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Technology usage patterns of the
Dutch youth in relation to social
isolation

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Abstract

The topic of this research paper is to answer the question of whether the increased use of technology by the young generation has an impact on their personal and social development, factors that can have an effect on a society. In particular, we will take a look at whether there is a correlation between technology usage and social isolation in the age range 17-25 of students in Nijmegen, the Netherlands.

We aim to find such possible correlations between growing up with technology all around you and the personal and psychological development of an adolescent. From psychological studies in other countries we know that there is a growing issue of young people isolating themselves from society. Based on a detailed definition of technology usage and isolation patterns we took a look at a possible connection between increased technology usage and personal isolation in the case of Dutch society, and how that manifests itself in the lives of the participants.

From the analysis conducted we found that there is a correlation between the usage patterns of technology and the isolation index of a person. We were able to confirm that this relation goes both ways, with each influencing the other in multiple ways. We could however not conclude that technology has an overall worsening effect on the capability of social interaction.

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1. Introduction

Since digital technology, and the internet in particular, takes up an ever larger amount of time in our lives it is important to take a look at what effects that might have. First on a personal level, and then how that person interacts with society. Social isolation, disconnectedness, and an inability to integrate into social environments like one's workplace or society in general can have widespread influences on how a country and its population develops into the future. Therefore it is important to take a look at and understand possible correlations and effects, both positive and negative, in order to guide the new youth into a good direction. This issue is an important one to solve because the currently young generation will become the future of our world. The word 'correlation' is a deliberate choice here as there is evidence that the relation goes both ways between social interaction and technology use, with each influencing the other in return.

We can clearly see trends that the use of digital technology has increased. For example, according to a survey by Dutch telecommunications company KPN, about 94% of 12-year-old children had their own personal smartphone in 2017 [1]. An exhaustive study by the Dutch Centraal Bureau voor de Statistiek¹ (CBS) went into even more detail on the age group 12-18: While the availability of internet access has seen a marginal growth from 94% in 2005 over 99% in 2009 to 100% in 2013, the ease of access and frequency of use has increased significantly. In 2005 only 22% of children had a smartphone that number grew to 45% in 2009 and 94% in 2013. The frequency of general internet use has also increased from 76% over 89% to 93% of teenagers of that age having used the internet daily in the last three month in the years 2005, 2009 and 2013 respectively [2]. Furthermore, research has shown that especially influences learned during the teenage and adolescence periods of youth have a lasting impact on character development. These determine a person's actions far into their life [3]. Hence why it is important to focus on this issue in the young generation in order to prevent bad habits from developing as early as possible.

¹Central Agency for Statistics

Due to this development the main research question of this paper is whether the increased use of technology in youth has an impact on their personal and social behaviour, factors that can have an effect on a society. In particular, we will take a look at whether there is a correlation between technology usage and social isolation of students between the ages 17 and 25 in Nijmegen, the Netherlands.

For the examination of this development we will focus our attention on examples in the Netherlands, with international cases for example from Japan serving as a baseline to reason from and relate our data to. The goal is to determine if there are trends in Dutch society that might indicate deterioration in quantity and quality of social interaction in the young generation that is caused by usage patterns of digital technology. Examples of this development can already be found around the world. In Japan they observe a phenomenon called Hikikomori, which translates to "pulling inward, being confined"². Hikikomori describes people who isolate themselves from the rest of society over long periods of time. The word can be used both to describe the condition and the patients suffering from it. Research has shown that there is no singular reason for this, but the introduction of modern digital technology has played a role [3]. This is however not a phenomenon limited to Japan anymore, and many other countries have residents which can be categorised as suffering from so called modern-type depression (MTD). MTD is a phenomenon which has been described as a similar condition outside of the Japanese context [4, 5]. Because of this the spread to the international community it will be our main point of reference for the Netherlands.

There already exists international research on this topic, for example by Caplan [6, 7] who examined a general psychological relation between loneliness and problematic internet use (PIU). He took a diversified look at possible connections and initially³ found that reduced face-to-face (FtF) communication can have a negative impact on one's interaction with the internet [6]. On the other hand more refined research from 2006 concluded that there does not need to be a relation between mental health and loneliness [7], people can be happy and productive even when isolated if their personality nudges them towards individualism. The evidence supports both cases and is thus inconclusive, which warrants further research, especially since Caplan did not do his work in the Netherlands. For more information on related work see chapter 2.

We will approach the problem in four steps, the main research question and three intermediate questions which will provide some direction and preliminary answers on parts of the main topic.

²<https://en.wikipedia.org/wiki/Hikikomori>, assessed on June 6th 2020

³in the year 2003

- The main research question of this paper is whether the increased use of technology in youth has an influence on their personal and social development, factors which can have an impact on a society. In particular, we will take a look at whether there is a correlation between technology usage and social isolation in the age range 17-25 of students in Nijmegen, the Netherlands.
- First, we will define behaviour patterns of self-isolation based on the phenomena MDT, Hikikomori and PIU.
- Secondly, we will generalise causes and effects in order to categorise our survey results and analyse what role modern digital technology plays in that context.
- Then we will do a survey to gather data. The results are analysed for possible correlations, specifically if abnormal technology usage can be connected to the previously defined behaviour patterns of self-isolation.

After a short introduction on what defines MTD and Hikikomori we will focus on just one aspect of the reasons behind them, namely the effects of digital technology in particular. To achieve this we will summarise what defines as MTD, Hikikomori, PIU, and internet addiction and compare and combine causes and effects of both phenomena to find a general template for its influences. This means that we will take a look at how the youth interacts with technology and analyse how that might have an effect on their social interactions and skills by means of a survey.

This is just a start on research about this topic in the Netherlands. There are plenty of possible follow-up questions, for example whether this is a demographically unrelated problem, meaning that over time all generations will be affected for the same or different reasons, or if there are differences for social classes other than academics. Inspirations for future expansion can be found in appendix A.1.

2. Related Work

As mentioned in the introduction there has been quite a bit of research done on the subjects of this paper. Before we go into any more detail let us take a look at a list of all the sources that had an influence on the chosen direction, contributed to parts of the theory, or were a source of inspiration for this thesis. Their contributions and results will be discussed in more detail at later points in the text.

2.1 on MTD, Hikikomori, isolation, and PIU

Stip et al. [3] conducted an exhaustive literature review which summarises characteristics of Hikikomori and Modern-type depression (MTD). They tried to classify patients and analysed a possible connection with internet addiction. They also looked for international occurrences of the phenomena by comparing and applying their results to a case study of a 21 year old Canadian male. Part of their conclusion was that internet addiction is a result of Hikikomori, but not in the sense of a duality as we will come to theorise in the next section.

Kato et al. [4, 5, 8] wrote an article which summarises papers that investigate if phenomena similar to Hikikomori exist in other countries, coming to the conclusion that MTD is a comparable entity. They did some follow up research as well, presented in [4] and [5]. There they investigated an international survey in which the researchers asked psychiatrists from nine other countries¹ to evaluate the international spread of Hikikomori and MTD. Out of the 247 responses (123 Japanese and 124 international), 239 responses came back positive, meaning that MTD indeed is an international phenomenon.

Caplan [6, 7] examined a general psychological relation between loneliness and problematic internet use (PIU). He took a diversified look at possible connections and initially (in 2003) found that reduced FtF commu-

¹Australia, Bangladesh, India, Iran, Japan, Korea, Taiwan, Thailand, and the USA

nication can have a negative impact on someone's interaction with the internet [6]. On the other hand a refined examination from 2006 concluded that there does not need to be a relation between mental health and loneliness. The evidence supports both cases.

Furlong [9] reviewed causes for Hikikomori. He argues "that the tendency to think of Hikikomori as a homogeneous group characterised by psychological malaise is misleading" [9]. He concludes that due to sociological changes and different ways to cope with the pressure, the influence on young people can manifest itself in multiple but equally disorienting or disturbing ways.

Suwa et al. [10] took a look at the phenomena of Hikikomori from a psychiatric perspective. Their literature review was concerned with possible connection between Hikikomori and other psychotic disorders. Some aspects of note include their focus on precursor mental issues like lack of fulfilment with yourself², the contribution of societal changes in Japan specifically, and the rising popularity of the internet in general.

Ho and Lee [11] did a survey on computer use and the relation to social behaviour in Hong Kong, asking participants about how much time they spend on their computers and which activities that time was used for. Amongst their conclusions is that gender plays a role in how technology influences a person's behaviour. Boys were showing a relation between the activities they were doing, while girls didn't show any correlation. Boys who mainly use their computer for social media or web browsing were more socially active than those who stated to be gaming on the computer. Their participants came from varying levels of secondary education.

2.2 on the influence of technology

Shaw and Black [12] investigated internet addiction and possible connections to social isolation in the USA. Their paper is a rather complete summary of the disorder in the light of isolating behaviours.

Oulasvirta et al. [13] examined and related data to provide evidence for the popular thought that mobile devices are building behaviour habits. They conclude that while these devices do indeed build habits and change the way we consume and share experiences, that does not necessarily have a negative impact. It is just a different approach than standard FtF interaction.

Moody [14] investigated "the association between Robert Weiss's bi-modal theory of loneliness and Internet use" [14]. He found, amongst other things, that there is a correlation between high amounts of FtF communication and low levels of loneliness.

Swigger and Swigger [15] examined how preschool children interact with computers. They examined interaction patterns and found that children are capable of socialising while using the computer and that there is not

²see Appendix A.2

necessarily a disruption of social interaction, but a balance administered by the children themselves.

2.3 on the effects of social skills on quality of life

Diener and Suh [16] discussed a threefold of indicators that are believed to have measurable impact on life quality, namely economic, social, and subjective indicators. They found that the quality can be related to and judged by those three criteria in conjunction. Individually, depending on other circumstances, these three indicators can indicate different developments in a persons life quality. When summarised they can help to arrive at an informed analysis of a persons quality of life.

Voydanoff [17] conducted research on a relationship between community interaction ("community participation and affective community resources" [17]) and job and marital quality, and individual job and marital quality. Amongst some other conclusions the relevant knowledge gained is that a lack of social interaction can have a negative effect on job quality, concluding that "these findings indicate that the affective community resources associated with community participation are positively related to job and marital quality" [17].

2.4 on psychometric surveying

Robinson et al. with their book "Measures of personality and social psychological attitudes" [18] took a deep dive into the details of psychometric assessments and surveying techniques, discussing relevant techniques for considerations of different forms of response bias, result and survey validity, methodical tendencies, and many specific evaluation scales. One chapter in their book focuses specifically on assessing social isolation and loneliness.

3. Research

The motivation for this research paper sprung from a desire to find a relation between technology use and its effects on social interactions in the young generation of Dutch. In order to be able to evaluate such matters we will first summarise modern psychological disorders that are linked to isolation and then consider how they might be connected to increased technology usage. Based on this we will create a template by which we can assess a person's risk to isolation and apply that template in a survey to assess data on this subject in the Dutch youth.

Besides the fact that behaviour like Hikikomori is believed to be due to personal factors and anxiety there is also a connection to the emergence of technology and the internet, on which we will focus. Research has found that the phenomena has indeed been spreading into other countries, where it is more commonly known as modern-type depression (MTD). Hence we will not focus on the phenomenon itself specifically, but try to generalise reasons for it and broaden the horizon of the template that we want to apply on Dutch society. Because this development has been noted in Japan first and because they have already done research on this topic, specifically on Hikikomori, this will serve as our initial point of reference. Based on that we will distil a list of reasons and effects that get attributed to the two phenomena and aim to review a relationship between isolation and technology within the young Dutch society.

3.1 Defining behaviour patterns of self-isolation

3.1.1 Definitions of isolation

Before we start with the analysis we need to agree on what exactly the term social isolation or social disconnectedness means. First of all, when we use the word isolation in this context it will be in reference to self-isolation. The behaviour patterns which we will be describing are all initiated by the isolated individual, be that voluntary or not. Other people do not force

such an individual to isolate themselves because of the way in which they use technology.

The two main types of isolation to consider for the scope of this paper are spatial and social isolation. The former being separation due to physical barriers, like great distances, while the latter is defined by psychological barriers and traditionally an absence of face-to-face (FtF) social relationships. Due to the scope of this paper we will also consider digital social relationships because of their technological origin. This type of interaction is very easy to access even when isolated and does offer an easy way to connect to similarly minded people. While digital communication does not give a traditional indication for social interaction like FtF does, it is a continually growing aspect of our modern society and therefore also important. However, FtF relationships remain the standard form of communication which, as mentioned in the introduction, continues to influence development of a society in a more direct way. This does also not eliminate the fact that isolated individuals can still have friends of the primarily digital variety with whom they interact on a regular basis.

Note that isolation is not necessarily equivalent to loneliness, where the latter is being defined by being discontent with a state of isolation. Someone who is lonely most likely has the desire to change something about that, while maybe not having the means or capabilities to do so. In contrast to voluntary isolation those who are lonely do not choose to distance themselves from other people and is embracing a state of solitude. Both of these, isolation with and without loneliness, need to be considered in the light of technology.

3.1.2 Relevant definition of friendship

With a big part of this thesis being about technology based personal interaction it is important to make a distinction between different kinds of friendships, specifically between those made online and those made by FtF interaction. Both kinds are relevant to the degree of social interaction a person has, as for example Caplan [6, 7] or Stip et al. [3] considered that an online friendship might counteract some effects of social isolation. Meeting the definition of social isolation given in the previous section 3.1.1 the more relevant kind of friends are those you can interact with both face-to-face as well as digitally, not exclusively via digital means. Those are the real social connections that are considered by social analysis and have an influence on the quality of life of a person as defined by Voydanoff [17], and Diener and Suh [16]. Connections and friendships formed online can be just as good friendships as those made FtF, but they lack immediacy and a real sense of connection to the outside world, which is the relevant factor for this thesis.

3.1.3 Impact of little social interaction on life quality

For the validity of this research we assume that a decrease in social skills has a negative impact on society as a whole, and the quality of life in that society. This stems from the fact that a society is based on people interacting on multiple levels, in their free time and professionally. In their 1997 paper Diener and Suh discussed which outside influences have an effect on quality of life. They concluded that "economic, subjective and social indices can all shed light on a society's quality of life" [16], of which all three aspects are affected by personal social interaction skills.

Specifically for a professional career successful interaction with colleagues and clients plays an important role in the quality of results and the satisfaction of said clients. These kinds of interactions, while not entirely similar to casual social interactions, require a certain amount of social skills and effective communication methods that isolated individuals do not train for extensively and therefore have less chances of succeeding in. Extrapolating from this fact we predict that, were the general population to become less efficient with FtF communication, the overall quality of an economy and hence the living quality will decrease. Researchers like Voydanoff agree on that by having shown that the amount and success of social interaction can have an effect on job quality [17].

3.1.4 Modern-type depression

Kato et al., a group of researchers initially focused on Hikikomori, first came up with the term modern-type depression. They define it as follows: "Modern-type depression is characterised by a shift in values from collectivism to individualism; distress and reluctance to accept prevailing social norms; a vague sense of omnipotence; and avoidance of effort and strenuous work" [4]. This phenomenon has the distinct difference to Hikikomori in that affected persons do not only isolate themselves spatially, but the focus of their solitude is based on social isolation. However, cases of this disorder show similar behaviour patterns as soon as they are isolated at home. While unhappy at work or school they take comfort in solitary activities such as internet usage or gaming, parallel to how Hikikomori spend parts of their time.

Importantly, this issue is not limited in scope to Japan, but has also been detected in other countries like Australia, Bangladesh, India, Iran, Japan, Korea, Taiwan, Thailand, and the USA [4, 5]. Stip et al. even argue that while MTD and Hikikomori might have different names these phenomena are born out of the same issues and might not differ at all: "There is debate as to whether this syndrome [Hikikomori] marks a culture-specific response to societal change in Japan [9] or whether it is an emerging psychiatric disorder that may be present elsewhere" [19]. They also suggest that Hikikomori as

a behaviour pattern could be beneficial to some individuals where it can help them to "regain a sense of identity and social connectedness through new means more suited to them [9]" [3]. This gives rise to the thought that MTD would be an issue that can be encountered in the Netherlands.

3.1.5 Hikikomori

Hikikomori was the first well documented behaviour pattern that is related to personal isolation. It originates in Japan. Recall the general meaning of the name; pulling inward, being confined. In this section we will take a look at what Hikikomori actually means in terms of its causes and effects.

Research in Japan has identified five main characteristics of Hikikomori [10]. While there is still debate about the exact definition of the cause those symptoms have mostly been agreed on by Japanese researchers:

- (1) spending a majority of your time at home
- (2) showing no intent of taking part in society, be that going to school or working
- (3) long duration isolation, commonly defined by a minimum duration of 6 months
- (4) separation from even those who actively keep trying to maintain a social relationship, for example friends
- (5) exclusion of psychotic disorders or mental retardation

Hikikomori has been diagnosed in about 1-2% of adolescents and young adults in Japan, Hong Kong, and Korea. The duration of a person's isolation can range from 6 months up to 4 years or more in some cases. Cases of Hikikomori are predominantly male [3].

Reasons for Hikikomori are less well defined, but are agreed on to be of psychological origin. Psychological reasons for isolation can be plentiful, including aversive or even traumatic childhood experiences, social exclusion as children, dysfunctional family dynamics, parental rejection, high academic pressure, or a loss of societal identity due to globalisation and urbanisation [3]. Importantly, researchers are still unsure about the relationship to technology, and that is why we will be looking for cases of such a correlation in the Netherlands. Suwa and Suzuki state that despite "[...] the Hikikomori phenomenon first appearing in the early 1990s, [...] Internet usage only reached 60% in 2001. Therefore, it is clear that the Hikikomori phenomenon preceded general Internet usage." They also reason that Hikikomori is only the final stage of this type of disorder, and that it is often preceded by "an episode of 'defeat without a struggle'" [10], similar to how patients of MTD feel. For subjects of Hikikomori problematic internet use (PIU) can be both

a consequence of and a reason for their isolation. Additionally, their medium of communication changes accordingly. "Internet addicts do not leave the home not only because they are totally absorbed in the Internet, but also because they have a tendency to avoid communication with others" [10].

There is also evidence that excessive internet usage and Hikikomori may counteract each other, at least partially. The use of the internet might help isolated Hikikomori to stay in contact with the outside world and interact with people with similar interests and issues [3].

3.1.6 Problematic internet use and similar disorders

The other big factor which we will take a look at is the growing amount of time the average person spends on the internet and what effects that might have, in particular if there is any relation between internet usage and a change in social skills. Another study by CBS has shown that the amount of time spent online by the Dutch aged 18-24 has increased from 2015 to 2017 [20]. Even if we were to assume that the percentage of those that are addicted, a small sub-group of the people who answered to use the internet 10 hours or more per day, would not rise further but stayed constant that would mean the total number of internet addicts has increased in those two years due to a growth of population. Because of this it is important to raise awareness to this group and analyse their behaviour to better understand how to combat the issue. In order to be able to adequately discuss this we first need to define what PIU means.

Caplan [6, 7] concludes that PIU can introduce affected subjects into a cycle of increasingly less and less FtF social interaction. This happens because more time spent on the internet reduces a person's availability and motivation for real personal interaction, increasing the chances of taking part in so little interaction that a person starts to isolate themselves. On the other hand, the main source for isolation appears to be social anxiety and the connection to PIU is less impactful, but socially isolated or lonely people do show a higher risk for PIU. He attributes that fact to several aspects, for example the increased anonymity in an online environment which reduces fear of social interaction and enables isolated people who might be isolated due to such fears to be interacting with like minded people. Additionally, said anonymity lessens inhibitions to enter conversations and makes it easier to engage in communication compared to FtF interaction. The easier access then quickly becomes the norm and a person will no longer take the effort for FtF interaction, just as the definition of MTD by Kato et al. suggested by mentioning an avoidance of strenuous activities. This ease of use does an affected person no good in an effort of regaining what are considered normal levels of social interaction because of their acceptance of the more comfortable way of communicating.

The distinction between a primary and secondary case¹ of PIU is an important one too, as observed by Yellowlees and Marks [21]. They observed that "it appears that individuals who are pre-morbidly vulnerable, especially with a history of impulse control and addictive disorders, are especially at risk of using the Internet in a problematic way" [21]. This indicates that cases of secondary PIU appear simultaneously with other problematic behaviour patterns.

Internet addiction is the next step in that pattern of PIU. People who excessively and predominantly use the internet and show "poorly controlled preoccupations, urges or behaviours regarding computer use and internet access" [12] are considered internet addicts. The disorder has been "associated with dimensionally measured depression and indicators of social isolation" [12] and naturally has a connection to the isolation issues which we are assessing in this paper.

3.1.7 Generalisation of isolating behaviour patterns

To conclude the section this paragraph summarises points from all three disorders. This will be the template that the survey is based on. The two disorders MTD and Hikikomori are closely linked and show similar identifying behaviour patterns, most of which are already mentioned in the previous section. In general we found that there are five relevant and important behaviour patterns that can indicate social isolation:

- (1) Dissatisfaction with the current situation, meaning a missing fulfilment specifically with one's social and professional activities, and with life in general.
- (2) Individualism and isolation. This behaviour is characterised by a shift from collectivism to individualism and subsequent isolation, including separation from formerly close acquaintances. Other indicators are an avoidance of communication in general and showing no intent of taking part in society, but it can also stem from a sense of omnipotence and perceived lack of necessity for interaction. A person who falls into this category does not perceive their isolation as loneliness.
- (3) Reluctance in accepting existing social norms. Additionally to reasons for category (2), behaviour patterns in this category can be traced to a distress with social norms, including aversive experiences with personal interaction like issues with family or high academic pressure, in relation to both local and global factors. Those factors can have produced an anxiety at social interaction.

¹see appendix A.2

- (4) Avoidance of strenuous situations. Face-to-face interaction can be less convenient because the additional effort it takes compared to digital communication or a total absence of interaction. Isolated individuals do not take that extra step anymore. Growing academic pressure also plays a role in this category.
- (5) Absence of other primary psychological disorders that could have caused a secondary occurrence of isolation.

Additionally, there are 3 other considerations which play a role in how we can interpret the results of the survey.

- (6) PIU can either be a cause for or the effect of isolation. It is important to consider that a correlation between PIU and isolating behaviour patterns in the results of the survey does not necessarily indicate that PIU is the reason for that isolation.
- (7) As mentioned before isolated individuals can still experience a certain degree of interaction over the internet. An online friendship or regular contact with someone in a similar situation can help to regain a sense of community and reduce a person's discontent with the situation.
- (8) Cases of Hikikomori are primarily male. We are interested in whether that also holds in cases of isolation in the Netherlands.

3.2 Influences of technology

3.2.1 Variations of technological interaction

The concept of technology is a broad one. From the most basic of tools to complex computer systems, it all fits the overarching definition. However, the scope of this thesis limits the number of applicable technologies significantly. We will focus our attention on modern electronic digital technology, such as computers or smartphones, due to their significance for the topic and increased prevalence in modern times. Any references to technology will be in regard to modern electronic digital technology unless stated otherwise.

For the means of investigating a concise research question we will classify technology use cases in three different groups. This distinction is based on how we interact with each specified group because that also defines where and when we use it, which in turn might be connected to how extensively someone uses it. That is an important distinction for our research question since we want to find out if we can identify isolated individuals by the way they interact with technology differently than regular people. These are the categories we will be using:

- (1) Home use devices. This does include your standard computer, both the desktop and laptop variant. Devices for entertainment, such as the television or game console, or smart home devices like Google Home or Amazon Alexa also fall into this category. The personal smartphone has a diminished role in this environment because of its limited size and thus decreased interaction proficiency, though it is not totally absent [22]. Use cases of this scenario are typically of longer duration and more focused on that particular task, such as when doing work on the computer, or during passive or interactive media consumption. Examples for the latter include reading blogs, watching videos or movies, and gaming.
- (2) Professional or public shared use. Entries in this category include all non personal devices that a person might use. Most prevalent of which is the interaction in a work or study environment where the user does not, or to only a very small degree, interact with the technology in a leisurely manner like they would at home. Other devices which fall into this category include computers for example in public libraries and internet cafes.
- (3) Public personal use. This category sums up all technology interactions that primarily, but not exclusively, take place in public areas and of which the level of interaction is kept personal and individual. Small portable devices dominate this category. That includes smartphones, laptops, and other handheld devices. According to research usage patterns in this category are frequently of short duration, for example a quick check for new notifications [13]. The median session length of 57 seconds for smartphone usage according to Soikelli et al. [22] indicates sporadic and less focused interaction.

As stated in section 3.1 socially isolated individuals usually do so at home. People who spend their time at home interacting with that class of technology can not simultaneously be taking part in FtF social activities with other people, which decreases their interaction level with the outside world. This is an important consideration for the survey. Therefore we will investigate the influence of all three categories and look for possible relations between each of them and their impact on social isolation, being mostly concerned with category (1) because it has the closest relation to personal isolation due to the spatial connection of using it at home.

Additionally there has already been research on habit building usage patterns of smartphones (category (3)), for example by Oulasvirta et al. [13] from Finland. They concluded that "Qualitative data suggest that although repetitive habitual use is frequent, it is experienced more as an annoyance than an addiction" [13]. Equally less significant for this paper are interactions with category (2) because of the limited user freedom. In a

professional environment a user will not engage in the same activities they do for the other categories.

3.2.2 Computer interaction of young generations

Related research from 2004 on students in the US shows that computer usage can, but does not necessarily, have a significant impact on someone's level of FtF social interaction [14]. More recent research on younger participants of a pre-school age, those who never knew a world without technology, supports the hypothesis that it can also enhance social behaviour in ways of giving the opportunity to more varied pastime [15], supporting the hypothesis that social interaction can successfully make the shift from purely FtF to more digital communication.

These two studies are however from vastly different time periods and about people of different age groups and may not be related. How does this sit in modern times? Do the results for students still hold? We will not only take a look at how young people currently use the internet, but also consider the manners in which they interact with each other both online and in FtF communication. Recall that the main research question is whether there is a correlation between technology usage and isolation in the age range 17-25, students from Nijmegen. Researchers in the USA have found that there does indeed exist a connection between the increase in technology use and the extent of people's discussion networks and amount of social interaction [23], and with this survey we are going to check for similar correlations in the Netherlands.

3.2.3 Effects of technology affinity

Children in our modern society grow up with technology woven into their lives. Their introduction to the capabilities and limitations of technology happens far earlier than for past generations, which means that they learn a more intuitive interaction with it than most contemporary adults who grew up in less technologically advanced times and needed to learn technology after the fact. This might have an effect on how they see technology and their interactions with each other through technological means. While adults are used to their learned behaviour of FtF communication and do not depend on technology to interact with each other we are quick to argue that technology does only have negative effects. That however has been shown to not be the case, young people can effectively distinguish between useful and problematic technology use and adapt their behaviour accordingly [14].

Furthermore, affinity to technology also depends on how frequently one uses it and how well versed one is in its functionality. Someone who is less versatile with controlling computers and/or spends less time doing so might be less likely to show PIU related behaviours simply because they do

not interact with technology that much. On the other hand, people who work with computers every day might be more prone to keep doing so at home. Based on this assumption we will do this survey with a differentiating factor on the target audience in mind, namely on which faculty a participant studies like will be elaborate on in section 3.3.1.

3.3 Data gathering by survey

The goal of this survey is to gather data with which we can answer the research question based on the criteria for isolating behaviour patterns we specified above.

3.3.1 Target audience

The target audience for this study is a slice of the total population of students in the Netherlands, namely those who are Dutch and are studying at the Radboud University Nijmegen (RU) where this research has been conducted. Because of a presumed possible difference in results for different degrees of technology affinity as described in section 3.2.3 we will be considering two groups of students; those who do primarily use technology in their degree and those who do not. These groups will be represented by beta science students, and alpha and gamma students respectively².

Additionally there has been research conducted in Hong Kong [11] that indicates that there can be a difference in the effects that technology has based on the gender of a subject. The social behaviour of male students in their data group was more prone to be influenced by the way they use their computer. Parallel to this we recognised that cases of Hikikomori are predominantly male, as mentioned in generalisation point (8) of section 3.1.7, and we will try to validate that fact with our findings.

There are a few restrictions on our research target that we face with this survey. The target age of the audience is a natural conclusion of the research question, and so is the language in which the questions are asked³. However, due to the scope of this thesis we are limited to one location (Nijmegen) and one social demographic (academic students). We will refer back to those limitations in section 4.6 and appendix A.3.1 and discuss the achieved validity of the results. This paper is just a sketch on possible influences and future research can narrow down the aim of the questionnaire or extend the data on this research to other communities.

²In the Dutch educational system these refer to the study of the products of human actions (alpha), the study of non human nature (beta), and the direct study of human actions (gamma) (source: <https://www.uu.nl/wetfilos/bijsluiter/alphabetagamma.html>, assessed on February 16th 2020).

³see appendix A.3.1.2

The effects of these restrictions on the research can manifest themselves in two ways, which are interlinked with each other. Due to the fact that Nijmegen has a university the size of our target audience relative to the other age groups is increased⁴. In 2016, 26 738 people, which is 15.42% of the residents of the municipality Nijmegen, were aged 18-24 years [24] while in the whole of the Netherlands only 8.66% of the population fell into this category [25]. With the total population of Nijmegen at 172 064 at the start of 2016 [26] there were 19 899 students registered at the Radboud University in October of the same year [27], which is approximately 12.6% of that and would be 74% of the age group 18-24 if all students were that age, which the majority is. The amount of academic students in relation to the total population is higher than average. This means that the results of this thesis will not be fit for direct generalisation and should be considered only in the scope of the demographic of students.

3.3.2 Survey setup and discussion

The survey we set up to use for this research contains questions that can be categorised into two parts, questions about technology usage and questions about social and emotional isolation.

The former part includes questions on how, when, and how much one interacts with different kinds of technology. This will also aim to confirm the technology usage categories described in section 3.2.1. Here we will be referring to different use cases of solitary or social nature, like media consumption and gaming or social media respectively, and giving an overview of the time spent on such devices. The questions of this section will be grouped into the three technology usage categories. Category (1), home use of technology, will be represented by the PC usage in a participant's free time. Category (2), professional and public shared use, will be represented by a participant's interaction with the computer at their workplace or university. Category (3), public personal use, will be represented by phone usage. All of these three representations do not include every nuance or possible device or their category, but they represent the large majority and thus main focus of the group. Additionally they are easily understandable and recognisable such that participants can answer them without reading the definitions which we gave earlier.

The latter part of the survey will be reviewing a person's state of social isolation. While analysing the two parts we will look for relationships between them to find out if there is indeed a correlation or not, and each category will also be analysed separately.

Next to the questions we designed ourselves for this research we used the "Emotional versus social loneliness scales" by Wittenberg and Russel

⁴see appendix A.3.1

et al. (Wittenberg scale) to assess a person's level of isolation and their feelings about that [18]. The scale consists of a total of 10 questions which are supposed to be answered on a Likert scale and subsequently added up to form a loneliness index for a participant. This choice was made because the scale does not only evaluate the scope of someone's isolation but also their feelings about the situation, all the while being short enough to integrate it as just one part of the questionnaire. The inclusion of a participant's feelings about the situation is an important one because with that we can indicate how complicit an individual is in the state of their isolation. As indicated in section 3.1.7 those who isolate themselves voluntarily, and hence have none or little negative feelings towards their isolation, are relevant to this research. Considering the effects of technology on involuntary isolation can be the topic of follow up research.

As mentioned before the questionnaire is split into multiple parts. We start off by gathering baseline data on the participant age, gender, and faculty to demographically place the results. Then come the two most relevant parts, about technology and isolation. The use of technology will be quantified by the two aspects we worked out before. The first of which is the amount of time spent using technological devices, which is a good indicator for PIU and related issues. Secondly the survey will investigate the usage categories described in section 3.2.1 with the goal of finding relations between them and their possible impact on social isolation. These will be indicated by the activities a participant is doing while using technology.

After that we introduce the Wittenberg scale as an overview over an individual's isolation. Due to the general scope of the scale and the omission of technology oriented questions we added some more specific questions on isolation ourselves. These are aimed at investigating not only the relationship between technology and isolation, but also the amount of FtF and digital interaction a participant has. These questions are based on reasons for isolation which we found in section 3.1.

Most of our own questions are designed to be answered on the same bipolar Likert scale as the Wittenberg scale, while questions with integer answers will be open in order to be as precise as possible and since we can not predict what the scale of some answers might be. Categorising and grouping results will be left as a part of the analysis for as much as possible. Additionally, because we rely on voluntary participation for obtaining our results, the questionnaire itself is deliberately kept as short as possible in order to motivate participants to complete the entire survey. Questions about technology use cases are designed to be answered using a ranking of the frequency of conducted activities. According to a discussion of response bias and response validity by Robinson et al. [18] forcing a participant to rank answers instead of listing them with equal weight helps to prevent conscious or unconscious socially desirable responses. For the full questionnaire and further discussion see appendix A.3. Since the questions themselves

are rigidly connected with the theory formed in the previous sections their validity for this exact research topic is given.

In an effort to maximise the number of participants by minimising the barrier of entry and making sharing the survey easier this research has been conducted using a digital online survey.

4. Analysis and results

Please note that the topics of this paper had been conceptualised and in particular the conducted survey for data gathering had been finished before the Coronavirus appeared around the time of New Year's Eve 2019/2020. Social distancing measures did not exist and the pandemic did hence not have any effects on the responses, specifically the time scales and frequencies of social interaction by the participants, in any way. However, as we have all experienced during this period, the prevalence and manner of both direct social interaction and internet communication has drastically changed. In light of the close relationship of those topics to the theoretical part of this paper it would be very interesting to take another look at the topic with a more recent dataset and compare the results with our current findings.

We received a total of 96 responses to the survey, of which 49 contained a complete and usable set of answers. We only used those in the analysis. The other 47 responses, which were incomplete, have been discarded. Additionally there was one response where a participant spent 1900 hours per day using their PC for work purposes. That answer set was also disregarded because it was obviously based on an illogical thinking. For more detail on those cases see the discussion in section 4.6.1. The data analysis was conducted using IBM SPSS. For reference a list of all the variable names used in the analysis and their meaning in the context of the survey can be found in appendix A.3.4.2. For the Likert scale which we used in the survey the answers will be represented in a range from 1 to 5, where the higher numbers represent higher frequencies of occurrence of that particular activity or feeling.

Any graphs shown in this section were generated with the `point.dodge` option of SPSS such that multiple data points with the same coordinates would be visible. Due to this the visual representation of some data points may not be entirely accurate with the data, but it is preferred for better visualisation. The data itself was not altered. Points to which this applies will appear in a line which is centred around the original coordinate and are hence clearly distinguishable as belonging to the same value as of the

data point in their middle. For an example take a look at fig. 4.2, at the graph for PC time at work in the top left corner. For Wittenberg index 20 at 5 hours spent on the PC there are two responses with that answer, which appear next to each other.

4.1 Computed data

During the process of interpreting the data we computed some additional variables from the existing data. One of those new categories was the isolation score indicated by the Wittenberg scale. The individual answers on the Likert scales were added up to form an indicator for loneliness on a scale from 0 to 40 where a higher score indicates more loneliness. Most variables could be added up directly while some others had to be reversed because the question was asked in such a way that higher agreement indicated a lower level of isolation. This was done according to the evaluation method which Wittenberg designed [18]. For reference those questions are marked by a star in the questionnaire in A.3.3.2. The results of our own isolation queries were added in much the same way.

4.2 Agreement of Wittenberg- and specific isolation scale

The main question that we want to answer relies on a solid definition of isolation, so that is what we are going to take a look at first. We will verify that the results of our specific questions on isolation are in agreement with the already verified set of the Wittenberg scale. In order to reveal common aspects and trends between multiple questions in the responses we conducted a factor analysis¹. For this we used a minimum eigenvalue of 1 and iterated over the data 25 times. This factor analysis contains all questions of the Wittenberg scale and all of our own personal isolation questions. There are a total of 13 variables from which SPSS extracted 5 components.

¹see appendix A.3.4.3

Component Matrix^a

	Component				
	1	2	3	4	5
W2 Satisfaction from groups	-.160	.564	.099	.463	-.011
W3 Good people around	.563	.320	-.083	.379	.230
W4 No one feels close	-.383	.481	-.541	.266	-.126
W5 Close person for support	.704	-.462	-.077	.102	.213
W6 Network of friends	.699	.357	-.153	-.193	-.189
W7 Can count on companionship	.779	.296	.226	-.270	-.058
W8 No special relationship	.693	-.274	.138	.390	-.186
W10 Has romantic relationship	.549	-.596	-.180	.182	.091
P1 Is happy with situation	.767	.077	.272	-.046	-.323
P2 Socialising FtF	.525	.312	-.448	-.371	-.338
P3 Socialising digital	.399	.464	.398	.339	.227
P4 Socialising time	.264	.289	-.035	-.424	.752
P5 Free time at home	-.362	.075	.770	-.202	-.174

Extraction Method: Principal Component Analysis.

a. 5 components extracted.

Table 4.1: Factor analysis: Wittenberg items and isolation scale

From this table you can tell that there are no large heaps of questions which are grouped together in one component but are not in another. Most questions have a significant impact in all components. This is sound with the goal of the scale because they all aim to evaluate the same measure, finding out about loneliness. We expect all questions to score similarly in the components because of that. There are only a few outliers that do not fit into some of the components, like for example P1 and P5 scoring the lowest absolute correlation by far in component 2, or P5 having a higher than average correlation in component 3 while W2, W3, and W5 have a low factor for it. All questions that aim towards finding out about the close social environment of a person, like friends and special loved ones and how frequently and well one interacts with them², have a low factor in the third component. These are all the ones that have this specific goal and no other questions are aimed towards the same results. Neither do any of them have a similarly low correlation with component 3. This tells us that this part of the survey gave sound results. Other than those few outliers the correlations in each component are in about the same ballpark and therefore also indicate soundness of the scales.

²questions with such a goal and a low factor in component 3 are: W2, W3, W5, W6, W8, W10, and P4

Additionally this can be verified by plotting the two scales against each other, for which we can expect a linear relationship between them because both aim to find the same index. We found a resulting coefficient of determination R^2 of 0.935, which is a good fit and hence confirms that both the Wittenberg and our own scale represent the same isolation factors.

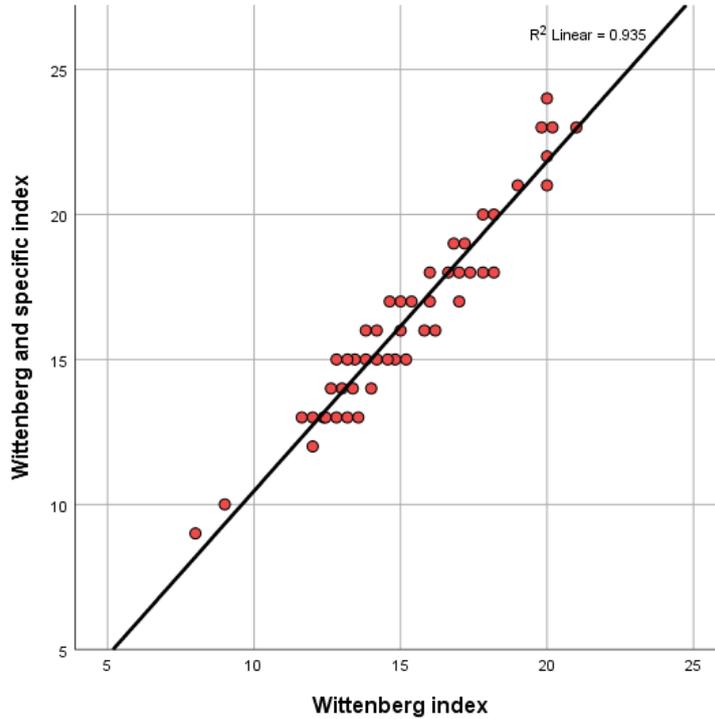


Figure 4.1: Plot: Wittenberg index against our specific isolation results

4.3 Relation between isolation and technology

4.3.1 Amount of time spent

Probably the most obvious of the indicators we found in the theoretical part for a possible connection between technology usage and isolation is the simple measure of the amount of time spent with each of the usage categories. So let us look at that first in order to get an overview of the results before we go into further detail about the other sections of the survey. In the following few graphs you can see the summed up result of the Wittenberg scale against the times the participants with that score spent on a certain activity.

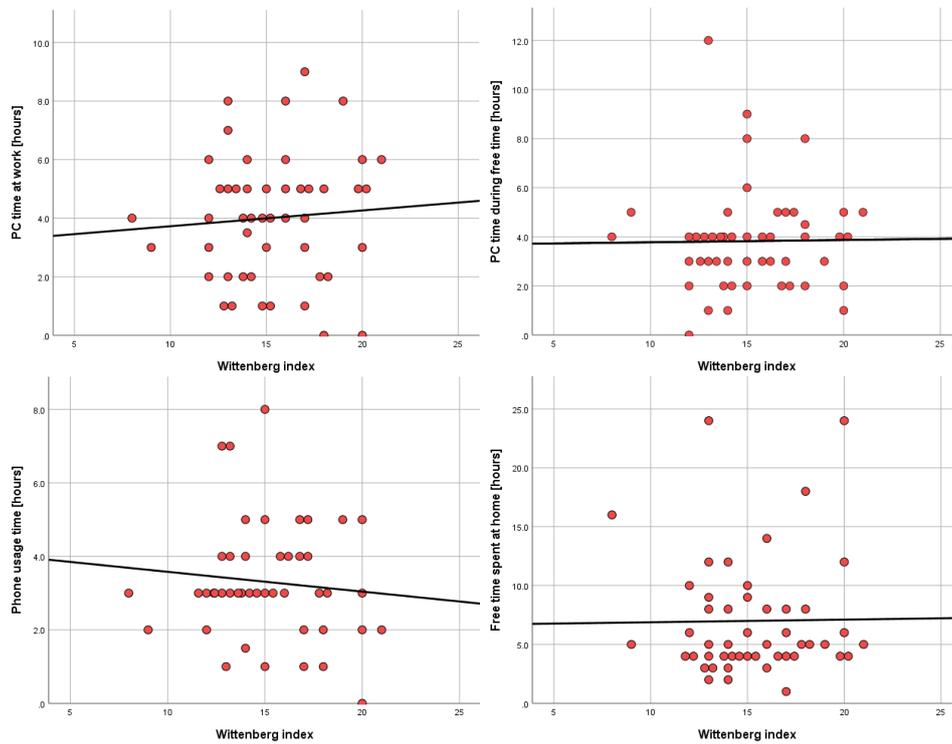


Figure 4.2: Plot: Wittenberg index against technology category usage times

Before we start with any specific conclusions it is noteworthy that some students spend their entire day, 24 hours, at home (see fig.4.2, "Free time spent at home" against "Wittenberg index"). This indicates that they considered the time spent sleeping or eating for example as free time as well. The existence of a result like that comes down to an imprecise definition of the question. We will discuss this along with other observations about the answer sets in section 4.6 about survey- and data quality. The results of this specific question need to be considered with a grain of salt.

However, we can derive some noteworthy conclusions from fig.4.2. The amount of free time spent at home and how a participant chooses to use that time do not have an impact on the Wittenberg index as indicated by the fit lines through those two graphs being very flat.

On the other hand the two remaining usage categories of a work PC and phone usage do have an impact on the Wittenberg index. The more time a participant spends on the computer at their workplace the more isolated they feel. That by itself however does not tell us that much about a person's behaviour as it could just be that those who use their PC more at work spend more time at their workplace in general. While one might expect that these people who spend more time on the PC at work have less time left to spend socialising because they work more our data can not confirm that suspicion

as you can tell by observed stability in socialising time for higher working hours of figure 4.3.

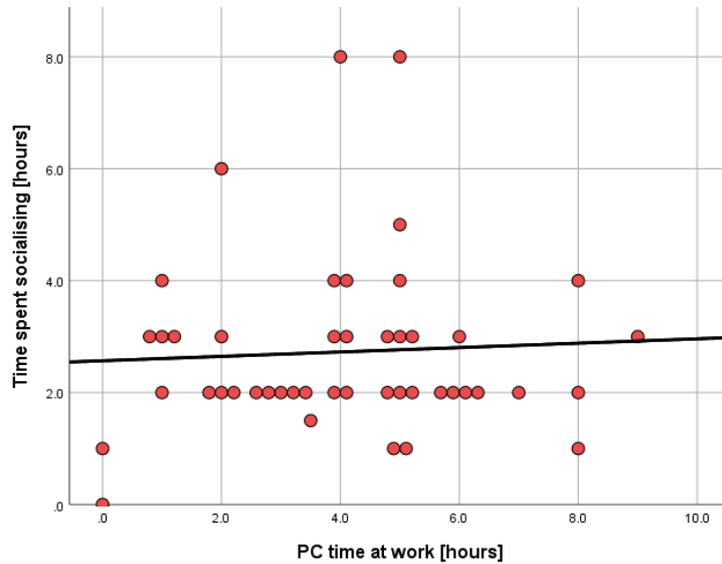


Figure 4.3: Plot: PC usage time at work against time spent socialising

For the phone usage it is the exact opposite, those who feel more isolated appear to spend less time on their phones. Let us take a look at whether we can determine a trend in the use cases that such individuals would prefer to engage in in the following section.

4.3.2 Use case analysis

Use case frequencies are indexed from 1, representing the highest frequency of use, to 6, representing the lowest frequency.

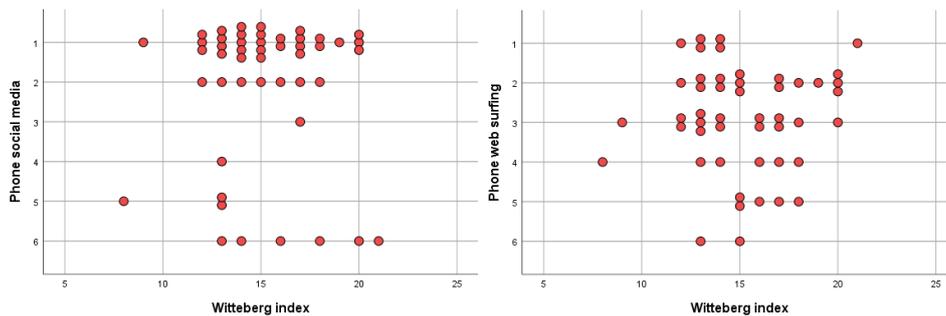


Figure 4.4: (1) Plot: Wittenberg index against phone use cases

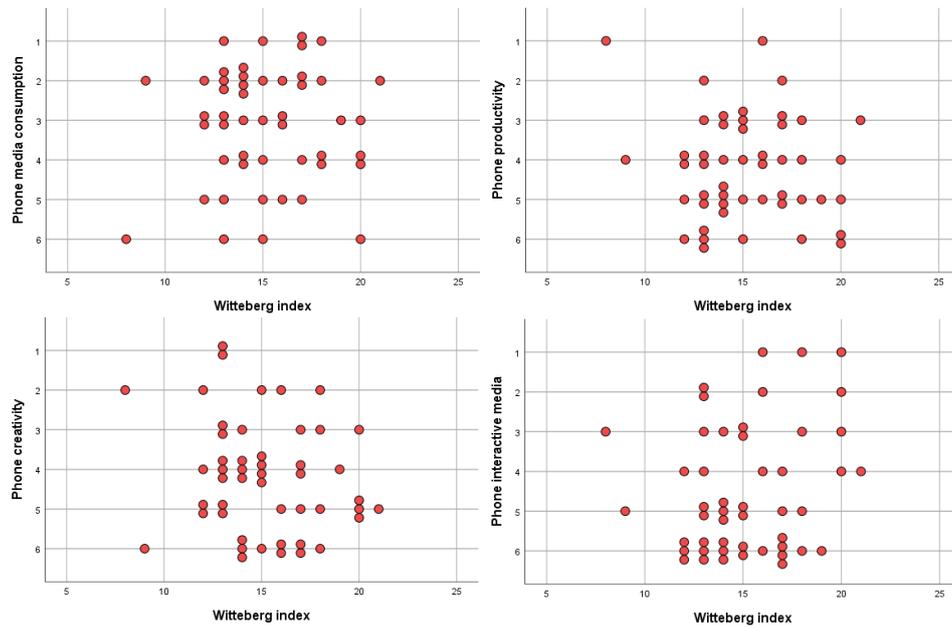


Figure 4.4: (2) Plot: Wittenberg index against phone use cases

Here you can see that a large portion of the participants indicated to use their smartphone primarily for social media interaction, and largely independent of their isolation index. The second most prevalent use case is web browsing closely followed by media consumption. Next up are productive and subsequently creative tasks, while interactive media was least frequently pursued by the participants.

The majority of the use cases do not indicate a tendency to certain tasks based on the Wittenberg isolation index. There is no observable correlation between the isolation index and a particular phone use case. The only exception to this result appears for interactive media use cases. People who indicated less interactive media activities, the frequencies 5 and 6, are clustered towards the lower side of the Wittenberg index. This indicates that those who do not feel very isolated use their phones less for this use case. The notion of interactive media has a strong link to gaming, which on the phone is a primarily solitary activity. It appears that those who indulge in such solitary activities show a tendency to feel more isolated, which agrees with the hypothesis that reduced FtF interaction does have an effect on social isolation in one way or another. At this point it is not clear which of those two is the cause and which is the effect, or if they are not interlinked with each other and influence another.

Let us also take a look at the use cases of the other two technology categories, starting with PC usage at work.

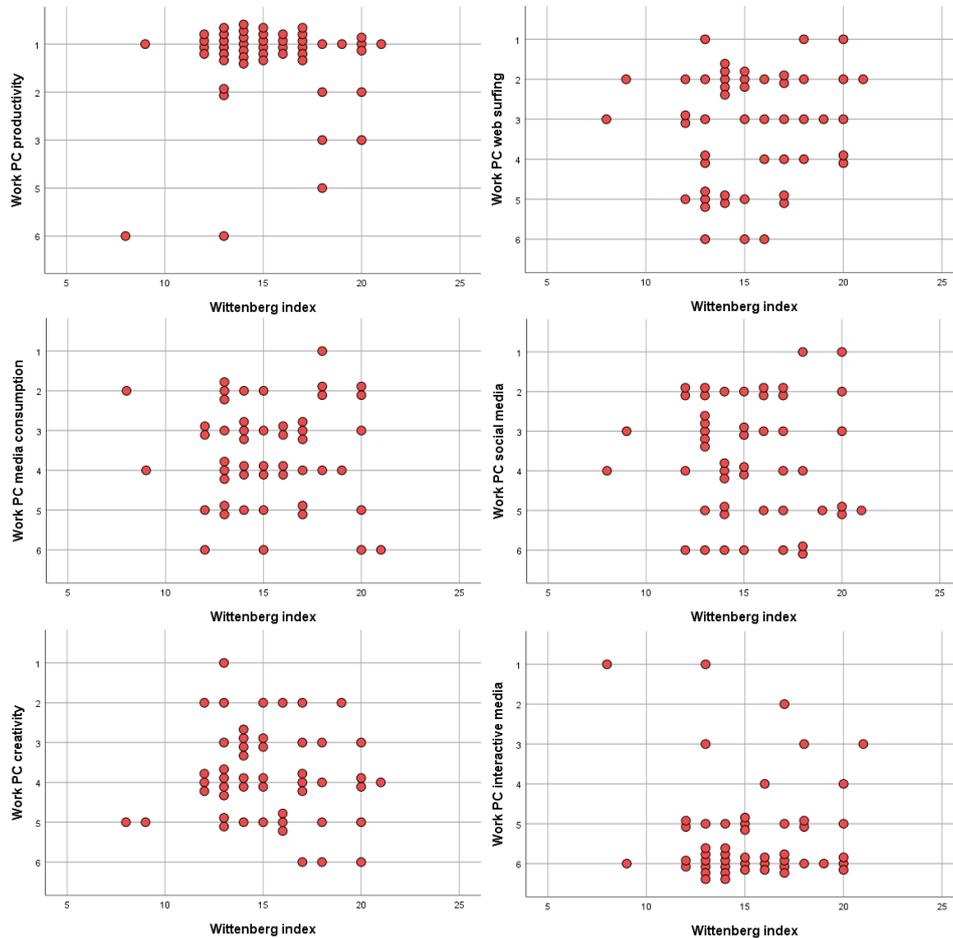


Figure 4.5: Plot: Wittenberg index against work PC use cases

As can be expected, the primary use case for the PC in this category is for productive purposes. Only 9 responses indicated that productivity was not their first priority. The use cases of web surfing, media consumption, social media and creativity were about equally balanced in terms of their frequency distribution, and except for media consumption they can all be at least partially related to professional purposes. Behind these interactive media was the least frequently consulted activity by as big a margin as productivity claimed the most frequent spot.

There is also no relation between either of the usage frequencies and the isolation index. There are no directional clusters or tendencies in that regard, such that we can conclude that the usage category (2) is not influenced by and does itself not influence the isolation index of a participant.

This agrees with the theory that we put up in section 3.2.1, which declared devices of this professionally oriented category to play a negligible role in the personal isolation of an individual. In contrast to the total isolation of Hikikomori the responses that we got indicate that participants are taking part in professional activities and show that, despite the fact that an individual may feel isolated, their professional workflow can be left unaltered. That can be seen in figures 4.2 and 4.3, as there is no trend in how much time an individual spends at home, and conversely can spend at their place of work. Whether this has any influence on the actual performance on the job or at university can not be directly determined from the data we gathered. Further research is necessary in order to verify or dispute the claims of reduced professional efficiency for socially isolated and hence less well trained individuals stated in the introductory section 1.

Lastly there is the category of PC usage during free time.

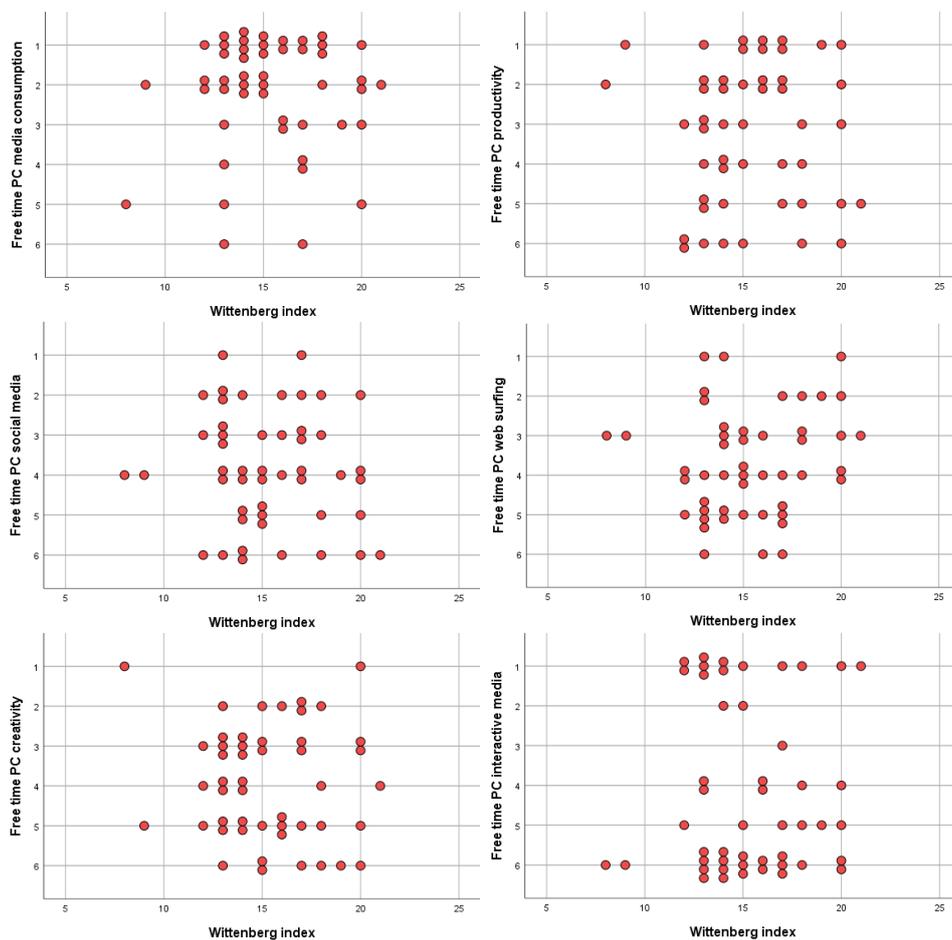


Figure 4.6: Plot: Wittenberg index against free time PC use cases

Media consumption has the highest prevalence in this category. The other five categories are about evenly distributed on the range of priorities. The only notable exception being that people either declared that interactive media be their highest or lowest priority, with not much in between.

There are no major trends to be found in this data set either, and thus we can say that the way in which a participant uses their PC at home does not have a relation to the isolation index in our dataset. In contrast to an increase of interactive media usage on phones we can not see a similar trend here. While considering that result it came to mind that the PC is not the only device in the category of personal private use at home that may contribute to this use case. Consoles also play a large part in the space of home entertainment and interactive media³, and we did not query our participants for any information on their ownership and usage times of those as this was something that we did not consider during the survey design in section 3.3.2. That is also something to keep in mind for future iterations and improvements on this survey, as we have discussed in section 3.3.2. The same holds true for the media consumption category where the television plays a huge role.

In summary, we did not find that any of the exemplary categories and activities have a distinct relation to the isolation index of a person, with the one exception being interactive media interaction on the smartphone. We were unable to confirm the proposed expectation of isolated individuals spending more of their free time at home and primarily using technology of the class (1), home use devices.

4.4 Examination of generalised patterns

4.4.1 Dissatisfaction with the isolated situation

After this more general look we now want to take a look at the proposed generalisation patterns of theoretical section 3.1.7 and in how far they apply to our test group. We will be starting with pattern (1), a participant's dissatisfaction with their situation.

³https://en.wikipedia.org/wiki/Video_game_industry#Economics, assessed on May 16th 2020

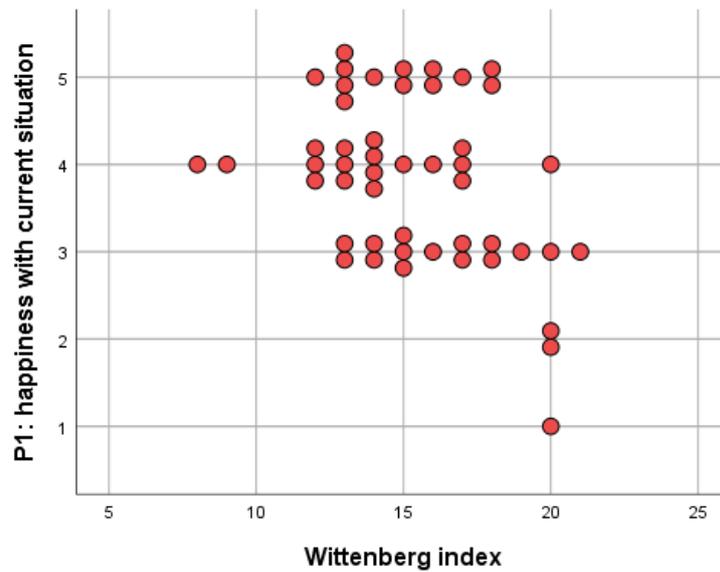


Figure 4.7: Plot: Wittenberg index against perceived happiness

There is a recognisable trend here. The graph confirms that participants with a lower isolation score are happier with their situation, while those who are dissatisfied generally scored a higher isolation index. Responses in our data set do indicate that socially isolated individuals tend to feel lonely. This is in accordance with our expectations from the definition of isolation in section 2.1.

4.4.2 Individualism and interaction patterns

Another factor which we wanted to assess with this survey was if the amount of socialisation with other people (pattern (2), individualism) and the manner in which one does so (pattern (4), effort avoidance) can give an indication for social isolation. Hence in this section we plot the total amount of time spent socialising, how individualistic someone is, and the two ways of social interaction which we categorised earlier against the isolation index.

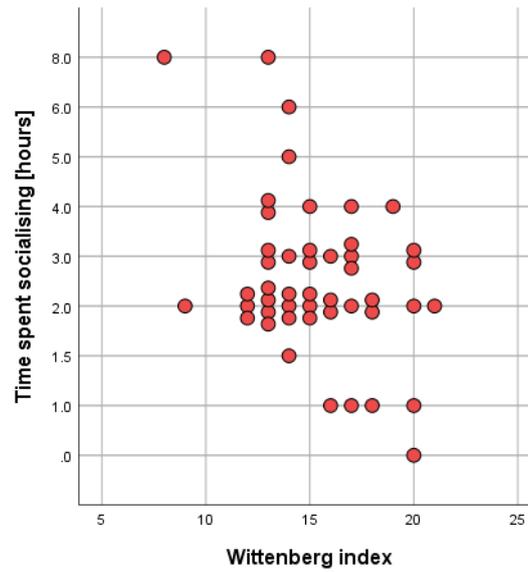


Figure 4.8: Plot: Wittenberg index against total socialising time

You can see that data points of a lower isolation index contain the larger part of the high frequency interactions, meaning that participants who are isolated do less socialising in general. The reverse holds true for the higher isolation indices, where we see a trend towards lower amounts of socialising time. This is consistent with the idea that participants who do not spend much time socialising feel more isolated, and it is in agreement with how the questions of the Wittenberg index are asked and what you would expect from our definition of isolation in section 3.1.1.

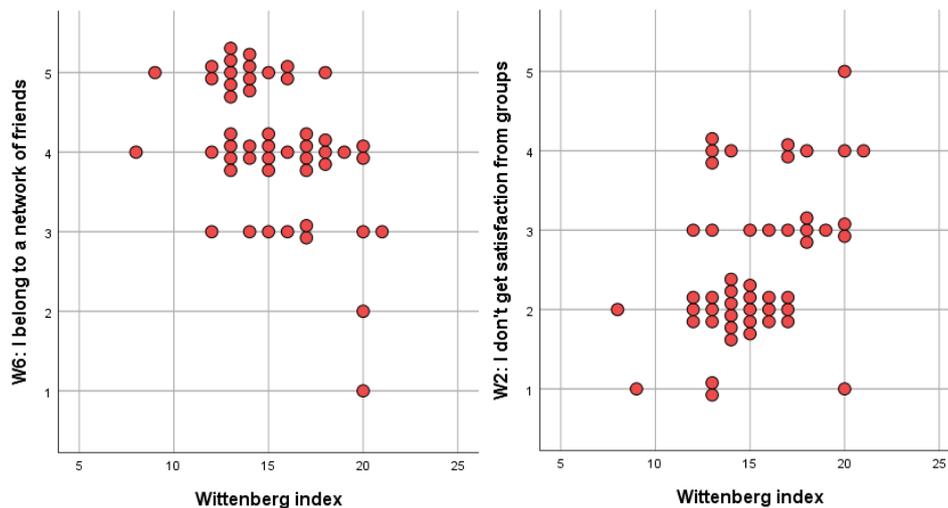


Figure 4.9: Plot: Wittenberg index against individualism indicators

Those with a lower isolation index tend to agree more that they belong to a network of friends. The opposite also holds true, a higher isolation score indicates that responses of that kind indicated a lower network of friends prevalence. The same trend can be seen in the satisfaction one receives from group interaction. These two graphs need to be considered with caution as they each reference a single factor of the Wittenberg scale against the sum, and hence the individual factors play a part in that total. But still, all of these three graphs confirm the role of the pattern of individualism.

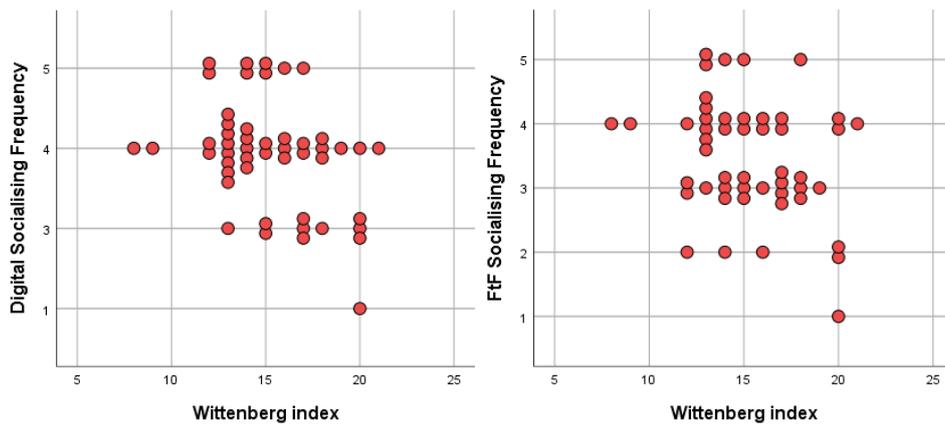


Figure 4.10: Plot: Wittenberg index against socialising patterns

In the last two graphs you can see that the average frequency of interaction is higher for digital mediums than it is for classical FtF means of socialising. This proves that the prevalence of modern means of communication, like for example WhatsApp on the smartphone, makes up a large portion of how we interact with each other. On the other hand the digital interaction graph seems to refute the theory that more isolated individuals would prefer to use less strenuous means of communication, the pattern of effort avoidance. However, this could also be due to a misaligned question, being such that participants may not consider digital communication less strenuous than FtF interaction.

The graph for FtF socialising frequency does not show a trend in relation to the Wittenberg index, hence with only this we can not confirm the pattern of effort avoidance in communication and interaction. We can however confirm that the modern youth, who grew up with technology as a part of their lives, is able to effectively use digital communication in social environment in parallel with FtF interaction as was proposed in section 3.2.2. An increased use of digital technology has not led to a presumed decrease in interaction time.

4.4.3 Gender differences

As for the last of the generalised patterns, there exists reason to believe that gender plays a role in the perception and level of social isolation (pattern (8), prevalence of male isolation). This section will take a look at exactly that, specifically if there is a relation between the isolation index and the amounts of time participants of each gender spend with certain activities that we have already analysed for the general case in section 4.3.1. To recap, we found that the PC usage during free time and the total amount of free time spent at home did not show a relation to the isolation index while the PC time at work showed an increasing and the phone usage time showed a decreasing relationship with higher isolation indices. Of the 49 cases which we used in the analysis 30 were female (blue dots) and 19 were male (red dots). No participants indicated to be of an otherwise unspecified gender.

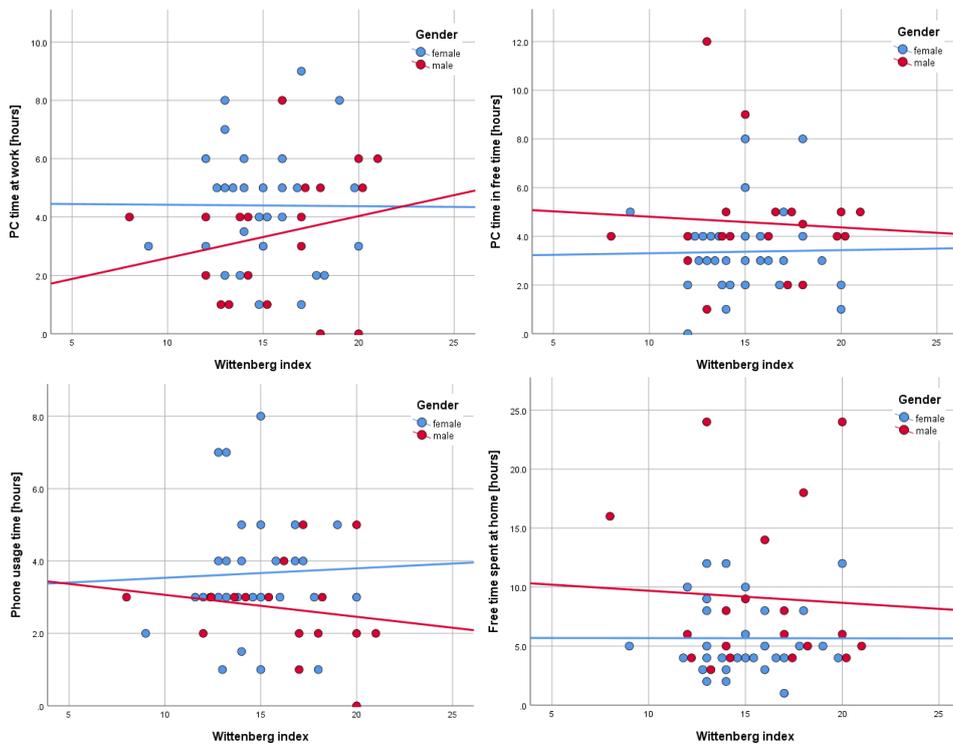


Figure 4.11: (2) Plot: Wittenberg index against technology category usage times per gender

Here we can see that the responses of female participants show a flat fit line for all of the time indicators. Both tendencies which we described in section 4.3.1 were generated by only the male population, and even in the other two categories the lines through the male population are significantly steeper. For the case of phone usage time the genders even go into oppo-

site directions, such that for female participants their time of use increased slightly for higher isolation indices. By this you can tell that the behaviour of female participants does change less, if at all, in relation to their social isolation while it does change for the males.

We can conclude that there definitely is a relation between the isolation index and the gender of a participant. In the theoretical part of this paper we discovered that this trend, at least in the Japanese Hikikomori, manifests itself such that the majority of the cases was male. Let us compare that with our finding on the isolation index.

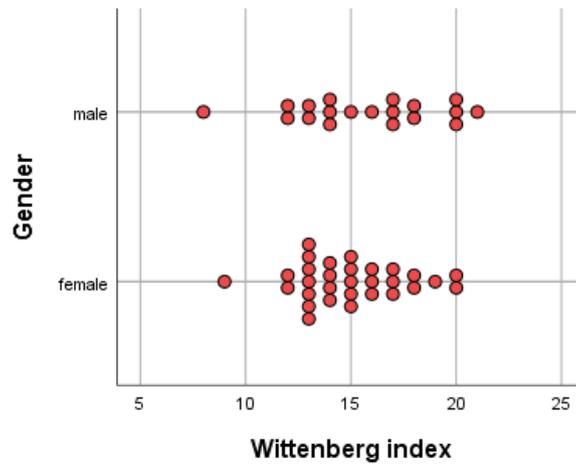


Figure 4.12: Plot: Wittenberg index against gender

As you can see there is a trend that female participants frequently feel less isolated in general, their distribution is skewed towards the left. For the male responses however we can not distinguish such a trend, the cases are evenly distributed on the isolation scale. Therefore we can not confirm that isolated individuals are predominantly male in our target audience, but we can note that their behaviour in the use of technology does differ. There are also less male participants in the dataset, so it might just be that we did not get enough data to come to a more decisive conclusion.

4.5 Technology affinity

Now let us take a look at whether the faculty at which a participant studies can give an indication for social behaviour patterns as we discussed in section 3.2.3. For this we plot the results of a number of social activity questions against the isolation index, this time per faculty. The answer set contained 13 participants from the alpha, 26 from the beta, and 10 from the gamma faculty. That gives us 26 students for the tech affine group 1 of beta students

and 23 for the presumed to be less tech affine group 2 made up of the alpha and gamma students.

Something to note independently from a specific behaviour pattern is that the isolation indices of each group are mostly evenly spread on the scale around the centre, but the higher isolation indices predominantly belong to beta students. There are also three outliers being such that the lowest scores were achieved by group 2 while the highest score was achieved by group 1. Those trends in the data are however minute and can hence not clearly indicate that the participants from one of the group showed a significant difference in their perceived isolation.

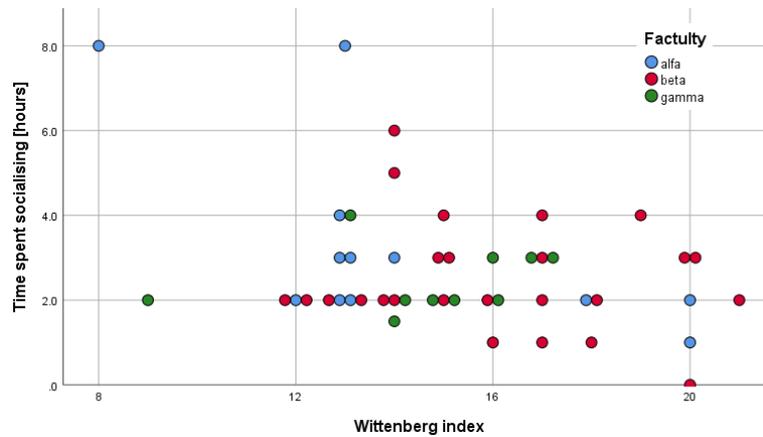


Figure 4.13: Plot: Wittenberg index against time spent socialising

Let us take a closer look at the behaviour patterns, starting with the amount of time spent socialising. As you can see in the graph, two individuals from the alpha faculty showed by far the highest amount, while four responses from the beta faculty showed the lowest amount. Besides those extremes however the responses are similarly distributed on the scale and there is no further indication that one group spends their time differently. We can however see that in general, the amount of time spent socialising decreases with a higher isolation index. This does again confirm the applicability of the Wittenberg index as we already found in section 4.4.2.

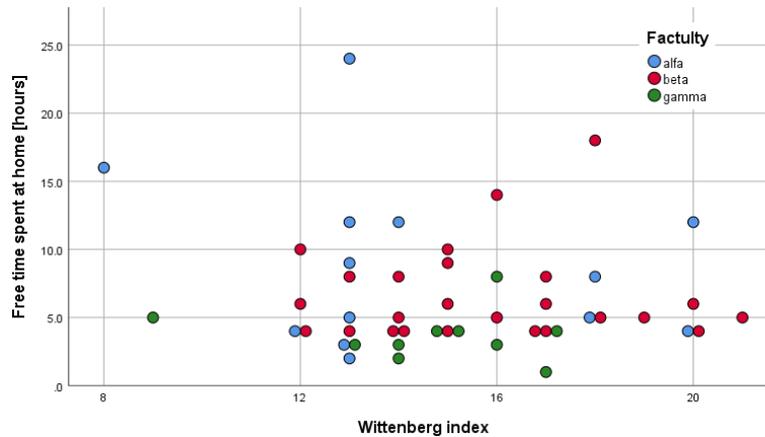


Figure 4.14: Plot: Wittenberg index against free time spent at home

For the amount of free time spent at home there are no major trends in the responses bound to the faculty. The amount of time spent at home does not give an indication about the isolation index of a response. You can however see that responses of group 2 cluster more towards the bottom of the time scale, showing that participants of those faculties spend less time at home in general. But since we can not find that same trend in the graph about socialising time it stands to reason that that time is not spend with friends but rather with other activities, like working or solitary free time activities that do not take place at home.

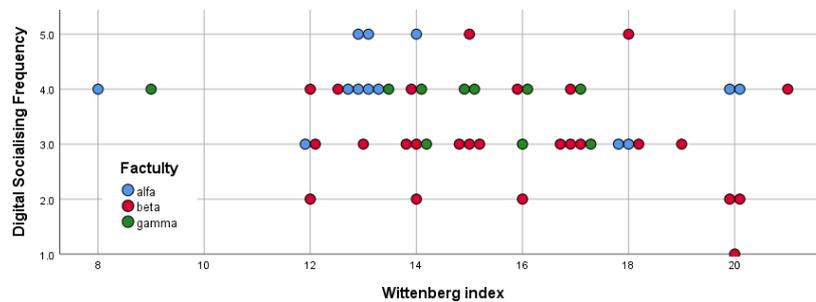


Figure 4.15: Plot: Wittenberg index against digital socialising prevalence

For the frequency of digital social interaction there is a difference between the groups. Participants of the beta faculty generally indicated a lower frequency for this type of interaction with an average of 3.1, while the other group averaged at the frequency 3.8. This is contrary to what we expected, being that the participants from the beta faculty were to be more technologically interested and hence would use the medium more.

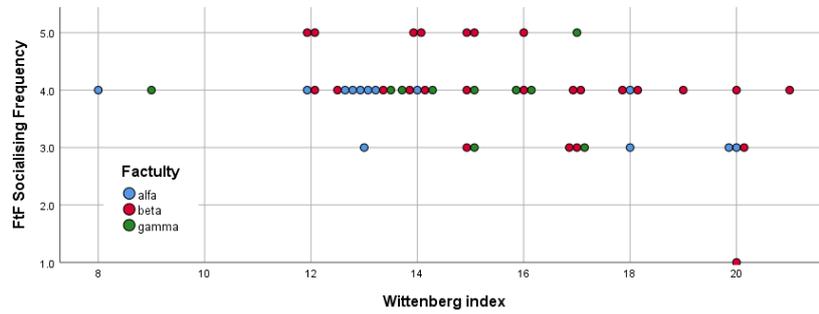


Figure 4.16: Plot: Wittenberg index against FtF socialising prevalence

For the direct FtF interaction the results are back to being very similar, with the majority of the cases of both groups indicating a frequency of 4. It is however notable that of the 8 participants that answered to use FtF contact almost exclusively, frequency 5, were of the beta faculty with only one exception, even if that may not have increased the average value by a considerable amount. Still, this is also contrary to the aforementioned belief that the more technologically interested people of the beta faculty would have a tendency to use digital communication more frequently. As you can see in figure 4.17 this seems to be a trend that holds only for the difference in social communication. We can not confirm that those who spend a larger part of their day with technology feel less inclined to do so in their free time as well.

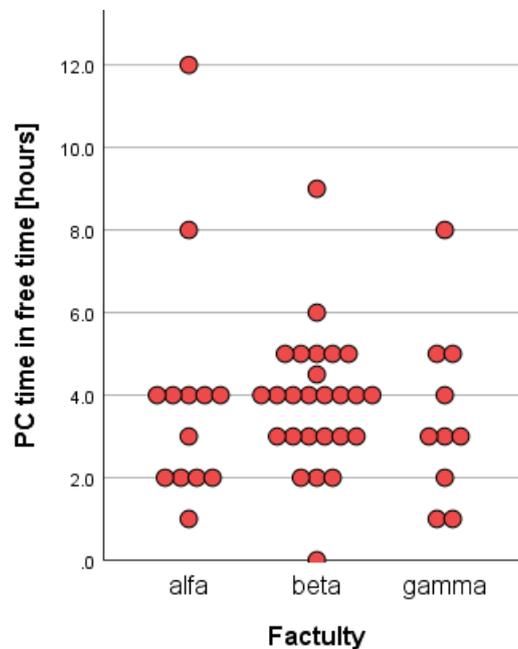


Figure 4.17: Plot: total time with technology per faculty

4.6 Discussion

Survey and data quality considerations

In general we are quite pleased with the results of the survey. With all of the consideration that went into the design of the questions and with the help of the preliminary test group we feel that the intent of the questions became clearer than it was in the first draft. That helped with streamlining the data and achieving interpretable results. However, during the runtime of the survey and the following analysis, there were a few other points of improvement that we noted. Those will be discussed in the following section.

4.6.1 Disregarded cases

With a total number of 96 cases it is quite notable that only about half of the participants did complete the entire survey. There are two possible reasons for that. First is that the survey was split up into different pages. Each page represented one category of the measures that we wanted to evaluate (basic information, device usage categories, and the isolation scales). From a perspective of response quality that is a good idea in order to avoid a certain response set. The idea is that participants should not know what the survey is about such that they give neutral and unbiased answers to each of the individual categories before proceeding [18]. On the other hand this opened up the possibility of participants not noticing that there were additional pages and just closing the survey somewhere in the middle. We were able to recognise such patterns in the data where some responses were complete up to the point of a page break, where the participant suddenly stopped entering data. 42 of the 47 disregarded responses were those where the participant stopped after filling in just the first page about their general information, making up the majority of those cases. Despite the fact that we had to disregard so many cases because of missing answers due to the page separation we still think that it was the right choice to make that separation. The quality of the answers is more important in this case, and we can expect a higher quality if participants are kept in the dark about the purpose of the survey. There are better ways to get more responses that maintain the same level of quality, like for example by prolonging the time of surveying or pursuing more aggressive marketing strategies to reach a wider audience. Those however will require more precise surveying methodologies as we will discuss in section 4.6.4.

On the other hand there were initially a few incomplete answers which we thought were due to us missing out on setting the survey to all mandatory questions. This was presumed to be the reason for participants missing some questions, be that deliberate because they did not feel comfortable answering or not. A couple of days after setting the survey online we rectified

that error and only accepted complete answers, but that did not have the desirable effect either as there were still many participants who simply closed the survey after the first page. In the survey system we selected a participant can, at any point during the process, close the browser tab or window without any warning, independent of whether they filled in all mandatory questions or not. A warning about unanswered questions only appears when selecting the final button that completes the survey. However, since that is on the last page most of the participants with incomplete answer would have missed that anyway. A better solution to this issue would have been to mention in the introductory text that there is more to the survey than just the first three questions on the opening page.

4.6.2 Wittenberg Scale, omitted questions

During the interpretation of the data we noticed a flaw in the questionnaire. Two of the 10 original questions of the Wittenberg scale have been omitted from our survey. The questions 1, "Most everyone around me seems like a stranger.", and question 9, "I am an important part of the emotional well-being of another person.", are missing. Since there is no obvious scientific reason to alter a verified scale in such a way that the conclusions might be less meaningful and descriptive we concluded that these questions were omitted by accident during the design of our questionnaire. The effect of this error is that the results of the loneliness scale lose some of their significance. Question 1 has a likeness to other questions like W2, W3, W4, and W6. This means that the omission of this question does not have a huge impact. Question 9 however has fewer and more vague connections to other questions like W4, W5, and W10, which also focus on the connectedness to other people, but usually in the other direction. While question 9 asks for the influence of oneself to another person's life the questions W4, W5, and W6 are more focused on the perceived connectedness of oneself. Hence question 9 plays a more isolated role and could have had an impact on the findings of this paper. However, with the questions which we added ourselves we were able to create some additional data (section 4.2) which makes this loss less severe. The proven validity of the Wittenberg scale will have suffered, even if just by a small amount. That is something what was unable to be regained with our own isolation questions.

4.6.3 Isolating behaviour patterns, definition of scope

In the analysis and results section 4.4 we discussed the behaviour patterns (1), (2), (4), and (8) in detail. For the other patterns ((3)(5)(6)(7)) our data was unable to provide more specific results than just the general analysis of section 4.3. There are varying reasons for that.

Pattern (3), acceptance of social norms, and (5), absence of other pri-

mary disorders, are simply tough to judge in such a short questionnaire. While there are measures and scales for each one of those, including them would have considerably increased the size of the survey. We wanted to avoid this and prioritised the much more directly relevant and isolation related scale by Wittenberg. The investigation of the other parameters is reserved for more in-depth research that could follow on this introductory overview.

The other two patterns, (7): the counteracting influences of online friendships and group identity, were left out during the creation of the survey. While we did consider other aspects of friendship we did not ask the participants to specify whether those were made and maintained FtF or just online. The perceived affiliation with others of the same isolation disorder is also only a small part of the Wittenberg scale, in which we again did not separate online and FtF interactions. Those are points of improvement for further research.

We also discussed that social anxiety or academic pressure could be other introducing factors for isolation. An analysis of this point was also dropped because of reasons of shortness. In addition to the assessments for example for other primary disorders they would have exceeded the scope of this paper.

4.6.4 Limits of online propagation

One limitation of the medium of an online survey of which we can not directly quantify the impact of is the propagation of the survey via the medium internet. While the physical advertising by means of flyers and posters in all buildings of the Radboud University is quite certain to have only reached students of the target demographic we can not say the same about the online mediums with absolute certainty. While we did only share the survey on websites and groups that are aimed at students of the Radboud University like the Twitter and Facebook pages of study groups and faculty organisations, we can not guarantee that no outsiders read the posts and take part in the survey. A better option for making sure that only students of the Radboud University would have been considered in the results would be to add an extra question to the questionnaire asking if and where a participant is studying and filtering out unwanted results in the analysis phase.

Another limit of the online propagation that could have had an influence on the results is the fact that we asked participants to share the questionnaire with their friends. We do not know how many participants actually did so or what the relation between primary and successive respondents is. This could have had an effect on the average and median values of the isolation index because those participants who shared the survey and those who received the link from a friend have, per that definition, at least one friend with

which they feel confident enough to share a survey about isolation. That could have skewed the results on the Wittenberg and isolation index.

4.6.5 Question and answer quality

During the analysis of the results an inconsistency in the range of answers to the question about the amount of free time spent at home became apparent. The answers in this category ranged from 1 to 24 hours. This indicated that some of the participants included the amount of time they spend sleeping at home while some did not. This is something that we would have needed to specify in the subtitle of the question. After the fact there is no way of figuring out who included sleeping time and who limited themselves to their waking hours. From the according graphic in figure 4.14 you can tell that a majority of the responses cluster towards the bottom of the time scale, indicating that most of the participants did not count their sleeping time into the result. But it is also clear that some did.

As mentioned before there was also one notable instance of an excessively large time scale answer. While we iterated through multiple manners of asking the questions and implemented feedback from a small test group before releasing the survey we apparently did not manage to make the questions entirely unambiguous, even with the aid of the introductory text and hints next to each of the question. Almost all participants answered in the expected range for responses and did hence understand the questions properly, but there were very few outliers who did interpret the questions differently. One response in particular for example claimed to spend 1900 hours per day working on their PC. This answer could simply have been a typographical error, but it could also be the result of misinterpretation of the scale of the answer that was required, for example by calculating their work hours per year. With this however being the only inconsistency in scale in the responses that were used in the analysis we concluded that the semantics and specification of the questions were well chosen. Still, it is something to keep in mind for future statistical research.

Issues in the precision of both questions and answers could have been minimised by being more precise in the formulation of the survey. More and longer explanatory texts and more examples could have prevented such small mishaps. However, we still think that generally the results of the survey went into a good direction and the questions were well enough defined. One of the criteria of this survey was to be as short and concise as possible after all. That criteria was chosen such that the questionnaire would suit the medium of an online survey, and by it only being an introductory overview into the topic that warrants further and more detailed research. Furthermore that is the reason for the choice of such a wide range of questions which delivered on many small subsections of the main research question. "Simplicity of wording" [18] is preferred in such psychometric surveys because

more complex and complicated questions could convolute their intention.

5. Conclusions

Lastly, let us sum up all that we found in the previous section 4 of the analysis. Based on our results we can not unambiguously state that there is a connection between technology and isolation in only one direction. There are aspects for example in the technology usage patterns of section 4.3 that do indicate that there is a relation between the amount and use cases of technology usage, and they go both ways. In some aspects our participants used technology more heavily at higher isolation indices, while in others the usage decreased.

This was also the case for our findings in the defined behaviour patterns. Some indicate a relation into one direction, while others hint towards the other direction. The case of how one chooses to interact with other people is an example for this. A generally high amount of digital communication lies in contrast with what we had initially expected for socially isolated individuals that depend on technology. We can confirm that a generation that grew up with technology woven into their lives are able to incorporate digital means of technology into their social interactions in a positive manner. On the other hand we found that for example certain aspects of phone usage can indicate a tendency towards higher scores on the isolation scale. These trends change in relation to how we select our target audience. The gender does play a notable role in how a participant uses technology, and also the faculty on which a participant studies plays a part in the results. These however do also not indicate a clear direction but vary in their impact and direction of influence.

In conclusion the duality of cause and effect of PIU and technology induced isolation (6), another one of the considerations for the behaviour patterns, appears to be the key point here because it is based on the twofold interaction of the two phenomena. It became clear that digital interaction and isolation can not be defined by one being the cause of the other. Their contribute to and influence each other in multiple ways.

Amongst the less technologically bound questions of this paper there are also some interesting conclusions. We were able to confirm that dissatisfaction with one's personal environment and social activity can have negative consequences on the isolation index and lead to loneliness. Similarly the size of the network of friends, how much time one spends with them, and how satisfying that interaction is do all influence the isolation index in ways you would expect. A difference between FtF and digital communication is apparent, though it does not indicate a change in interaction quality. We also found a differentiation in how different groups interact with each other, such that both gender and technology affinity play a role.

In conclusion we can note that there is no unambiguous connection between the technological reasons we proposed and the perceived social isolation of an individual. As discussed in the introduction and research sections there are known indicators that go both ways, and we can confirm that. On the other hand we can not directly confirm that the quality of life of the participants in our data set was deteriorating. However, during the process of manifesting a theory and designing and analysing the survey we dug up some interesting aspects on which follow up research can further our understanding of the connection. Those are listed in appendix A.1.

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A. Appendix

A.1 Inspirations for future research

This is a summary of all ideas and inspirations for future research that came to mind during the writing process of this paper. These can give more insights into the reasons behind some of the conclusions we found, or could themselves show interesting relations to the isolation perception and isolation index. Activities to conduct in future research include:

- solidifying the results by an extension of the target demographic to include other age ranges and social classes
- making a distinction between totally isolated individuals and those who only abstain from FtF interaction. Some people only use FtF or digital interaction exclusively while others use both. This differentiation can also include the kind of contact you have via digital means, be they either with people you know from FtF interaction, with those who you do not know from FtF interaction, or with those who you do not know at all.
- considering other causes for isolation for example by including reasons like social anxiety, the existence of other primary psychological disorders, or high academic pressure
- making a distinction on dissatisfaction patterns, for example dissatisfaction with only your social life, professional life, or life in general
- considering the effects of technology on involuntary isolation. This would be one of the fields in which the positive influences of technology could be more prevalent and hence better defined
- examining whether we can confirm the decrease of professional efficiency due to isolation in the Netherlands
- elaborating on the analysis about technology usage categories by including more devices per category, for example the use of the television or game console that we mentioned

- repeating the survey again now that the Coronavirus has had its influence on social interaction patterns and comparing the results with what we found in this paper

A.2 Primary and secondary psychological disorders

Psychological disorders like MTD and Hikikomori can be classified as primary or secondary cases, with the distinction being that the disorder can be caused singularly by outside effects (primary) or as a product of other disorders (secondary). The latter of which is characterised by the behaviour being triggered by other psychotic disorders like anxiety or other personal disorders [10]. Since we take a sociological and technological point of view within this paper we will not concern ourselves with psychotic disorders and their effects. Any mention of MTD or Hikikomori in this paper is about their primary variants if not explicitly denoted otherwise.

A.3 The survey

A.3.1 Target audience considerations

The chosen target audience of academic students from the Radboud University of Nijmegen (RU) is the product of several considerations, some of which are of a practical nature while others are based on requirements of the research topic. Due to the fact that students at the RU are just a slice of the total population. This choice comes with some effects that we need to keep in mind in the result discussion.

A.3.1.1 Academic students at the Radboud University

The choice to limit our target audience to academic students from the RU was largely based on practical reasons. Those being that the RU as the institution where this research has been conducted offered us the most control about the selection of our participants. An inclusion of other educational institutions would have come with higher logistical effort and would thus not have been as well controlled as we would want for this initial general survey. Furthermore, assessing the prevalence of the problem posed in the research question in other social classes outside of academia would introduce an imbalance of responses from the two kinds of sources. This would unnecessarily complicate the formation of valid conclusions from the results because the reasons for answering a question in a certain way would multiply. To keep the research focused and the answers unambiguously analysable the choice was made to constrict the social class that we survey, and such

more elaborate and detailed survey plans can still be considered for future research.

A.3.1.2 Survey language

During the creation of the survey we had to consider what the target audience for this research is, and thus in which language the questions on the questionnaire will be asked in. Due to the fact that this research focused on occurrences of isolating behaviour patterns in the Netherlands we chose to exclude international students who are just temporary inhabitants of the country. While some of them might stay for longer or come back at some point in their lives the majority of internationals will have no significant long time impact on Dutch society. And since that, the Dutch society, is what this research is aimed at we chose to ask the questions in Dutch. This choice makes the questionnaire easier to understand for Dutch participants and gives them the chance to answer in their mother tongue, which encourages detailed and more accurate answers without a language barrier. It also hints at the fact that we want to find results and hence possible improvements locally which might encourage participants to be more involved in answering the questions.

A.3.1.3 Age range

The research question asks for an investigation of the Dutch youth, which can, depending on your definition of youth, be a rather large and diverse group of people. In order to formulate a concise theory, and hence a valid questionnaire, we had to define that range properly. Based on the choice made for academic students as our target audience a lower boundary for the age of a person was given, assuming that the average student starts their higher education at the age of 17 or 18. But there is also an older generation of students who want to further their education. We drew the line at 25 years because that is, according to the general consensus¹, an age where on one hand the brain of person slows its development and on the other hand a person is considered an adult. Everybody older than that is no longer considered to be part of the youth.

A.3.1.4 Sample size validity

With a total of 22976 students registered at the RU Nijmegen² in October 2019, a desired confidence level of 95% and a margin of error of 5% we will need $n=378$ participants for a completely valid result. Our actual sample size of $n=46$ does not quite reach that amount of certainty over the results,

¹<https://en.wikipedia.org/wiki/Adolescence>, assessed on June 6th 2020

²<https://www.ru.nl/english/about-us/our-university/facts-figures/>, assessed on June 6th 2020

but it is large enough to get an initial overview which can suggest further research. And that is the whole idea of this paper after all.

A.3.1.5 Participant bias

In order to reach as many targets as possible whilst at the same time minimising a possible bias for technologically biased participants the online survey was advertised and spread on multiple channels, both online and on the campus. Amongst those were putting up flyers, sharing on social media, and asking participants to share the survey with people they know. We assume that, in modern times, every student at the RU has the means to take part in and answer an online survey. By spreading the survey on online channels the initial response might be limited to those who actively and frequently use social media, hence why we chose to put out flyers as well to reach a broader audience. Participants who were referred to by contacts imply that they have at least one social contact and are not fully isolated, which presents an interesting case for our research.

A.3.2 Validity of the Wittenberg scale

Robinson et al. [18], from whom we integrated the Wittenberg scale, contributed a validity analysis for each of the given questionnaires. For the Wittenberg scale they concluded with positive correlations³ to the UCLA loneliness scale [28], which is regarded the most commonly used scale for loneliness and does therefore serve as a valid benchmark. They found a 0.59 correlation with the UCLA scale for emotional loneliness items in the Wittenberg scale, and a 0.81 correlation with the UCLA scale for social loneliness items in the Wittenberg scale. Additionally, the Wittenberg scale is internally sound. Robinson et al. found that items of the UCLA scale correlate significantly higher with the appropriate parallel question in the Wittenberg scale than they do with the inappropriate one, indicating that participants who would take both surveys would be diagnosed with the same answer patterns.

A.3.3 The questionnaire

This is a representation of the questions used in our survey. The survey itself was done in an online environment and can hence not be copied into this paper accurately⁴. What follows is a summary of the questions and their according scale for answers. The indicator <open> refers to open questions where the participant can give an integer answer of unlimited

³correlations are given in the range of (-1,1) where a positive number indicates higher correlation

⁴find the online version of the survey at www.esurveycreator.com/s/BachelorSurvey&preview=1&DO-NOT-SEND-THIS-LINK-ITS-ONLY-PREVIEW

range, the indicator <likert> refers to a Likert scale using metrics on how frequently a participant experiences the proposition of the question on a scale of "never, rarely, sometimes, often, very often". Some questions are marked with <likert>*, which indicate a reverse correlation. The indicator <rank> refers to a questions where participants must rank the following possible technology use-cases by how much they do each one of the following activities: social media, media consumption, interactive media, web surfing, productive activities, creative activities. Each of the categories also includes an example of an activity in that category to prevent a degree of ambiguity. The initial ordering of answers of this category is randomised to prevent a bias based on initial conditions. The answer categories to all other questions are indicated in the same style of format. In order to reduce unusable results and make the survey easily understandable the questions were first tested on a small group (n=7), from which we incorporated feedback to streamline the questions.

The questionnaire was designed in English and later translated and adapted into the Dutch language.

A.3.3.1 Avoiding response set tendencies

A big part of statistical surveying is the task of avoiding a so called response set. The concept of a "response set refers to a tendency on the part of individuals to respond to attitude statements for reasons other than the content of the statements" [18].

Among the techniques to avoid this Robinson et al. mention the use of so called forced-choice items and refers to forcing the participant to choose between two or more given answer patterns. In comparison to open questions this requires more effort and hence consideration by the participant and increases the quality of the response, while also avoiding possible non-decisive answers like "don't know" or "not sure". They also help to prevent a response set of social desirability, the tendency of participants to want to make a good impression.

A second measure we took to avoid response set was to split up the survey into multiple pages. The reasons for and effects of this were discussed in section 4.6.1.

A.3.3.2 English original

Your data will be anonymised. No personally identifiable data about you will be stored and your answers can not be linked to you in any way. Your response will be recorded with a randomly generated index that is independent of your answers. Please answer honestly. For questions referring to time spent doing an activity please answer with your daily average time in hours each day during the last year.

— General information —

- How old are you? <open>
- What's your gender? <male/female/other>
- What faculty do you study in? <alpha/beta/gamma>

— Technology usage —

- How much time do you spend on a computer at university and work? (Average daily, in hours) <open>
- At university or work, what do you use the computer for? <rank>
- How much time do you spend on a computer at home? <open>
- In your free time, what do you use your personal computer for? <rank>
- How much time do you spend on your phone? <open>
- What do you use your phone for? <rank>

— Wittenberg Scale —

- (W2) I don't get much satisfaction from the groups I participate in. <likert>
- (W3) There are good people around me who understand my views and beliefs. <likert>*
- (W4) There is no one I have felt close to for a long time. <likert>
- (W5) I have a very good friend or romantic partner who gives me support and encouragement. <likert>*
- (W6) I belong to a network of friends. <likert>*
- (W7) There are people I can count on for companionship. <likert>*
- (W8) I do have one specific relationship in which I feel understood. <likert>
- (W10) I do have a special love relationship. <likert>

— Our specific isolation questions —

- (P1) I am happy with my current social situation. <likert>
- (P2) When socialising I do so with face to face interaction. <likert>
- (P3) When socialising I do so with digital interaction. <likert>
- (P4) How much time do you spend socialising? <open>
- (P5) How much of your free time do you spend at home? <open>

If you want to support my research please share this survey with your friends and fellow students. We appreciate the help!

A.3.3.3 Dutch adapted

Het invullen van deze vragenlijst duurt slechts 5 tot 10 minuten. Vul alle vragen in.

Je data wordt anoniem opgeslagen. We slaan geen data op die jou kan identificeren. Als index gebruiken we een toevallig gegenereerd getal dat niet gekoppeld is aan je antwoorden. Beantwoord de vragen eerlijk.

Met de tijd die je aan een activiteit besteed wordt het gemiddelde aantal uren per dag in het afgelopen jaar bedoelt.

[— General information —]

- Hoe oud ben je? <open>
- Wat is je geslacht? <vrouw/man/anders>
- Op welke faculteit studeer je? <alfa/beta/gamma>

[— Technology usage —]

- Hoe veel tijd besteed je op de uni en je werkplek aan de computer? (gemiddelde aantal uren per dag) <open>
- Waar gebruik je de computer voor op de uni of je werkplek? <rank>
- Hoe veel tijd besteed je thuis aan je computer? <open>
- Waar gebruik je de computer voor in je vrije tijd? <rank>
- Hoe veel tijd besteed je aan je mobieltje? <open>
- Waar gebruik je het mobieltje voor? <rank>

[— Wittenberg Scale —]

- (W2) Ik haal niet veel voldoening uit groepsactiviteiten. <likert>
- (W3) Ik heb goede mensen om me heen die mijn ideeën en overtuigingen delen. <likert>*
- (W4) Er is voor een lange tijd niemand met wie ik me verbonden voel. <likert>
- (W5) Ik heb een goeie vriend/in of romantische partner die me steunt en aanmoedigt. <likert>*
- (W6) Ik hoor bij een netwerk van vrienden. <likert>*
- (W7) Er zijn mensen naar wie ik altijd toe kan gaan voor gezelschap. <likert>*
- (W8) Ik heb een specifieke relatie of vriend/in die me begrijpt. <likert>
- (W10) Ik heb een unieke romantische relatie. <likert>

[— Our specific isolation questions —]

- (P1) Ik ben tevreden met mijn huidige sociale situatie. <likert>

- (P2) Sociaal contact hebben doe ik oog in oog. <likert>
- (P3) Sociaal contact hebben doe ik via digitale communicatiemiddelen. <likert>
- (P4) Hoe veel tijd besteed je aan socialiseren? <open>
- (P5) Hoe veel uren van je vrije tijd besteed je thuis? <open>

Bedankt voor het meedoen!

We zouden het waarderen als je deze enquête deelt met je vrienden en studiegenoten.

Klik op "Gereed" als je alle vragen hebt beantwoord.

A.3.4 Data analysis considerations

A.3.4.1 Data classification

In addition to our own specifications the survey system created a number of additional fields for each response. Those were an answer ID, a resume code, the date and time of start and end of a participation, and the participation status (completed or not) for each of the responses. All except one of those fields were discarded immediately upon downloading the responses from the survey website to guarantee anonymity. The one exception was the answer ID. There was no pattern recognisable in those IDs so the anonymity of the participants was not violated. We kept the answer ID in the data for easier data handling.

For the analysis of the responses we then used the following response scales:

- Nominal: A nominal scale was used for the answer ID, gender, and faculty. In a nominal scale the values of responses do not have a relation to each other. Due to that fact we were able to encode response fields with a string answer to an integer representation for analysis. For example, in the gender category the female gender was encoded as a 1 while the male gender was encoded as 2.
- Ordinal: An ordinal scale was used for the response fields that required a ranking. Those were used for the use-case ranking for each of the three technology categories of professional PC usage, personal PC usage and phone usage, and for the Likert scale responses to the Wittenberg scale and some of our own isolation questions. These answers do have a relation to each other but can not be put on an absolute scale or directly used in calculations because an answer of a response of "sometimes" does not necessarily indicate a frequency twice as high as "rarely".
- Scalar: A scalar response scale was used for response fields that contain answers which can be put on a scale. Those include answers on

age, time of usage for all technology usage categories, and the time of socialising and isolation. These have a clear relation to each other and can be put on a scale where 0 indicates no time at all for example. Thus the distance between units is constant. Two hours is twice as long as one hour.

A.3.4.2 Variable naming scheme

Here is a complete list of all variable names and their meaning used in this document and the SPSS analysis.

- AID: the answer ID created for this response.
- AGE: age of the participant.
- GEN, NGEN: gender, where GEN is the gender as a string and NGEN is the converted numerical representation (1=female, 2=male).
- FAC, NFAC: faculty, where FAC is the faculty as a string and NFAC is the converted numerical representation (1=alfa, 2=beta, 3=gamma).
- PWT, PFT, PT: The letter T indicates that this variable represents the time spent on a particular device. The prefixes PW, PF and P stand for the use-cases of PC at work or university, PC in their free time, and phone usage. These prefixes hold for the following 6 categories as well, which represent the ordering chosen by the participant. These are the activities that a respondent had to rank according to the frequency with which they conduct this activity.
- PWS, PFS, PS: social media interaction on the respective medium.
- PWM, PFM, PM: media consumption.
- PWI, PFI, PI: interactive media.
- PWW, PFW, PW: web surfing.
- PWP, PFP, PP: predictive activities.
- PWC, PFC, PC: creative activities.
- W2, W3, W4, W5, W6, W7, W8, W10, WSC: These variables represent questions of the Wittenberg scale. What the indices of each questions refer to can be found in the questionnaire at A.3.3.2, while the variable WSC indicated the final loneliness score of a participant.
- P1, P2, P3, P4, P5: These variables represent our own questions about isolation. The indices for these can also be found at A.3.3.2.

A.3.4.3 Factor analysis

A factor analysis is a data analysis technique which scans the survey data for correlations between all the answers to the questions. The algorithm tries to figure out aspects of questions that show a high similarity between each other and summarises them into components. Each component is then given by the strength of correlation that each question has in that group. This means that if more than one question and their answers converge on similar results and indicate the same tendencies then they will be assigned high weights with the same component. The weight of a question in relation to a component can be either negative or positive. Positive correlations confirm each other while for negative correlations the answers are still strongly related to each other, but in an inverse manner. For example the relation between the time spent awake and the time spent sleeping is obviously very high, but if there component in which they are both gathered up were based on the sleeping time a high negative correlation would be found to the time awake.

With this it is easier to uncover trends in the results and find relations between the questions. This is both useful to validate the quality of the questions by checking for undesirable relations, but it also helps with finding trends in the data which can indicate interesting results that warrant further analysis in the conclusions.