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The importance of digital and face-to-face human contact networks for knowledge diffusion in technical higher education

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Abstract: The study focuses on the importance of human social networks. We narrowed the focus to technical higher education and compared the effectiveness of social human contact networks based on digital and face-to-face contact. The human social network is illustrated using graph theory to illustrate the concept of "six degrees of separation". We investigate whether the work of university lecturers was made easier or more difficult by the immediate spread of digital education following the outbreak of the coronavirus epidemic. An exploratory inductive method was used for the study, which allowed us to gain a deeper insight into the views of practitioners in technical education and to explore their feelings about the research topic.

Keywords: online education, Covid-19, higher technical education, human contact networks, graph theory, six-step distance, graph theory

1 Introduction

With the onset of the coronavirus epidemic, the widespread uptake of digital education at national level happened virtually overnight. All age groups have been affected by this rapid and important change. Our research has focused primarily on technical higher education, and we will now highlight the specificities of this field. The emergency situation created by the pandemic has posed major challenges for all those involved in education. Educators had to take immediate action. They had



to master the use of online platforms for digital education to a level that would enable them to help students when necessary. Most of the trainers already had this knowledge, having used e-learning systems in their teaching activities, but teaching in the online space required a completely different teaching methodology. In the case of classes with a larger number of students, the technical difficulties were cumulative, since in most cases the platforms for online meetings were not prepared for such a heavy workload. At the same time, human contact networks have also changed. Face-to-face meetings have been replaced by online-only contact. Relationships have become more personalised, and more informal conversations have become even less important in digital education. Human interactions have been reduced and minimised. Instructors have uploaded course material into virtual space, so the importance of taking notes during the lesson has also been relegated to the background. Instructors were able to check digital presence after the fact, making the use of the catalogue obsolete. The student could not afterwards claim why he had not signed the catalogue while attending the class. This is both a relief and the elimination of a source of contention. At the same time, the instructor had little control, in the case of a lecture with a large number of students, over whether the student, having joined the class, was actually a participant or whether he or she had just signed in. This problem was better addressed in the smaller practical classes. The central question of the research is whether university lecturers in technical higher education consider digital teaching to be more effective in enriching students' knowledge or whether it is based on face-to-face presence. Another research question is whether it is easier for both students and lecturers to flow relevant information when teaching online.

In summary, the hypotheses of the research according to the opinion of the interviewed subjects are:

H1: Digital education is more effective for students' knowledge acquisition than education based on face-to-face contact only.

H2: When teaching exclusively online, it is easier for both students and teachers to obtain relevant information.

To confirm or refute the research hypotheses, a qualitative methodology was applied using a semi-structured interview design. The main themes of the guide were: experiences, feelings and memories of digital education, advantages and disadvantages of digital education. Exploring experiences, feelings and memories of digital education, advantages and disadvantages of digital education. This gave the interviewees the opportunity to express their experiences freely and to share their opinions and thoughts. Given the qualitative nature of the research, the limitations of the research cannot be extended to any population, but could serve as a basis for future quantitative research. The interviews were conducted with the help of 6 practitioners in higher technical education. The sampling was done in an



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arbitrary way by interviewing familiar lecturers and our results are not representative. The interviewees were very helpful and cooperative. Interviews were conducted online and were recorded with the unanimous consent of the collaborators. A transcript of the interviews was then prepared and the responses were processed using a traditional content analysis method following the guide's guidelines. Due to the exploratory nature of the interviews, they can be used as a basis for further research and statistical analysis. In terms of gender, there were 3 male and 3 female respondents. The research underlying the analysis was self-administered in 2021.

2 Human networks

The role of human contact networks is of paramount importance for the flow and sharing of information. Their function is increasingly being taken over by information networks. In addition to being fast and wide-ranging, the dissemination of information in the online space has another advantage: the transmission of undistorted information. (Lövey, Nadkarni 2003). The vast majority of communication in the online space takes place in writing, with the exception of the use of platforms specifically designed for live speech. However, there is also a way to record the conversation on these platforms. In this sense, the undistorted flow of information can be ensured more easily than in face-to-face forms of encounter. As already mentioned in the introduction, attendance at meetings can be tracked at any time without any special setting. Material of any kind (whether images, documents or spreadsheets) shared online can be retrieved and accessed at any time afterwards. These advantages are also useful in many cases in the field of education. Students cannot claim to have attended a class if their name does not appear on the list of course participants. From the instructor's point of view, a student cannot claim that he or she did not receive the materials required for the course, as it is clearly provable whether the data in question was available to the student, and the elearning interface also allows instructors to track which students have even opened the course material they have published. At the same time, in questionable cases, the protection is also available to the students. Instructors cannot claim knowledge for which they have not provided material, nor can they inadvertently ban a student for missing class if they have attended. Online networks make it easy to track the flow of information. Access to relevant information in the online space is usually achieved with less effort than without the use of online interfaces.

Human networks of connections (whether digital or based on personal presence) and knowledge creation are closely linked and their interaction is not accidental. Looking at the role of networks, their interaction with information flows is evidence. According to Fukuyama (2000), networks can be understood as an



alternative channel for information flows. Already in the 1900s, Karinthy described a theory in his narrative "The Chain Eyes", according to which all the people on earth are connected through five acquaintances. A similar theory is described by Albert-László Barabási in his book *Behálózva* (2013). This is the theory of the six steps, which has now become a concept known as "six degrees of separation". "Even gigantic networks of acquaintances shrink into very small worlds, since we all have a lot of acquaintances" (Barabási, 2013. p. 44). In his research, Barabási describes the network of acquaintances between people as a graph. The points of the graphs are the people themselves, and the connections between people and people are the edges of the graphs. This principle, or graph theory, can be used to represent not only a society, but also the internet itself (the World Wide Web) or even a cell (Bíró 2017). According to the graph theory model, one edge per point is needed to unfold an entire society. A single connection between two people results in a dense network within which all points are accessible. The threshold is only one (Ishii&Kawahata, 2020). In general, a single person has many more social connections than just one. In other words, our society far exceeds the single threshold set by graph theory. Sociologists estimate that a person usually has an acquaintance network of between two hundred and five thousand people (Kacziba, 2021). The more edges we add to a graph, the harder it is to find an isolated point in it.

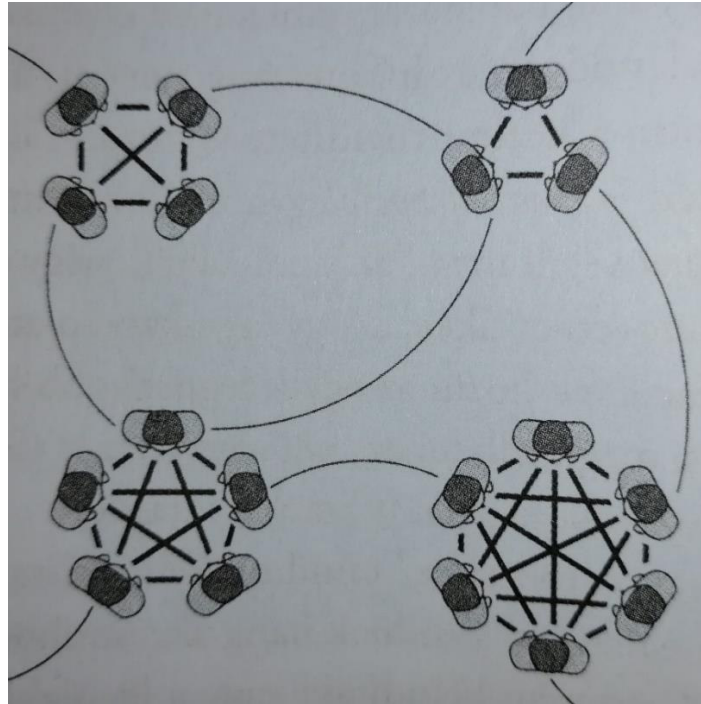
According to the Poisson distribution, there is a prominent vertex value and most of the points have the same number of edges connected to them as the average vertex. Significant deviation from the mean is rare.

According to the theory of Poisson distribution, social relationships are characterized by a uniformly structured network with the highest number of individuals with average connectedness capital, i.e. all individuals in a human network of relationships have an average number of connectedness elements (edges in terms of graph theory) (Boissevain & Mitchell, 2018). The number of individuals with very different relationship counts (i.e., overly social and completely antisocial) is distinctly rare.

Mark Granovetter's (1973) research "The Power of Weak Relationships" is one of the most influential sociological studies of our time. According to Granovetter's research, all human society can be divided into small groups that are relationship-rich. Members of the narrower groups are bound together by stronger emotional ties. These individuals also tend to have a circle of friends made up of the same people. The closer this relationship between two people, the more common intersections there are in their social network. These social circles with a smaller number of elements, more closely related to each other, are connected by looser ties with "weak ties" to other (more closely related) social circles. That is, more closely connected social circles are connected to other social circles with looser ties (Hossain, 2019).



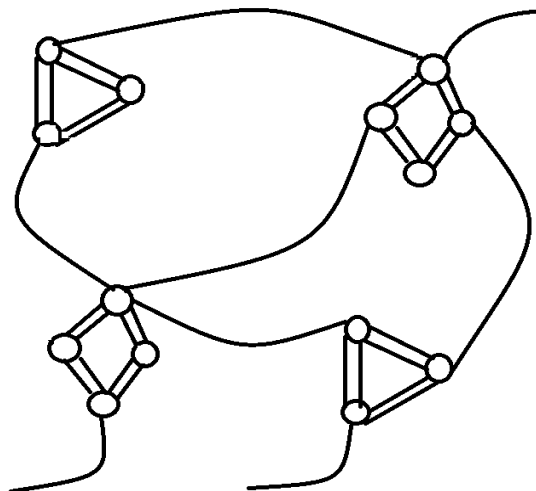
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1. chart:

Source: Barabási (2013. 50.p)

Graphically, points in smaller social circles are connected by two edges. Some members of smaller groups are connected to other circles by a looser link, illustrated by an edge.



2. chart:

Source: Own editing based on Barabási (2013)

According to Granovetter (1973), these weak social ties play a major role in our ability to communicate with the wider external world. He gives a concrete example of this. When a person is looking for a job, his immediate close contacts can be of little help because they move in the same social circles as the job-seeker. However, these weak ties can be the way to the outside world, because they are the ones who go to different socio-social places from the jobseeker and get their information from different places, and thus can be more helpful than people from the immediate circle of friends (Molnár, 2020).

Csermely (2005) has similar findings, reporting in his research that weak links between knowledge creation and networks are the link between knowledge creation and networks.

Cross and Parker (2004) have also investigated the importance of connections and networking in the world of work. In their research they found that it is not enough to have the right knowledge and good skills for a worker to be highly successful. They also place great emphasis on relational capital, on human network connections. The rapid and widespread diffusion of acquired knowledge among members of an organisation is a prerequisite (Szántó-Tóth 1993).



3 Methodology

To answer the central questions of the research, we conducted an expert interview with renowned academics with many years of experience in technical higher education.

According to the interviewees, the hypotheses of the research are:

H1: Digital education is more effective for students' knowledge acquisition than education based on face-to-face contact only.

H2: When teaching exclusively online, it is easier for both students and teachers to obtain relevant information.

In order to confirm or refute the research hypotheses, a qualitative methodology was used, using a semi-structured interview schedule with both open and closed questions, giving the interviewees the opportunity to freely express their experiences and share their opinions and thoughts. The main themes of the guide were: experiences, feelings, memories, advantages and disadvantages of digital education. Exploring experiences, feelings and memories of digital education, advantages and disadvantages of digital education. Sampling was done arbitrarily by interviewing familiar educators, our results are not representative. Given the qualitative nature of the research, the limitations of the study cannot be extended to any population, but could serve as a basis for a future quantitative study. The interviews were conducted online on Zoom and Teams digital platforms. The interviewees were very helpful and cooperative, and a recording of the interviews was made following unanimous consent of the participants. The transcripts were then prepared based on the recordings, followed by the processing of the responses using a traditional content analysis method. The results are presented according to the themes of the guide. Due to the exploratory nature of the interviews, they can be used as a basis for further research and statistical analysis. In terms of gender, there were 3 male and 3 female respondents. The research underlying the analysis was self-administered in 2021.

4 Results

The analysis of the interviewees' answers led to the following results: Digital education has several advantages over face-to-face education alone.

"I was very happy when we switched to digital education in our country. We already knew from the English news that there was a big problem and that the tightening was not unexpected. It's easy to get sick, so I was worried when we had to teach in person, even if we were wearing masks," said one interviewee.



Among these benefits, interviewees cited greater effectiveness in protecting their health, greater comfort and safety, increased energy efficiency due to the absence of travel and a much more efficient way of managing time.

"I have to travel from the suburbs to the capital and spend several hours a day travelling. It's a great relief to be able to use this time for more useful activities", says another trainer.

In their experience, student information is more accurate and it is easier to monitor student activity thanks to digital platforms. Students cannot escape responsibility afterwards and have to take responsibility if they are withdrawn from a course or cannot complete a course in a given semester.

"During digital education, even the more timid students dare to speak up during group assignments. Once I learned about the Teams feature to create group rooms for students, I divided the participants into smaller groups and they were able to discuss a number of professional issues with each other in class. This is not possible with face-to-face teaching, as the room is more overheard with the conversation between the groups and the more shy ones are not as active as they could be. I think it's a useful thing", according to one interviewee.

Digital tracing eliminates many sources of contention. Students cannot claim that there was no course material or that they did not receive the catalogue. That is why lecturers feel more secure in this respect. The trainers also shared that the transition to digital education initially caused serious difficulties, but that in the course of subsequent use, the platforms used in digital education have been further improved by the developers and are now no longer a problem to use. The ability for educators to take advantage of the benefits of digitalisation has been a significant facilitator in the transfer of knowledge. They were able to use online programmes that made their work much easier, they could use different learning apps to make the lessons more colourful. Thanks to the platforms used for digital learning, teachers were able to set up group rooms where students could work together in small groups. This allowed groups to work separately from each other without interfering with each other's work. This also allowed more shy students to get involved in class work. The group class activities made for very interesting lessons. The consensus of the interviewees was that teaching exclusively online would not be an ideal solution.

"Personally, I missed seeing the students, seeing their faces, their eyes. It's important feedback for the instructor to see if everyone understands the subject. I see them taking notes, if they get stuck while taking notes I repeat it again. That way I can't see who is where they are, what they understand or don't understand, where they are in the note-taking process, whether they need further explanation". Teacher's opinion during the expert interview.



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People are social beings and need the perceptions and experiences they get from personal encounters. Education that requires personal presence has many essential elements in building human networks of relationships. Relationships based on personal contact are more trusting and friendships and group cohesion are more easily formed. The digital network is better suited to maintaining and nurturing established relationships than to building social relationships (possibly friendships) that have not yet been formed. However, digital education has a number of advantages, which have already been outlined above. Interviewees agreed that it would be beneficial to develop a teaching method where trainers can combine the benefits of digital and face-to-face teaching. There are several possible ways to achieve this. This would depend largely on the individual preferences of the instructor, the subject taught, the technical constraints and the capabilities of the students.

"Digital education certainly has its advantages. It would be good to keep them, but there is also a need for face-to-face contact. Somehow it would be useful to combine the two forms of education and develop some kind of hybrid teaching method." An expert interview during an instructor's opinion.

Two hypotheses put forward during the research:

H1: Digital education is more effective in terms of students' knowledge acquisition than education based solely on face-to-face contact.

H2: When teaching exclusively online, it is easier for both students and instructors to obtain relevant information.

Analysing the interviewees' responses, both hypotheses of the research are considered to be accepted and supported. Given the qualitative nature of the research, the limitations of the research cannot be extended to any population, but could serve as a basis for future quantitative research.

5 Conclusion

The study focuses on the importance of human social networks. The topic is narrowed down to technical higher education and the effectiveness of social human contact networks based on digital and face-to-face contact is compared, with a focus on technical higher education. Human contact networks permeate all our lives. Whether they are digital or face-to-face. People are fundamentally social beings who need each other's company. It is up to the individual to decide how much of a social network they need. It is natural that we have more social and less social human counterparts. The role of human social networks is of paramount importance in the flow and sharing of information. Their function is increasingly being taken



over by information networks. This is also true for human networks of contacts in higher education in engineering.

The hypotheses hypothesised in this research are:

H1: Digital education is more effective for students' knowledge acquisition than education based on face-to-face contact only.

H2: When teaching exclusively online, it is easier for both students and teachers to obtain relevant information.

In order to confirm or refute the research hypotheses, a qualitative methodology was used, using a semi-structured interview schedule with both open and closed questions, giving the interviewees the opportunity to freely express their experiences and share their opinions and thoughts. The main themes of the guide were: experiences, feelings, memories, advantages and disadvantages of digital education. Exploring experiences, feelings and memories of digital education, advantages and disadvantages of digital education. The interviews were conducted with the help of professionals experienced in higher technical education. The interviewees were very helpful and cooperative. The interviews were conducted online using Zoom and Teams digital platforms. Sampling was done in an arbitrary way by interviewing familiar academics and our results are not representative. Due to the exploratory nature of the interviews, they can be used as a basis for further research and statistical analysis. The qualitative nature of the research means that its limitations cannot be extended to any population, but it can serve as a basis for future quantitative research. In terms of gender, there were 3 male and 3 female respondents. The research underlying the analysis was self-administered in 2021. By analysing the interviewees' responses, both hypotheses of the research are considered to be accepted and supported. In the future, we would like to further extend our research with quantitative methodology and explore further findings on this topic.

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