well-being [63].

Despite that, the majority of the studies discovered the high-frequency use of mobile phones and the internet are closely associated with depression and anxiety [67,69,70,72–74,76]. The influence of mobile device usage can be a severe problem for teenagers which studies have concluded that overuse may cause suicidal and self-harming ideation [71,72,79].

5. Discussion

This review sought to assess the studies concerning the influence of ICT on teenagers. Further analysis of existing studies revealed a significant under-representation of research studying the effects of interaction between teenagers and ICT in terms of skills, competencies, well-being and health. This under-representation may be limiting the evidence to suggest an understanding of the effects of ICT on teenagers. Thus, addressing the gaps will be crucial to improve the understanding and ideas of the research areas. The following sections analyse the most studied research areas, least studied research areas and most used research methodologies from all the papers being reviewed.

5.1. Most studied research areas

Research on both negative implications of ICT on teenagers' well-being and health has experienced significant growth in the last years. Besides, it is also true of these areas' intersection, with increasing numbers of teenagers' well-being and health-related problem are being reported. The most prevalent of these problems reported is the excessive use of technologies (e.g., internet, computers, smartphones, mobile devices) associated with mental health issues and poor physical fitness. Several studies indicated that teenagers that are categorized into the same internet addiction (IA) cohort were linked to severe depressive symptoms [64,73,74,76]. One of the reasons is because the majority of teenagers have exceeded the ideal screen time limit when using digital devices. According to [64], teenagers' recommended screen time is a maximum of two hours per day. Besides, the extensive use of digital devices also constituted to poor physical health such as musculoskeletal pain, overweight or even unbalance diet [51,54,56–58].

5.2. Least studied research areas

The existing research has limited evidence on the negative implications of ICTs on teenagers' skills and competencies. As such, several studies discussed that teenagers had misused their digital skills to perform unethical conduct – plagiarism, cyberbullying, and cybercrime [33,35]. The results further indicated that excessive use of digital devices is more likely associated with poor academic competencies [41–43] and due to lack of concentration and facilities in rural areas to assist their learning [40,44].

Besides, there is a paucity of evidence to determine the positive effects of ICT on teenagers' health and well-being. Only several studies discussed how teenagers are exploiting technologies to improve their health and well-being. The studies covered teenagers from different countries (Bangladesh, Germany, Republic of Ireland) and aimed to introduce the integration of mobile health and internet-assisted application to teenagers living in both developed and developing countries. Internet assisted mobile health (mHealth) application such as CopeSmart was created to help teenage patients to consult physician or therapist on a health-related matter over the internet [49,50] and it is particularly useful for them that are living in geographically isolated and disadvantaged areas. The main differences are clear enough to distinguish technologies' exposure to improve health among teenagers from urban and rural areas. The study on teenagers from rural areas in Sweden has restricted access to healthcare technologies and services [47].

5.3. Most used research methodologies

The methodology used from the reviewed articles is mostly involved in quantitative research. Most researchers are practicing this method when collecting and analysing data.

Some studies also aim to focus on validating theories and hypotheses [67,69,74]. This method requires a large number of respondents to perform statistical analysis and to draw conclusions based on the derived hypothesis. The data gathered is based on numbers and the results are often reported in graphs or tables. However, several limitations of quantitative research should be considered, in which data obtained are more narrowed focus, structural bias and lack of context. Besides, some studies adopt a mixed-methods approach [3,47,62], where both quantitative and qualitative methods are being used. Hence, both approaches are essential for gaining different kinds of knowledge. Moreover, several major studies are performing self-reported measures that may be subjected to bias outcomes and subsequently decrease the results' accuracy.

Overall, the findings in this review show the current state of ICT impacts on teenagers despite the existence of limitations and to provide a comprehensive knowledge of this research area and at the same time present research-based evidence that may beneficially contribute to future studies.

6. Conclusion and future works

The findings of this study showed a diverse influence of ICT usage in skills, competencies, well-being and health of teenagers. Several potential apparent negative effects can be highlighted. The excessive use of the technologies has projected the impact to the extent where the abuse of digital skills among teenagers includes plagiarizing, cyberbullying and cybercrime. These misconducts have created a considerable influence on the teenager's overall development.

It has also been identified that the increase in usage of gadgets leads to poor academic performance and competencies in teenagers. The main reason is the loss of interest or concentration on studies when teenagers are prone to gadgets addiction. Therefore, the likelihood of gadget addiction is correlated to distraction and failure to achieve academic success.

Social media usage by teenagers in an extensive manner has resulted in the risk of getting depression consequently, increases academic stress and contributes to negative well-being. The situation where teenagers spend less time in physical activities and more screen time particularly social media has caused them to be socially isolated. This has somewhat constituted the ideation of self-harm or suicide. Also, prolonged use of devices may cause delayed sleep schedules, potentially increasing the chances of depression, anxiety and social problems.

Health complications are noticeable where the use of electronic devices for long hours is associated with the consumption of sugary beverages and the promotion of a sedentary lifestyle. This has resulted in teenagers being less active and having poor dietary habits. The sedentary behaviour not only affects the increase of body weight but also leads to musculoskeletal symptoms such as back pain,

fatigue and sleep disturbance. Therefore, the results of the current study suggest that the use of ICTs may have both positive and negative implications for teenagers.

Based on the studies reviewed, it is apparent that some extensive and comprehensive research should be conducted to gather information on how ICTs have influenced teenagers in different regions of the world. The regional study may help the researchers to identify positive and negative influences of ICT adoption among the population; nevertheless, it can provide insights on how to mitigate the risks of the increasing negative impacts and tap on to the benefits of the readily available positive impacts, effectively. Besides, more research should be presented on how teenagers from different geographical locations, namely urban and rural areas, are engaging with ICTs to extend their academic performance abilities.

While it is helpful to see research involving technologies on improving teenagers' overall healthcare, but the current knowledge on its positive influence is still narrow; therefore, further studies on this gap should be carried out. It is recommended that studies should focus on the implementation and adoption of mobile health applications that aim to increase the outreach on health services among teenagers, notably from rural areas.

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