

Virtual proximity: so far away but close enough?



Folmer Osinga
Bachelor's Project
Thesis final draft
27/01/2023

University of Groningen

Word count: 6183 (with references and appendices: 7776)

Abstract

Existing literature brings evidence that physical proximity is important for learning. Virtual proximity is the closeness between two actors described in their sharing of information through a non-physical way. The study presented below investigates whether virtual proximity can be a substitute for physical proximity. The specific topic is the effectiveness of learning compared between geographical and virtual proximity for students at the University of Groningen in the Faculty of Spatial Sciences. Using quantitative research methods and a questionnaire, data is gathered from students that have received education in both the period that they could go to campus physically (September 2018-February 2020) as well as that they had to receive that education in a virtual way (March 2020-June 2022). The data is used to examine whether there is a significant difference between the two time periods. Furthermore, the study aims to explain how the social life of students has been influenced by the pandemic and the obligation to meet virtually as a result thereof. The results show that virtual alternatives cannot be a perfect substitute for physical education, but can be helpful as addition to education when it comes to courses that rely heavily on literature.

Introduction

Background

In the last two years, the worldwide situation experienced a huge shock when the covid19-pandemic hit. Specifically, for the academic environment, this meant a difficult task to find new ways to communicate with other students, teachers, and scholars. In the Netherlands, at one point, all academic education was supposed to be given in a digital way. Hansen (2014) proves how being geographical proximate is important for learning. Elements that physical education entail are face-to-face contact, making relations in the classroom and students can learn from one another. However, could a virtual way of educating young people at universities be a suitable substitute for 'normal' physical education? Investigating whether this is a suitable substitute during times of distress could maybe tell something about it being a substitution during 'normal' times.

Moreover, not only for the academic but for all communities over the world, it might be interesting to explore how different types of proximity influence the daily lives and the interactions of those communities. Doing this research in the Netherlands at this moment in time makes sense since the Dutch health organization (RIVM) did suggest evidence for an increase in new covid19-infections in the fall of 2022 (RIVM, 2022). At the time of writing the thesis, this increase proved to stay within acceptable limits and no new measures had to be taken at educational institutions. It does however prove that such unpredictable events can take place anytime, which is another incentive to research how proximities work and influence one another.

For policy planners, it stays interesting to explore ways to keep people connected, also during (future) times of unexpected events of disruption. Spatial scientists could find merit in this type of research, as it gives insight into how digital connectivity plays a role in the closeness between two actors. In the two years that were influenced by the pandemic, governments have felt obligated to take heavy measures, which sometimes included people not seeing each other in person for days or weeks. How this exactly pans out in the future is unsure, but it is known that it has had a huge impact on people's lives. Policymaking in the Netherlands had to be done in an instant, taking measures that had 100% impact, knowing only 50% of the facts, while taking responsibility for 100% of those measures (Rijksoverheid, 2020).

Generally speaking, people learn from other people close to them, think of a child and its parents, a student and its teacher. Physical proximity is highly and positively influential on knowledge spreading, innovation, but also for economic activity (Howells, 2002), especially for creating a comparative advantage toward other (economic) actors (Boschma, 2005). Continuing studying this topic is of high interest to the academic community and furthering this research contributes to keeping the standard of academic education high. Especially times impacted by short-term disturbances need to be looked at and investigated. In the end, for education, it could prove to be beneficial to prepare for disturbing times. Education cannot stand still and needs to continue, therefore having alternatives ready in times of distress, is a must. Evidence of this can be found in the recent pandemic, when suitable alternatives lacked and decisions were taken hastily, perhaps without the right considerations.

Taking higher education as the core of this research provides a good chance of finding differences between virtual and physical ways of educating young people. At the same time, it serves an opportunity to investigate a social element, which is important for students in higher education (Terrazzas-Carrillo *et al.*, 2014). In general, students that go to university physically, have a higher grade of social interaction with other students than students who do not go (as often) (Moghisi *et al.*, 2015). Students create a social life in the period they are studying, and in this light, the research investigates whether these students still create that social life in a period that is mainly about virtual communication.

Research Problem

In this thesis, the aim is to find an explanation for the problem of how the lack of geographical (in this case physical) proximity can be accounted for by virtual proximity. During the worldwide pandemic of covid19, there was clear cause for the lack of physical proximity, after all, governments and health organizations decided it would be best to suppress infections. Doing this, a huge decrease in physical proximity was observed. It is interesting to find out whether virtual proximity played a role (and moreover can in the future play a role) in the substitution of this geographical proximity, in relation to learning and educative purposes. Investigating whether virtual proximity can be a substitute for geographical proximity can prove to be interesting looking at future pandemics and how to deal with them.

The implication of lower geographical proximity has an influence on social connections between students. As discussed earlier, being socially connected is an important part of this specific period for that generation. Can virtual proximity also be a substitute for making and maintaining those connections when physical proximity is low?

In academic literature, there exists a gap in the topic of virtual proximity. Research on virtual proximity does make clear that physical presence can always be supported by the virtual presence (Baldassar, 2008; Kędra, 2021) and can sometimes add another, positive dimension to being present (Tomek & Giles, 1999). However, it does not become clear whether it can function as a replacement. Therefore, the research question for this thesis is as follows:

- To what extent can virtual proximity be a substitute for geographical proximity for academic education in times of covid19?
 - What relationship has the lack of physical proximity on learning of students at the Faculty of Spatial Sciences at the University of Groningen?
 - What relationship has the lack of physical proximity on the interpersonal social connections between students at the Faculty of Spatial Sciences at the University of Groningen?

Structure of the thesis

For the assigned Bachelor Thesis, a certain structure is expected. The structure for this thesis is basically made up of four blocks: 1) introduction: explains the background of

the research and what the research problem at hand is and also introduces the research questions. 2) theory: shows a theoretical framework derived from suitable literature about the specific topics and brings conceptual model/ multiple hypotheses forward. 3) methodology: clarifies how the research is structured and how actual data are gathered, used, and analysed. 4) results: displays the results coming from the research and shows all of the statistical work, afterwards a conclusion is drawn, and there is room for a discussion about the results. Then, limitations, future research and policy implications based on this study are introduced.

Theoretical framework

Geographical proximity matters a lot for learning and the creation of knowledge (Hansen, 2014). But next to geographical proximity, different proximity dimensions exist. There is a wide body of academic literature on these proximity dimensions. Boschma (2005) wrote a critical assessment of the five main dimensions of proximity that are described in this literature. The five main proximities are geographical, social, institutional, organisational, and cognitive, explained as follows.

Based on Boschma (2005) geographical proximity is defined as “spatial or physical distance between economic actors, both in its absolute and relative meaning” (Boschma, 2005; p69). Social proximity is explained as “socially embedded relations between agents at the micro-level” (Boschma, 2005: p66). Institutional proximity is referred to as fixed ties between actors looking at the macro-level. Organizational proximity is defined as the arrangement in which alliances share organizational ties. An example of being organizationally proximate could be that two companies in different fields of work, have the same hierarchy within their organization. Finally, cognitive proximity is described as closeness between actors regarding effective collaboration toward knowledge gain. Two people working as surgeons in the hospital are cognitive proximate, at least more than a surgeon and a car mechanic for instance.

These five main proximities cover most concepts within the realm of innovation and network creation between actors. However, other proximity dimensions do exist, and should not be forgotten, like virtual proximity. Virtual proximity is coined by Coughlan (2014) as the way closeness is described in terms of using communication technologies and information between two or more actors (Cassi & Plunket, 2015; Cantner & Meder, 2007). Bisbee & Wisniewski (2018) add that virtual proximity can make human capital and the creation of networks in businesses thrive within existing physical proximity-heavy environments. Virtual proximity needs to be high between two actors to function as a substitute for physical proximity (Eastin & LaRose, 2006). Further, Hawthornthwaite *et al.* (2000) explain that ties between people can be maintained very well through virtual alternatives rather than meeting physically. These ties do need to be created face-to-face before a virtual alternative can act as a substitute (Hawthornthwaite *et al.*, 2000).

There is a lack of literature on proximity dimensions in the context of (short-term) disturbance, like for instance the impact of covid. Research on how geographical proximity is influenced by climate change (see, e.g., Fadly & Fontes, 2019) and Brexit (see, e.g., Tian *et al.*, 2021) is abundant, but how geographical proximity is influenced by a worldwide epidemic lacks existence in academic literature. This specific type of research is hard to do when no disturbance is present. Much work on proximity in this context is in the making.

In the context of this study, geographical proximity is considered a colocation between two actors. Virtual proximity is defined as a lack thereof, where virtual alternatives take up the function of colocation.

The scholarly belief is that an increase in the distance between two actors causes a decrease in the innovation and network creation between the two (Graevenitz *et al.*, 2022). This consensus is sometimes threatened by different authors, who introduce

the emergence of the internet as an incentive to make knowledge sharing and network creation perfectly possible while physical presence is not obligatory (Keller & Yeaple, 2013). Earlier, Morgan (2004) stresses how digitalization has caused the 'death of geography', explaining how spatial distribution is constantly enabling new ways of communicating, wherein physical proximity is not necessary. Therefore it becomes clear that forms of virtual proximities are finding ways to be a substitute for physical proximity.

Defining the Concepts

Knowledge exchange and learning

To define learning as introduced in the research question, it is important to get a hold of the concept *knowledge* and understand that. There is a vast body of literature and a lively debate on the topic in the academic circle. Hereunder an introduction to the concept *knowledge* is given and afterwards, the focus turns to learning and its characteristics.

It appears that a general division of knowledge exists, in multiple forms (Jensen *et al.*, 2007). The main one is the dichotomy of tacit and codified knowledge (Johnson *et al.*, 2002). The difference between the two is that codified knowledge can be written down, whereas tacit knowledge is much more difficult to write down. Following this, Johnson *et al.* (2002) add that a lot of tacit knowledge is to a certain extent codifiable and that some units of codified knowledge need a form of tacit knowledge to be translated into a codified form that is universally understood.

In line with the division between tacit and codified knowledge, there is a division between two main methods of learning. The two main methods described in the literature are DUI (Doing, Understanding, Interacting) and STI (Science, Technology, Innovation) (Jensen *et al.*, 2007). The first could be considered as learning that goes hand in hand with tacit knowledge. The latter is then considered as learning fitting codified knowledge. It might seem that there is perfect parity between the two types of knowledge and learning. However, that is not the case. Parrilli & Alcalde Heras (2016) show that most of the time, especially the two modes of learning, go hand in hand to function in their best way. Thus, making a division between the two becomes more difficult in the context of learning regarding innovation (Parrilli & Alcalde Heras, 2016). But for learning regarding education, this division can be made more easily (Santner, 2018). However, the two should never be completely separated.

Fitting the concept learning to proximity can be done by making clear that the DUI-method needs geographical proximity more than the STI-method to function as a working mode for learning. While acknowledging that both STI and DUI need a certain amount of proximity, Santner (2018) shows that for DUI, a more practical approach is necessary for learning. Alhusen & Bennat (2021) add that experience is a must for the DUI-method of learning. Following this, physical proximity seems to become a necessity for the DUI-mode, whilst the STI-mode does not need that proximity. After all, codified knowledge is easier to write down, than tacit knowledge. This then implies that written knowledge can be shared better through the STI-mode. Codified knowledge is often already written in some form and can therefore be transferred

between actors more easily through other forms of proximity than geographical proximity. If two companies use the same type of machinery, they can use the same codified knowledge, which is written down in a manual.

Substantiating the concepts of DUI and STI in the context of this research, the DUI-mode can be defined as learning by doing(, using and interacting) (Jensen *et al.*, 2007). As a counterpart, the STI-mode is defined as learning by reading, or learning through digital technology. The DUI-method fits learning while physically close, much better than the STI-method. Practical education that is part of the DUI-method needs geographical proximity to thrive. The STI-method functions better without the physical proximity, it should also work when geographical proximity is low.

Social Interconnectedness

Understanding how social interconnectedness works in relation to proximity dimensions, is crucial for this specific study. Next to learning, it is the main topic of the study. Social interaction proves to be of huge importance for students in higher education (Terrazzas-Carrillo *et al.*, 2014). The concept of social interconnectedness is explained by Dalton (1961) as the way two or more personalities interact with each other and the closeness they experience following these interactions. It is exactly this closeness that is important for this research. The experienced closeness that Dalton (1961) talks about, is a major part of physical proximity and is fully dependent on the ability to be close to another personality. As earlier introduced, the digitalization and globalization of the world have made this physical proximity less important. However, it stays a big question if virtual alternatives can provide the same experienced closeness that is so necessary for social interconnectedness. Kellerman (2022) shows that in the period influenced by the Covid19-pandemic, still face-to-face contact prevails over virtual contact. This statement is countered by Morgan (2004), who stretches that digitalization will be the death of geography. Thereby implying that virtual connections will become a substitute for physical and geographical proximity. In turn, this does imply that lower proximity has an influence on the social interconnectedness between different people.

The expectation is that virtual proximity will never become a perfect substitute for physical proximity. But that is not what should be hoped for, in the end, it should not be assumed that a pandemic lasts forever. Within this context, virtual proximity should only fulfil a role when a short-term disturbance occurs. It could be very well that virtual proximity is a working alternative, but results should make that clear.

Hypotheses

Hypotheses based on the research question and the literature used in the theoretical framework of this thesis are the following.

Furthering the definition of the concept learning and following its division into DUI and STI, it becomes evident that this division should be hypothesized as well. Taking into account that knowledge sharing through doing (DUI) needs more physical proximity than knowledge sharing through reading (STI), the hypotheses are therefore as follows:

H1: Courses that have a high level of DUI will be affected more by lower physical proximity than courses that have a low level of DUI.

And, following H1, it becomes evident that courses with a low level of DUI ought to be less influenced by a lower physical proximity. Assuming that courses with a low level of DUI automatically have a high level of STI, it follows that these courses are not affected that much by lower physical proximity and thus can be substituted much better through virtual proximity. So, the hypothesis on the STI-mode is as follows:

H2: Courses that have a high level of STI will be not substantially affected by lower physical proximity, because virtual proximity is a suitable substitute.

According to the literature, social interaction takes place in both situations: when physical proximity is high as well as when it is low. According to multiple authors (e.g. Keller & Yeaple, 2013; Bisbee & Wisniewski, 2018), virtual alternatives can be a suitable substitute for physical ways of communicating. Although they prove to be not a perfect substitute, they can prove to be of help and become better over time. Therefore the hypothesis is as follows:

H3: Virtual proximity cannot be a perfect substitute for geographical proximity when it comes to social interaction.

The hypotheses are brought together in the next paragraph which introduces the conceptual framework. As figure 1 reveals, there are two forms of proximity in play for this research: geographical and virtual proximity. They both have an effect on learning (in the two modes of learning) and on social interaction. According to the literature, there will not be a significant change in the learning by reading (LBR) that fits the STI-mode. But there will be a big difference between geographical and virtual proximity when it comes to learning by doing (LBD) in the DUI-mode. According to the literature, the same goes for the impact on social interaction. Virtual proximity can provide suitable alternatives when it comes to social connectedness between students.

So, if looking at the switch from being geographically close to virtually close, the hypothesis suggests that social interaction and DUI will take the biggest hit between the two time periods.

Conceptual Model

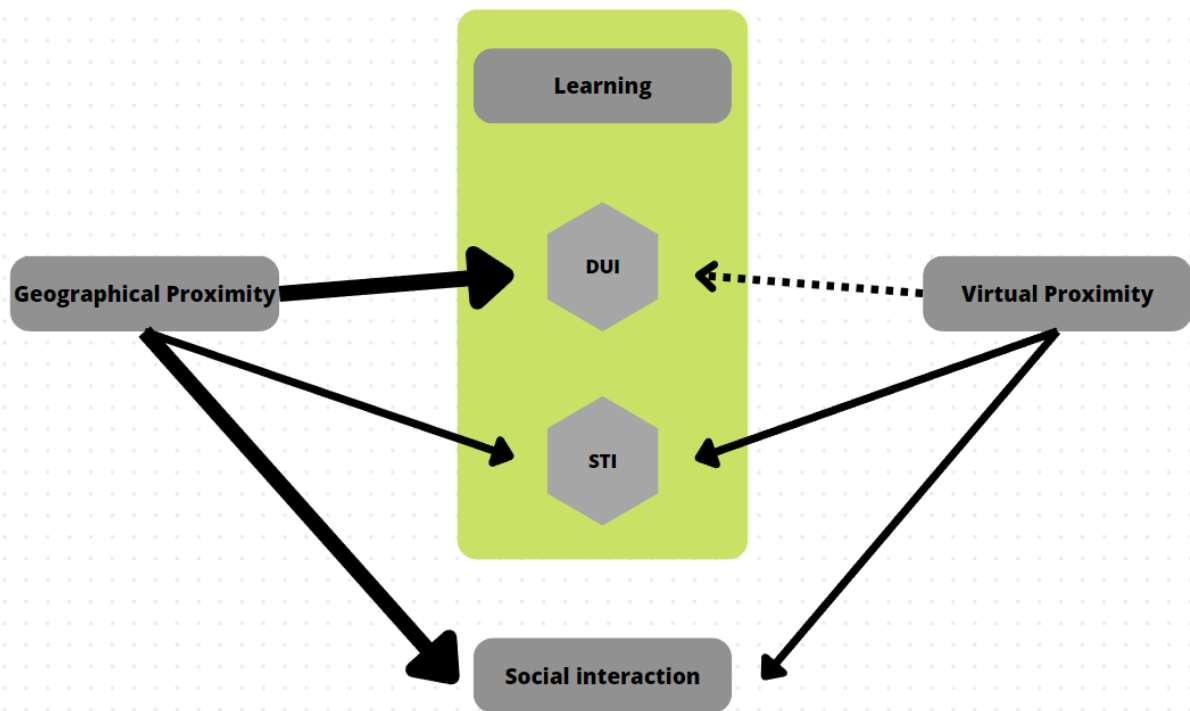


FIGURE 1: Conceptual model of the literature review. The thickness of the arrows shows how strong the relation is. Dotted lines suggest there is a relation, but not a strong one. (Source: author, 2023)

Methodology

Type of research

The unit of analysis of this research is students, their grades and their social connections. Students are a group that are suitable for researches investigating higher education. After all, they are the population group that has received the two types of education that the study is about. The time period in which data is gathered is December 2022. Questions that are asked, infer about the time period between September 2018 and June 2022. This time period is chosen, since the covid19-pandemic prevailed in the middle of this window. It can provide an overview of the different time periods, when asking questions regarding these time periods. Quantitative research is most suitable towards this end: it makes for an easy comparison between different periods of time.

Having defined the concepts of knowledge and social interconnectedness, it becomes possible to substantiate those concepts. Level of learning can be defined as a grade, and counting interpersonal social connections gives useful information about social interconnectedness. Grades are an ordinal variable, defined as a number and therefore suitable for quantitative research. A count of number of interpersonal social connections obtains a ratio variable, for which quantitative research also suits best. Thoughts about making this research mixed-methods existed, however, this does not fit the research questions at hand. The questions inquire *what* relationship virtual proximity has on learning and social interactions, not *why* this is the case.

Questionnaire design

Prior to creating the questionnaire for the students, it was important to find a way to substantially make a difference between certain courses that were taken. As explained earlier, a division can be (and is) made between LBD and LBR. Making the division between courses that are based on LBD and LBR is mainly based on the difference for courses if they have practical education. Courses that do not have a practical of any kind and are mainly based on going to lectures and reading articles, base their learning on the earlier explained STI-method. Courses that make use of practical education to exchange knowledge (e.g. computer practicals, fieldwork, statistical assignments) are based on the DUI-method. Practical education needs face-to-face contact to succeed and students need to be together to solve problems, as the literature suggests.

Eight courses have been chosen that are given in the first and second year of the faculty's Bachelor's programmes. These are divided into two categories as spoken before: DUI and STI. They are shown in figure 2.

DUI (learning by doing)	STI (learning by reading)
Statistics 2	Physical Geography
Geographic Information Systems	People, Place & Culture
Landscapes	Urbanism & Planning
	Governance Dynamics

FIGURE 2: division of courses into DUI-method and STI-method. (Source: author, 2022).

Together with the seven courses shown above in table 1, also the course Philosophy of Social Science was part of the questionnaire. This is the course of which the WhatsApp group has been used to find participants for the research. It will be taken out of the analysis, since there can be no comparison between the two time periods. All people in the WhatsApp group have followed that course digitally. This way, students are not selected through WhatsApp, but it is to make sure that all students in this specific population are reached out to.

As shown in appendix 2. *Questionnaire questions*, students are asked some general questions on gender and starting year of their programme. After that, they get asked for all the eight courses if they took them digitally, physically or in a hybrid format. They then also get asked what their grade was when finishing the course. Students that took the course twice because of a fail the first (or second) time, submit the grade with which they passed the course. Denying grades with which students did not pass the course in the analysis is done so only the effectiveness of learning is entered in the analysis. It is a simple way of operationalizing learning between the two time periods for education.

Furthermore, the questionnaire asks respondents how their social life changed between the time period before and the time period during the Covid19-pandemic. This question yields data for the question if there is a statistical difference between the two time periods regarding social interconnectedness. There is also a question on attendance at university before and during the pandemic. Data coming from answers given to this question may be used as a control variable.

Sampling strategy

Sampling will consist of snowball sampling, using two different chatgroups which contain students from the Faculty of Spatial Sciences (FSS). Both groups were created for courses given during the covid19-period to give updates on how the course would be taught. All students in these classes were obligated to be part of this group. Although a WhatsApp-group beforehand would suggest getting a biased sample, using these groups it became easy to get a suitable sample from this specific cohort of students. During the data collection period, it became clear how hard it actually was to find the right set of students who have experienced both ways of receiving education, physically and digitally. Snowball sampling is used for such occasions, therefore it became the main way of yielding answers for this survey. Choosing this specific Faculty was done because, in relation to other Faculties, more practical education is being given to students.

In turn, using one cohort of students, provides an opportunity for making an easier comparison between the two time periods. Because all students are part of one cohort, this also negates other external influences that could play a role. Moreover, because all these students are in the same course, it covers all students within one class.

Going further into the research, first had to be established how many respondents were necessary to get a trustworthy sample that actually can make sense and show something for this specific student population. To this end, select-statistics.co.uk was consulted to gain insight into how many respondents were

necessary. According to the Education Office of the FSS, every year an average of 230 students enter the faculty.

Calculator

What margin of error do you need? <small>5% is a common choice</small>	<input type="text" value="10"/> %	
What confidence level do you need? <small>Typical choices are 90%, 95%, or 99%</small>	<input type="text" value="90"/> %	
How big is the population? <small>If you don't know, use 100,000</small>	<input type="text" value="230"/>	
What do you believe the likely sample proportion to be? <small>If you're not sure, leave this as 50%</small>	<input type="text" value="50"/> %	
Your recommended sample size is		53

FIGURE 3: recommended sample size for this specific research. (Source: select-statistics.co.uk, 2022)

In researches like these, normally a 95% Confidence Interval is used. This Confidence Interval goes hand in hand with a 5% margin of error (for 90% Confidence Interval, this is 10% margin of error, etc.) and shows how strict the statistical test is assessed. If the margin of error is lower, it gets harder to state a statistical test gives a significant result.

As becomes clear from figure 3 above, according to select-statistics.co.uk, a minimum of 53 respondents is advised as sample size. This specific site is a reliable source when it comes to doing statistical analysis. Choosing a margin of error of 10% instead of the common choice of 5% is done purposely. Using a 5% margin of error yields a recommended sample size of 145, which is, time- and energy-wise, impossible. As will prove in the results section, the definitive $N=57$, which passes the advised mark of $N=53$.

The sample population exists of students at the FSS at the University of Groningen. Only students that have been studying there for at least three years are suitable, this is to make sure they have experienced both going to the university physically as well as receiving education through virtual alternatives. That is also why this specific sampling population has been chosen, it is to make sure all students that could have taken part in the questionnaire, are at least studying for three years at the University of Groningen.

Data from the surveys will be analysed using multiple statistical test methods, which include paired samples t-tests or suitable non-parametric alternatives. In the case that variables are normally distributed, a two-samples t-test provides for clear data analysis, if not, a non-parametric alternative like the Mann-Whitney U-test could bring a solution. Both of these tests use the mean number of a ratio variable between

(for instance) two time periods or two different locations. An example could be that the grades are not asked for two time periods (like in this research), but from students attending a university in Groningen and their peers in Amsterdam. In this specific case, it can show in a basic but specific way how the grades of the students compare between the two time periods.

In relation to the goal of the analysis and because only a comparison between the two time periods is made, Jamovi is used to run independent sample t-tests. Jamovi is an open software-programme that is easier to use than SPSS and it can run t-tests just as well.

Ethical Considerations

There is no power relation between the researcher and the participants. Since the researcher is a student himself, his positionality is equal to the participants, which shows that a power relation is not present. Data of respondents is to be stored safely on a computer with internal hard-drive, which is only available for the researcher. Only the researcher has access to this data. At any point in the research, a respondent is able to withdraw from participation in the survey and research. After the thesis is written and submitted, the data will be deleted if a sufficient grade is obtained.

To guarantee the anonymity of respondents, no names, phone numbers or any other personal details are asked from respondents. Only their starting year and sex is asked. The design of the questionnaire does not make it clear what the exact goal of the questionnaire is. It becomes clear that the study looks into differences between the time periods prior and during the pandemic, but it does not become clear how modes of teaching fit into this.

Results

Education

This part will show descriptive results of the distribution of the survey, then results obtained from a selection of statistical tests.

Male	31	2016 or before	1
		2017	4
		2018	9
		2019	17
Female	26	2016 or before	0
		2017	6
		2018	8
		2019	12

FIGURE 4: Distribution of respondents, grouped for sex and year of study start.

In figure 4 the distribution of respondents of the survey is shown. The division between female and male students is somewhat equal. It also appears that the biggest share of respondents started their study in 2019. This does not come as a surprise, since that is the cohort that is subject of interest for this research. After all, this is the cohort that experienced physical education as well as digital (or hybrid) alternatives.

	N						Normally Distributed
	Physical	Digital	Hybrid	Digital/Hybrid	N.A.		
Statistics 2	11	32	14	46	0	NO	
Physical Geography	26	29	1	30	1	YES	
People, Place & Culture	25	27	0	27	5	YES	
Governance Dynamics	14	29	12	41	2	NO	
Urbanism & Planning	44	13	0	13	0	YES	
Philosophy of Social Science	0	53	4	57	0	NO	
Geographic Information Systems	31	4	22	26	0	YES	
Landscapes	13	37	6	43	1	YES	

FIGURE 5: Different number of respondents grouped per course, counted per type of education. Note: Philosophy of Social Science is not part of the analysis, since there are no respondents who followed the course physically.

From figure 5 it becomes clear how the number of respondents are fluctuating between the eight different courses that were included in the questionnaire. Some courses are normally distributed and some are not normally distributed. This is of interest for which statistical test is suitable for analysing the data and can also be found in figure 5. In the end, the two groups that are compared to each other are on the one hand 'Physical' and on the other hand 'Digital/Hybrid'. All the t-tests and Mann-Whitney U-tests that have been run, are found in appendix 3. Figure 6 below summarizes them neatly.

COURSE	Mode of Learning	Average Grade Physical	Average Grade Digital/Hybrid	Type of test	Significant difference?
Physical Geography	STI	7,05	6,60	Two-sample T-test	Yes
People Place & Culture	STI	7,18	6,60	Two-sample T-test	Yes
Governance Dynamics	STI	7,02	6,57	Mann-Whitney U-test	Yes
Urbanism & Planning	STI	6,93	6,33	Two-sample T-test	Yes
Statistics 2	DUI	7,25	6,60	Mann-Whitney U-test	Yes
Geographic Information Systems	DUI	7,62	6,85	Two-sample T-test	Yes
Landscapes	DUI	7,78	6,73	Two-sample T-test	Yes

FIGURE 6: Results of the statistical tests for all of the courses in the analysis.

It immediately becomes clear from figure 6 that all average grades scored by the respondents were higher when the courses were followed in a physical way. The 'physical' grades also all are significantly different from the 'digital/hybrid' grades. Interestingly enough, when comparing the mean differences between grades obtained for the different types of modes of learning, there is a significant difference between physical and digital/hybrid, as we can see in table 8 in appendix 3. It proves courses that rely on the DUI-method of learning, are more influenced by the change to virtual alternatives of education than courses that rely on the STI-method of learning.

Social interconnectedness

For the second topic of this research, the results are shown below. Table 9 shows the results of the statistical tests run for data on social interconnectedness.

Paired Samples T-Test

			Statistic	df	p
Interactions before COVID	Interaction during COVID	Student's t	9.07	56.0	< .001
		Wilcoxon W	820 ^a		< .001

^a 17 pair(s) of values were tied

Descriptives

	N	Mean	Median	SD	SE
Interactions before COVID	57	4.21	4	0.840	0.111
Interaction during COVID	57	3.11	3	1.097	0.145

TABLE 9: paired-samples t-test and Wilcoxon W-test result for number of interactions during and before the COVID19-pandemic hit.

Above, table 9 reveals that there is a significant difference for number of interactions between the period before and the period during the pandemic. It could be an indication of how the availability to be physically close is necessary to have more social interaction with other people.

Conclusions

The results show that courses that make use of the DUI-method when it comes to learning, are more heavily influenced by the use of virtual alternatives than courses that function using the STI-method of learning. Therefore, H1 should be assumed to be true. H2 is not supported by the results, since the grades between all courses that rely on the STI-method appear to be significantly different between the physical and virtual education time periods. Last, H3 is supported by the results of this research. It becomes apparent that in the time period where virtual proximity needs to be an alternative for geographical proximity, it cannot live up to the expectations. There is a significant difference between social interactions between students for these two time periods.

Concluding, it can be said that some parts of education can be substituted than others. But peripheral social matters that are also part of a student's life during the period receiving education cannot be substituted as well. This finding is an addition to existing literature in the sense that it makes clear how virtual proximity functions as a substitute. Literature already suggests how virtual proximity works on its own, but this study shows how it can work on its own, whilst taking the role of geographical proximity. Thus, it can be positively said that to a small extent virtual proximity can be a substitute for physical proximity when it comes to higher education. Courses that make use of LBD are influenced more than their counterparts that use LBR, but in both

cases virtual proximity cannot be a perfect substitute. Social interaction is difficult to replace by virtual surrogates.

One of the limitations of this study is that it is mainly descriptive in nature. There are also no control variables between the two time periods for which the tests have been run. This makes it difficult to support inferential claims about different populations than the one which was part of the research. A bigger study with more respondents from different locations is necessary to make claims about a bigger population. Further, using a 10% margin of error is a limitation to the study, however, taking a stricter margin of error required for a lot more respondents, which was time- and energy wise impossible. To be able to say something about the analysis, with this specific limitation, was a necessity. Thirdly, using grades as an operationalization for assessing learning quality, is a choice that is not perfectly fitting. Other variables should have been accounted for in the survey. Additionally, the decision to refrain from including failing grades for the courses in the survey, should be controlled by another variable.

Further research should include more inferential statistics, also using regression models in their analysis. In those researches it should also be better defined how grades and additives can give a clear view of how students are doing. Other research could get into the topic what type of virtual alternatives work better than others, and why this is the case. Also, different types of proximity could play a role in these studies. Maybe when cognitive or organizational proximity is high, virtual proximity can become a substantially better substitute than it is for geographical proximity.

A (two-)yearly study at universities could prove how social interconnectedness behaves between students. Universities could also investigate whether hybrid education is suitable for normal times. They could examine if education at a distance works for lecturing courses. This could be at least interesting for guest lecturers that for instance live abroad.

For future reference, policymakers should take note of the difference between types of courses when making choices in disturbed times. At least, when it comes to education, it is clear that courses that use a practical element in their lectures, need physical proximity for students to obtain a higher grade. This could imply that these courses should be tried to be taught physically at all times. Moreover, when it comes to grades in university, courses that rely on learning by reading, can be given digitally, even in 'normal' times.

References

- Alhusen, H. & Bennat, T. (2021). Combinatorial innovation modes in SMEs: mechanisms integrating STI processes into DUI mode learning and the role of regional innovation policy. *European Planning Studies*, 29(4), 779-805.
- Baldassar, L. (2008). Missing Kin and Longing to be Together: Emotions and the Construction of Co-Presence in Transnational Relationships. *Journal of Intercultural Studies*, 29(3), 247-266.
- Bisbee, B. & Wisniewski, K. (2018). Virtual Proximity. *Talent Development*, 72(6), 26-30.
- Boschma, R. (2005). Proximity and Innovation: A Critical Assessment. *Regional Studies*, 39 (1), 61-74.
- Cantner, U. & Meder, A. (2007). Technological Proximity and the choice of cooperation partner. *Journal of Economic Interaction and Coordination*, 2(1), 45-65
- Cassi, L. & Plunket, A. (2015). Research collaboration in co-inventor networks: combining closure, bridging and proximities. *Regional Studies*, 49 (6), 936-954.
- Coughlan, T. (2014). Enhancing Innovation through Virtual Proximity. *Technology Innovation Management Review*, 4(2), 17-22.
- Dalton, R. H. (1961). *Personality and social interaction*. Boston, MA: D. C. Heath and Company.
- Eastin, M. S. & LaRose, R. (2006). Internet Self-Efficacy and the Psychology of the Digital Divide. *Journal of Computer-Mediated Communication*, 6(1), 0-0
- Fadly, D. & Fontes, F. (2019). Geographical Proximity and Renewable Energy Diffusion: An Empirical Approach. *Energy Policy*, 129, 422-435.
- Hansen, T. (2014). Juggling with Proximity and Distance: Collaborative Innovation Projects in the Danish Cleantech Industry. *Economic Geography*, 90(4), 375-402.
- Hawthornthwaite, C., Kazmer, M. M., Robins, J. & Shoemaker, S. (2000). Community Development among Distance Learners: Temporal and Technological Dimensions. *Journal of Computer-Mediated Communication*, 6(1), 1.
- Howells, J. R. L. (2002). Tacit Knowledge, Innovation and Economic Geography. *Urban Studies*, 39(5-6), 871-884.
- Jensen, M. B., Johnson, B., Lorenz, E. & Lundvall, B. A. (2007) Forms of Knowledge and modes of Innovation. *Research Policy*, 36(5), 680-693.
- Johnson, B., Lorenz, E. & Lundvall, B. A. (2002). Why all this fuss about codified knowledge? *Industrial and Corporate Change*, 11(2), 245-262.

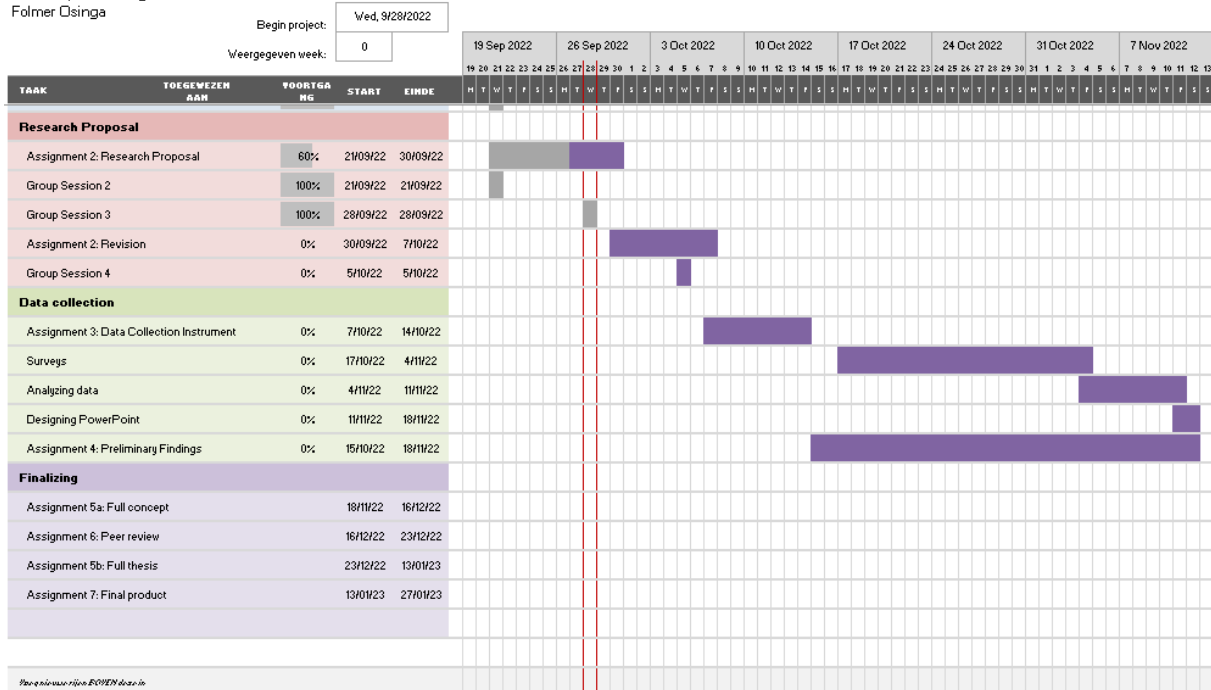
- Kędra, J. (2021). Virtual proximity and transnational familyhood: a case study of the digital communication practices of Poles living in Finland. *Journal of Multilingual and Multicultural Development*, 42(5), 462-474.
- Keller, W. & Yeaple, S. R. (2013). The gravity of knowledge. *American Economic Review*, 103(4), 1414-1444.
- Kellerman, A. (2022). Social-spatial interaction, proximity, and distance: from face-to-face to virtual communications. *Applied Mobilities*, 7(4), 394-412.
- Moghisi, R., Mokhtaria, S., Akbar Heidari, A. (2015). Place Attachment in University Students. Case study: Shiraz University. *Procedia - Social and Behavioral Sciences* 170, 187 – 196.
- Rijksinstituut voor Volksgezondheid en Milieu (2022). *Stijging aantal coronabesmettingen zet door*. Retrieved on 4/10/2022 from <https://www.rivm.nl/nieuws/stijging-aantal-coronabesmettingen-zet-door>.
- Rijksoverheid (2020). *Letterlijke tekst persconferentie minister-president Rutte en minister Bruins naar aanleiding van de maatregelen tegen verspreiding coronavirus in Nederland*. Retrieved on 25/01/23 from <https://www.rijksoverheid.nl/documenten/mediateksten/2020/03/12/persconferentie-minister-president-rutte-en-minister-bruins-naar-aanleiding-van-de-maatregelen-tegen-verspreiding-coronavirus-in-nederland>
- Santner, D. (2018). Proximity and modes of innovation - evidence from two agricultural engineering industries in north-west Germany. *European Planning Studies*, 26(5), 877-894.
- Select-statistics.co.uk (2022). *Population Proportion – Sample Size – calculator*. Retrieved on 17/11/22 from <https://select-statistics.co.uk/calculators/sample-size-calculator-population-proportion/>
- Terrazas-Carrillo, EC. Hong, JY. Pace, TM. (2014). Adjusting to New Places: International Student Adjustment and Place Attachment. *Journal of College Student Development*, 55 (7), 693-706.
- Tian, Y., Ma, S., Rui, R., Yu, Z. & Tian, M. (2021). The Analysis of Impact of Brexit on the Post-Brexit EU Using Intervented Multivariate Time Series. *Acta Mathematicae Applicatae Sinica, English Series*, 37(3), 441-458.
- Tomek, I. & Giles R. (1999). Virtual Environments for Work, Study and Leisure. *Virtual Reality*, 4(1), 26-37.

Appendices

1. Timetable

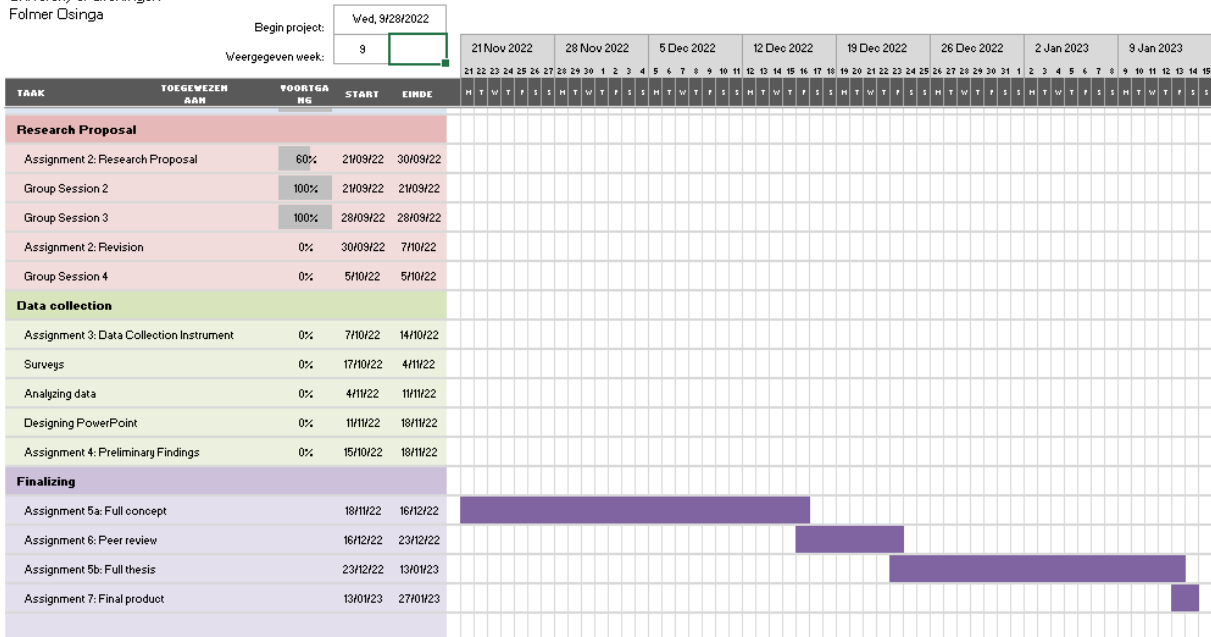
Bachelor's Project

University of Groningen
 Folmer Osinga



Bachelor's Project

University of Groningen
 Folmer Osinga



2. Questionnaire questions

Hi and welcome to this questionnaire. This survey was created to gather data for the Bachelor's Project of Human Geography & Planning of Folmer Osinga. The survey asks questions on educational differences between the period before COVID19 hit and the period in which COVID19 had an impact on education. Questions inquire about grades, attendance and social interactions.

The survey will take approximately 3-4 minutes. Thanks for helping. By clicking the button below, you

accept your anonymous answers are stored and used for solely the purpose of this Bachelor's Project.

What is your gender?

- Male
- Female
- Non-binary/third gender
- Prefer not to say

What year did you start studying?

- 2016 or before
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022

The next couple of questions ask you to (roughly) tell your grade for certain courses in the programs of Spatial Planning & Design and Human Geography & Planning. Also, I would like to know whether you received that grade taking physical, digital or hybrid classes.

- Statistics 2
 - Physical
 - Digital
 - Hybrid
 - Not applicable
 - What was your grade?
 - 1 2 3 4 5 6 7 8 9 10
- Physical Geography
 - Physical
 - Digital
 - Hybrid
 - Not applicable
 - What was your grade?
 - 1 2 3 4 5 6 7 8 9 10
- People, Place & Culture
 - Physical
 - Digital
 - Hybrid
 - Not applicable
 - What was your grade?
 - 1 2 3 4 5 6 7 8 9 10
- Governance Dynamics
 - Physical
 - Digital
 - Hybrid
 - Not applicable
 - What was your grade?
 - 1 2 3 4 5 6 7 8 9 10
- Urbanism & Planning
 - Physical
 - Digital
 - Hybrid
 - Not applicable

- What was your grade?
▪ 1 2 3 4 5 6 7 8 9 10
- Philosophy of Social Science
 - Physical
 - Digital
 - Hybrid
 - Not applicable
 - What was your grade?
▪ 1 2 3 4 5 6 7 8 9 10
- Geographic Information Systems
 - Physical
 - Digital
 - Hybrid
 - Not applicable
 - What was your grade?
▪ 1 2 3 4 5 6 7 8 9 10
- Landscapes
 - Physical
 - Digital
 - Hybrid
 - Not applicable
 - What was your grade?
▪ 1 2 3 4 5 6 7 8 9 10

How much social interactions did you have weekly before COVID19 hit PHYSICALLY?

- <2
- 2-4
- 5-7
- 8-9
- 10+

How much social interactions did you have weekly in the COVID19 period DIGITALLY?

- <2
- 2-4
- 5-7
- 8-9
- 10+

What was your percentage of attendance roughly?

- Before COVID19 hit.
 - 0-20%
 - 21-40%
 - 41-60%
 - 61-80%
 - 81-100%
- During the COVID19-period.
 - 0-20%
 - 21-40%
 - 41-60%
 - 61-80%
 - 81-100%

3. Statistical tests

Education

As introduced in the theoretical framework and the hypotheses, the expectation is that courses with practical education will have a significantly bigger difference in grades achieved by students in times when physical education was possible, contrary to times when this was not possible. Three courses with and four courses without practical education have been tested with these parameters. The differences between grades between the two time periods shown below for the seven courses. When a t-test result is shown, the data is assumed to be normally distributed. However, the Mann-Whitney U-test result is also always given, since N is not bigger than 30 for both groups. A disclaimer that needs place here, is the combination of Digital and Hybrid forms of education. Not making that combination, did not yield a big enough N for some groups. In Table 1, 2, 3 and 4 the test results are shown for four courses without practical education.

Independent Samples T-Test

		Statistic	df	p
Grade_Geography	Student's t	3.03	54.0	0.004
	Mann-Whitney U	199		0.002

Group Descriptives

		Group	N	Mean	Median	SD	SE
Grade_Geography	Physical		26	7.05	7.15	0.529	0.104
	Digital/Hybrid		30	6.60	6.50	0.569	0.104

TABLE 1: two-samples t-test and Mann-Whitney U-test result for grades achieved on the course Physical Geography, grouped for the way of receiving education.

Independent Samples T-Test

		Statistic	df	p
Grade_PPC	Student's t	3.79	50.0	< .001
	Mann-Whitney U	162		0.001

Group Descriptives

		Group	N	Mean	Median	SD	SE
Grade_PPC	Physical		25	7.18	7.10	0.510	0.102
	Digital/Hybrid		27	6.60	6.80	0.580	0.112

TABLE 2: two-samples t-test and Mann-Whitney U-test result for grades achieved on the course People, Place and Culture, grouped for the way of receiving education.

Independent Samples T-Test

		Statistic	p
Grade_GD	Mann-Whitney U	185	0.048

Group Descriptives

	Group	N	Mean	Median	SD	SE
Grade_GD	Digital/Hybrid	41	6.57	6.60	0.487	0.0760
	Physical	14	7.02	6.85	0.740	0.198

TABLE 3: Mann-Whitney U-test result for grades achieved on the course Governance Dynamics, grouped for the way of receiving education.

Independent Samples T-Test

		Statistic	df	p
Grade_Urbanism	Student's t	3.34	55.0	0.002
	Mann-Whitney U	118		0.001

Group Descriptives

	Group	N	Mean	Median	SD	SE
Grade_Urbanism	Physical	44	6.93	7.00	0.606	0.0913
	Digital/Hybrid	13	6.33	6.40	0.390	0.108

TABLE 4: two-samples t-test and Mann-Whitney U-test result for grades achieved on the course Urbanism & Planning, grouped for the way of receiving education.

The four courses presented above were given without practical education and used the STI-mode of learning. It was expected that there would be little to no difference between the grades achieved when education was digital compared to when it was physical. However, Tables 1 through 4 show us that the difference between the grades does prove to be of significance.

Tables 5, 6 and 7 will reveal the results on the three courses with practical education and the difference between achieved grades by students between two time periods.

Independent Samples T-Test

		Statistic	p
Grade_Stat2	Mann-Whitney U	106	0.003

Group Descriptives

	Group	N	Mean	Median	SD	SE
Grade_Stat2	Digital/Hybrid	46	6.60	6.40	0.778	0.115
	Physical	11	7.25	7.30	0.513	0.155

TABLE 5: Mann-Whitney U-test result for grades achieved on the course Statistics 2, grouped for the way of receiving education.

Independent Samples T-Test

		Statistic	df	p
Grade_GIS	Student's t	4.58	55.0	< .001
	Mann-Whitney U	141		< .001

Group Descriptives

	Group	N	Mean	Median	SD	SE
Grade_GIS	Physical	31	7.62	7.70	0.593	0.106
	Digital/Hybrid	26	6.84	6.85	0.701	0.137

TABLE 6: two-samples t-test and Mann-Whitney U-test result for grades achieved on the course Geographic Information Systems, grouped for the way of receiving education.

Independent Samples T-Test

		Statistic	df	p
Grade_Landscapes	Student's t	-5.48	54.0	< .001
	Mann-Whitney U	69.0		< .001

Group Descriptives

	Group	N	Mean	Median	SD	SE
Grade_Landscapes	Digital/Hybrid	43	6.73	6.80	0.614	0.0937
	Physical	13	7.78	7.90	0.590	0.164

TABLE 7: two-samples t-test and Mann-Whitney U-test result for grades achieved on the course Landscapes, grouped for the way of receiving education.

Tables 5 through 7 above present the results of courses that contain practical education and make use of the DUI-mode of learning. The expectation that these courses would yield higher grades when given physical is clearly seen in these tables. The three courses have a significantly higher grade when educated physically than educated digitally/hybrid. However, that was also the case for the four courses that did not use the DUI-method. So, that does not give us much to go on. But it does make for a nice comparison between the two if taking a look at the difference in average grades between LBR and LBD.

Independent Samples T-Test

Independent Samples T-Test

		Statistic	df	p
B	Student's t	2.80	5.00	0.038
	Mann-Whitney U	0.00		0.050

Group Descriptives

		Group	N	Mean	Median	SD	SE
B	Practicum		3	0.827	0.780	0.204	0.118
	No Practicum		4	0.520	0.515	0.0812	0.0406

TABLE 8: two-samples t-test and Mann-Whitney U-test result for grades achieved on the courses, grouped for the method of teaching: with or without practicums.

Table 8 shows the difference between the means for LBR and LBD. Since the N=7, the two-samples t-test can be ignored. The Mann-Whitney U-test result shows that there is (barely) a significant difference between LBR and LBD. Though, this is a nice result which can help (dis)prove the hypotheses.