

The Power of Sociograms in Enhancing Student Well-Being

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1. Motivation and Procedure (LV)

1.1 Issue Identification (LV)

The topic we have developed our product around is student well-being. It is a topic which has gained a lot of attention during the last decade because the well-being of Danish students has been steadily declining. According to The National Survey on Well-being, the development of the proportion of students in grades 3 to 9 with the highest overall well-being has been steadily declining, going from 93 pct. in 2015 to 89.8 pct. in 2022 (*Uddannelsesstatistik*, n.d.). The trend is especially negative among the older students in primary school, where 7th-grade students with the highest well-being scores express an overall well-being score of 88.6 pct., 90.6 pct. when it comes to social well-being, 84.2 pct. when it comes to academic well-being, 85.7 pct. when it comes to order and quietness, and 51.9 pct. when it comes to support and inspiration (*Uddannelsesstatistik*, n.d.). No one reason can exclusively account for this development, but possible explanations point to the Primary School Reform of 2014 (Nielsen et al., 2020), pressure from social media and a performance culture (Det Nationale Forsknings- og Analysecenter for Velfærd, 2020; Grynberg, 2021), as well as the COVID pandemic (Danmarks Evalueringsinstitut, 2022). The average number of students in a class has also been increasing; in 2009 17 pct. of all students attended a class with a minimum of 25 students, and this number has increased to 28 pct. in 2019 - an increase of 64 pct. (Danmarks Lærerforening, 2019). Well-being is therefore not only a relevant topic but a pressing issue.

However, despite the vast amount of attention that the topic has attracted, the term itself is not universally defined. In the discourse within pedagogical and educational science, student well-being is understood in terms of the presence of positive emotions and experiences: optimism, belief in one's self, trust in the external world, the feeling of joy etc., and by the effect of these the drive and resourcefulness of the students (Sederberg & Stolpe, 2019, p. 24). This also explains why social and academic well-being affect each other; when social life is successful, one might experience a safer learning environment to work on improving academic performance. And reversely, if the academic performance is going well, there might be more energy to invest in the social aspects of the class (Sederberg & Stolpe, 2019, p. 24).

Even though there is no consensus on the definition of well-being, the implications of well-being are well documented. Students who express a greater feeling of psychological well-being also show higher emotional intelligence (Lee et al., 2012). Students who attend school, because they are motivated to do so, report a higher sense of well-being than students who attend because of a sense of duty (Van Petegem et al., 2007). And students who experience bad well-being are less likely to complete an education in the future (Sundhedsstyrelsen, 2022).

Within the pedagogical understanding of the mechanisms behind well-being, the concept of student well-being is broken down into several subcategories: self-assessed well-being, sociocultural well-being, competence-based well-being, and normatively justified well-being (Sederberg & Stolpe, 2019, pp. 27-28). It is also acknowledged that well-being is not an absolute term, but an experience term very much defined by the individual student (Sederberg & Stolpe, 2019, pp. 27-28). Thus well-being might be achieved differently for different students. If, for instance, a girl from 8.A expects to have around five close friends, while a boy from 8.B might expect to have just one close friend, and they both express that they have three close friends, then despite them scoring the same on a survey, their self-assessment of well-being might differ significantly - which can then go unnoticed. The way in which well-being is measured is therefore critical in terms of gaining an accurate understanding of the nuanced and multifaceted concept that is well-being.

1.2 How is Well-Being Measured? (LV)

Since the implementation of the Primary School Reform in 2014 (Folkeskoleloven, 2014), it has been obligatory for every primary school to perform The National Survey on Well-being (Børne- og Undervisningsministeriet, n.d.). The survey focuses on four topics: social well-being, academic well-being, support and inspiration, and order and quietness (Styrelsen for Undervisning og Kvalitet, 2023). Students from grades 4 to 9 are asked to fill out a questionnaire consisting of 40 questions with statements, which they must answer on a five-level Likert scale, from “strongly agree” to “strongly disagree” and “very often” to “never”, with the opportunity to choose “I do not wish to answer” at each question (Undervisningsministeriet, n.d.). According to § 56 b of the Primary School Law, it

is stated that *"the school principal shall conduct an annual measurement of students' well-being with the purpose of monitoring and enhancing students' well-being. The individual students' responses may only be used for conducting statistical and scientific investigations of students' well-being."* (Folkeskoleloven, 2014). In the guide for schools and teachers, developed by the Ministry of Children and Education, it is therefore repeatedly emphasized that the individual student's response may not be used as a basis for pedagogical or administrative actions toward improving the well-being of said student; the individual response should only serve as a tool to gain an overview of well-being on a class or school level (Styrelsen for Undervisning og Kvalitet, 2023). There is also no standardized procedure on how to follow up on the results from the survey; that is up to each individual school. However, it is recommended that schools develop an action plan and select focus areas on which to implement initiatives on improving well-being as well as investigating the underlying reasons for why the results appear as they do (Styrelsen for Undervisning og Kvalitet, 2023).

And it is this investigation of the underlying reasons for the well-being results that we wanted to help initiate. Because even though the survey asks "Do you like your class?" it does not offer a follow-up question asking "Why?". And while it will provide the teacher with a percentage of the students in a class who very often feel lonely, it will not disclose which students feel that way. In other words, the measures of the self-assessed subcategory of well-being - which is highly individual (Sederberg & Stolpe, 2019, pp. 27-28, 32-34) - are predominantly performed quantitatively, as exemplified in the extract of results of the National Survey on Well-being above (*Uddannelsesstatistik*, n.d.), and thus does not allow for a nuanced insight into the mechanisms that constitute these specific well-being results. From § 56 b subsection 2 of the Primary School Law, it is also stated that the measurement of students' well-being must be carried out using this tool provided by the Agency for IT and Learning (Folkeskoleloven, 2014). Each individual school must therefore use a supplement tool to the National Survey if they wish to measure student well-being in a different way than the National Survey does or identify these underlying reasons that the National Survey does not shed light on.

This quantitative approach to measuring well-being is not exclusively used in the National Survey on Well-being. In a literature review on how well-being is measured, it was concluded that 27 of the 33 studies in review exclusively used a quantitative approach to measure well-being (Hossain et al., 2023). The many different approaches to measuring well-being along with the broad and unspecific conceptualizations regarding well-being indicate a lack of consensus regarding the definition and measurement of well-being (Cooke et al., 2016). The quantitative approach that is a part of the above-mentioned surveys has the advantage of being easily adapted into various settings and working with large samples, but it can neglect the intensity, duration and frequency of the emotions that students express as well as the contextual influence. And this is why a more qualitative approach is needed to understand the underlying mechanisms that constitute the individual experience of well-being for each student (Hascher, 2008). All of this motivated us to create a supplement tool that would actually allow for the opportunity to ask the questions “Why?” and “In what way?” to enable the teachers to identify what well-being means for every single student and thereby encourage immediate action to combat the lack of student well-being.

1.3 Initial angle: Learning Styles (LV)

We initially wanted to approach the issue of student well-being from the angle of learning styles. We started the conceptual and practical development of a digital tool for the teacher to use in order to gain an overview of the learning styles of the students in a class. A website containing a questionnaire regarding overall well-being but with a focus on the individual student’s challenges and preferences towards the learning environment e.g. in which situation the student feels they optimally learn the most, with answer opportunities being for instance “when the teacher explains”, “when reading about it”, “when talking with others about it”, “when watching a video on the topic” etc. All students would then fill out the questionnaire, and the teacher would be presented with the results in a simple and user-friendly way to gain an overview of the classroom’s learning styles and preferences. Ideally, the patterns in the students’ answers to the questionnaire would then offer

opportunities to e.g. make certain group formations or divide the classroom into different sections with different tasks surrounding the same topic.

This is when we first encountered the issue of balancing the gain of large amounts of data while still presenting them in a way that makes the data useful and attractive to take into account for the teacher when structuring a class. The amount of data collected from this kind of questionnaire with these types of questions would be very comprehensive and rather unstructured, so we chose to categorize the learning styles into learning styles based on theoretical models. This way, the data would be more interpretable and easier to grasp, thereby making the application of the website more attractive for the teacher. Furthermore, to deepen our understanding of the needs of the teacher - seeing as they would be the ones ultimately deciding whether or not to use our solution - we consulted Maria, a teacher who is currently doing her Master of Arts (MA) in Learning and Innovative Change at Aalborg University, and who has interest and practical experience with accommodating different learning styles in a classroom. She emphasized this balance between harvesting enough data for it to be useful but not overwhelming and the importance of creating a tool that leaves the teacher not only with information but also a more practical guide of sorts for how to use the information to improve well-being going forward.

1.4 Change of Angle (LV)

As we kept developing our project based on learning styles, we discovered not only that there are a vast amount of models for categorizing learning styles (Cassidy, 2004; Hawk & Shah, 2007), all with different focus areas, but we also discovered the polarization within the scientific community regarding learning styles. Despite wide popularity, there seems to be no scientific foundation supporting learning styles (Letter, 2017; Pashler et al., 2008; Riener & Willingham, 2010; Willingham et al., 2015). We knew that if we were to base our solution on a model within education and teaching, it should reside on a strong scientific foundation, and the lack of such a foundation made us question whether our solution would then only be used by people who subscribe to that specific model, and whether our product might be discarded by customers in a few years, were the scientific

community's opinion of the model to change. A way to ensure the applicability and scalability of our product without a strong theoretical foundation would then be to make our product as universal as possible in its conceptual approach to learning styles such that it would not be dependent on the endorsement of a specific model. However, this would only bring back the above-mentioned issue of balancing the gain of a lot of data while simultaneously presenting it to the teacher in a simple and applicable way. If we chose to not use any sort of categorization or model, it would become computationally and visually difficult to create an overview of a classroom, thus harming the user-friendliness of the product and thereby the likelihood of it being implemented in educational institutions. Moreover, the scale of even our minimal viable product would be too comprehensive for us to realistically end up with a functional product.

We could not find a way around this wall that our project hit, but instead of abandoning the entire project, we decided to change the angle at which we would approach the issue of well-being. We then took a few steps back and revisited our conceptual breakdown of well-being and we then instead chose to focus on the social relations in the classroom. As we have already described, this is an incredibly important and influential factor for well-being (Benningfield et al., 2015; Lee et al., 2012; Sederberg & Stolpe, 2019, p. 24). But even with this quite drastic change of approach to our product, we did not feel that the first weeks of our product development were wasted. On the contrary, many of the technical applications that we had implemented onto our website prior to the change of angle carried over to the website that we wound up launching, and the research we found regarding well-being as well as the insight we gained from Maria to identify the needs of our user base turned out to be essential for our final product. That is also why we will return to discuss many of these challenges and considerations that became evident in the early stages of our product development; they were crucial to take into account throughout the entire process of our product development, and they remain so as we now reflect upon the product.

2. Product Description (SM)

2.1 Product Ideation (SM)

Our new aim was to create a platform which could assist teachers in understanding and managing social relationships in classrooms. To achieve this, we envisioned a web application which would provide teachers with a range of tools tailored for this purpose. We decided on a web application as the medium due to its accessibility for both teachers and students. In selecting a name for our product, we sought a name which encapsulated both social relationships and educational purposes and thus we came up with “Connected”, which we will also reference our product as. Additionally, we prioritized a design which would be intuitive and user-friendly to ensure a smooth experience for both teachers and students.

We envisioned the web application’s primary feature to offer an easy visual understanding of social dynamics in a classroom through sociograms. A sociogram is a visual representation or diagram which depicts social relationships within a group (Sobieski & Dell’Angelo, 2016). In the process of generating a sociogram, we needed to develop a questionnaire. Our object was to gather information on the academic- and social relations students have, to see connections between students. Additionally, we wanted our questionnaire to involve information about the student’s overall well-being, motivation and interests.

In developing the conceptual foundation of how our sociograms could be presented visually, we took inspiration from the interview we had with Maria. Maria came with the insight that apart from looking at who works well together it would also be interesting for teachers to see who was not working well together. However, due to ethical considerations, this will be discussed further. Generally, we began to question how we might include more information in the sociograms rather than just positive relations. As we delved deeper into this we developed the concept of incorporating gradient scales for the nodes. This approach would enable us to obtain a better understanding of students’ self-perceived well-being by capturing their responses. This would allow teachers to gain deeper

insights into the social dynamics since a student might not have many relations but still feel well.

On the website, we have also made various pages regarding the power of sociograms and general information about Connected and our purpose. And we have incorporated a section on data collection as well as a practical and ethical guide for the teachers to use to ensure responsible usage of the platform. We will return to the importance of providing these guides in our discussion.

Due to the decline of well-being being particularly severe amongst older students in primary school (*Uddannelsesstatistik*, n.d.), we targeted our product to 7th to 9th grade students and their teachers. And we expect students within this age group to possess sufficient introspection to participate in the questionnaire. So while our product could potentially cater to various age groups throughout the Danish educational system, it would require changes to the questionnaire, and so to avoid an extensive amount of extra work for our beta release, we chose to do it this way.

2.2 Project Timeline (SM)

To ensure progress and deliver a tangible product we decided on a minimum viable product (MVP) as a crucial step in the developmental process. After the decision of making sociograms the primary tool of the platform, we also decided this would be our MVP since it would be an essential part of our platform. Furthermore, we organized a project timeline on what could realistically be accomplished in three months and divided this into three different categories:

1. Minimum viable product: A web application which would allow for data collection through a questionnaire and utilizing a Python or Javascript application to generate sociograms through the data. The primary aim of the MVP was to develop a functional foundation for our application.
2. Mid-tier product: Building on the MVP, our mid-tier product would be an interconnected web application which both the questionnaire and sociograms could be

generated from. Teachers would here be able to access both the questionnaire and sociograms without the need for separate applications.

3. Ideal product: In addition to the features mentioned in the previous tiers, the ideal product would aim to expand the web application with a variety of different tools such as a tool for group formation.

By separating our developmental phase into these three tiers, we ensured a systematic progression. By having this approach we always knew the steps to come and what to work on. As our end product, we reached the mid-tier stage and had an interconnected functioning web application.

3. Technical description of the product (SM)

3.1 Front End Design (SM)

Front end design is everything visible to the user and everything the user can interact with. The front end design of our webpage plays a crucial role in providing an intuitive and visually appealing interface for the teachers using the product. In order to achieve this we used various technologies and frameworks.

To establish the underlying structure of the web page we utilized a free HTML and CSS template obtained from the website html.design (Kant, 2020). HTML stands for Hyper-Text Markup Language and serves as the skeleton for the web page, defining the structure and layout of the web page. CSS or Cascading Style Sheets should be seen as skin, hair and overall design of the web page enhancing visual aesthetics. To ensure a responsive front end design which adapts to different screen sizes and devices, Bootstrap 4 (Otto & Thornton, 2013) was utilized. Bootstrap is a widely used open-source CSS framework which offers a collection of pre-designed styles and components. The framework by Bootstrap utilizes a grid system which dynamically adapts its layout and appearance depending on the device being used.

In order to make an interactive and dynamic design for the webpage JavaScript (Flanagan, 2006) and jQuery (js.foundation, n.d.) were utilized. jQuery is an open-source JavaScript library which offers a variety of tools enabling an interactive design. For the Connected web page, jQuery was utilized to create a carousel slider on the front-page, different event handling mechanisms and loading in the sociogram. Event handling mechanisms involve responding to user interactions such as a button click, keyboard input or mouse movement which can then execute a custom action such as a “Thank you for participating” text. jQuery was also utilized to create the navigation bar for the web page making it simple for the user to navigate the web page.

To make a common thread throughout the web page, a colour scheme was created for this purpose. To create a visually appealing aesthetic our colour scheme consisted of complementary colours which contribute to different elements not clashing (Zonnenberg, 2019). To create graphics we took use of both *Canva* and Adobe Illustrator (Adobe Inc., 2019). Canva is a graphic design platform where it is possible to create and design graphical elements but the website also contains premade templates which the user can manipulate. Adobe Illustrator on the other hand is a software where the user can create graphical designs from scratch which was used to create the logo such as other graphics.

In summary, the front end of the webpage incorporates a variety of different front end tools such as HTML, CSS, Bootstrap Javascript and jQuery to create an intuitive and visually appealing web page. The front-page of our web page can be seen in Appendix 2, which showcases some of the various graphical front end features.

3.2 Back End Design (SM)

Back end design is essentially the engine behind the web page structure. The back end design takes care of how the database is structured and also the underlying code of the website. To achieve this we utilized a Flask framework (Grinberg, 2018) which enables Python (Van Rossum & Drake, 2009) to push and pull data from the website, meaning Python can be incorporated into the website.

To obtain data points from students about their social and academic well-being, a questionnaire had to be created. The questionnaire was created using Python where information from the front end is retrieved by Flask. The script then writes the data by the user to a CSV file which later can be utilized to create new tools such as the sociogram (see Appendix 3 for the questionnaire).

For the sociograms to not be accessible to everyone a login form was needed. The login form was also created using Flask. After a user input has been made, Flask parses the information to a CSV document containing login credentials. One will be granted access to the sociogram page if the credentials add up.

The sociograms were created using the Python library igraph (Csardi & Nepusz, 2006). The script first parses the information from the user input from the class name on the website and then filters out which class to create the sociogram from. Through igraph nodes and edges between the students are then defined. For the sake of easy visual comprehension for the teachers, we decided to colour the edges differently depending on the answers from the students about who they work well with and who they do not. If two students both answer they work well with each other, the edge will be a colour in accordance with our colour scheme. If only one and not both of the students answer they work well together, then the edge will have a different colour. The same goes for the edges in accordance with students who answer they do not work well together.

The nodes of the different students will also receive a colour on a gradient scale from dark grey to light blue depending on their answer to a question such as “How well do you feel socially (from 1 to 5 where 1 is not so good and 5 is great)”. If they feel well they receive a light blue node. The sociogram is then visualized using the igraph library’s plotting capabilities. The graph’s layout is determined using the Fruchterman-Reingold algorithm. The Fruchterman-Reingold algorithm assigns the nodes and edges repulsive or attractive physical properties which we found pleasing for the visualization of the sociogram compared to other algorithms. Flask then parses the image generated to the front end of the website making it visible to the user. The front end design of the sociogram can be seen in Figure 1. The website can be accessed at <https://connected-f4xn.onrender.com> (see Appendix 1 on how to use the website).

students' emotional states about specific topics (Gardner et al., 2018). From the free-written text, we could also utilize Term Frequency-Inverse Document Frequency (TF-IDF) analysis to extract important keywords on different themes and questions. As a common thread throughout the creation of our product, we have aimed to visualize data for it to be more comprehensible, and this could also be done for the TF-IDF by utilizing word clouds (Robinson, 2022).

An addition to the questionnaire could be to ask the "Cantrill Ladder" question (Gallup, 2009), which is featured in the *Health Behavior in School-Children* (HBSC), a WHO collaborative cross-national study on student well-being (WHO, 2020) that has been used in the last 30 years and has inspired many of the Danish surveys on student well-being (TrygFondens Børneforskningscenter, 2015, p. 17). The question could sound like "Imagine a ladder. Step ten represents "The best possible life" for you, and step zero represents "The worst possible life" for you. Where do you perceive yourself to be on the ladder at present?". We imagine tweaking this question to ask about the student's self-assessed well-being and have them rate their well-being on this ladder as well as write a small free-written text about their answer and what their well-being at zero and ten looks like, respectively. Thereby we could analyze the free-written answers with NLP techniques and tie up the different steps with keywords from the free-written text, making it easier to comprehend for the teacher why the students might be on e.g. step five and what it would require to reach step ten.

At the current state of the website, teachers are not able to change the questionnaire and ask questions they have designed themselves. We would, however, like to incorporate this feature, and by using AI we would be able to detect if the teacher's self-designed questions complied with our ethical and legal guidelines. An AI chatbot on the website could also be useful if the teachers had specific questions about specific students. The chatbot would then be trained based on the answers of the students and would help aid the teacher with providing useful help for the students based on previous experiences with similar conditions. Machine learning could also be implemented into other tools such as group formation. This would require students to evaluate a particular group they had been involved with and thereby generate groups utilizing this data. These applications could

add to the scaling of Connected making it applicable to other areas of the educational system such as study group formation at universities.

When contemplating the implementation of these AI features, it is, however, crucial to acknowledge their potential downsides. The utilization of AI is growing rapidly (Forbes Advisor, 2023), and not only should we make sure that Connected is and will continue to be compliant with the laws and regulations surrounding AI. We would also need to ensure responsible use of these features by expanding our practical and ethical guidelines on the service. Though we envision that the use of AI would prove resource- and time-saving, it would only be helpful to the extent that the teacher remains critical of the artificially produced assessments of the class. For example, with a successful implementation of a group formation tool based on machine learning, we would emphasize that this would be one possible formation and a recommendation alone, why the teacher's professional assessment would still be needed. In other words, our AI tools should aid the teacher but never replace the teacher.

A way to optimize the original sociogram would be by visualizing cliques and groups through the edges between nodes. As mentioned, we have used a Fruchterman-Reingold algorithm to design our sociogram layout, but this might pose a potential challenge in terms of comprehensibility, especially in large classes. If a class has perhaps three or four groups that the majority of students identify they belong to, then it might add unnecessarily many overlaps of edges if no clustering within the sociogram is possible. Allowing for this group layout would have the sociogram more directly reflect the actual social groupings within the class and could thereby enhance the interpretability and desirability of using the sociogram (Huang et al., 2006).

A different way to structure the sociogram could be to have the distance from the centre of the sociogram represent how many connections the student has, so that the students with the most connections are in the middle and the students with the least connection reside closer to the periphery (Huang et al., 2006). Instead of the teacher counting or otherwise having to gain an overview of this themselves, the overview would be easily interpretable from the sociogram. We also contemplated the possibility of dividing the circles into e.g. four distinct corners to categorize interests and learning preferences. In

doing so, the strengths of our original idea with learning styles - identifying the different learning preferences, motivations, interests and challenges in the classroom - would not need a theoretical foundation but could be utilized in connecting it with the social relations. If for example student Emma has many social relations but struggles with presenting in front of the class, and student Ida does not have many relations but excels in class presentations, then it might benefit Emma academically and Ida socially to pair them up when practising these presentations. Similarly, the teacher could initiate relations in the classroom according to interests and motivation. So with this application, we imagine teachers to visualize and initiate these multi-beneficial relations that they might not otherwise have been able to identify.

At the product's current design students are asked to freely recall other students with whom they do and do not work well with. But the utilization of this retrieval design introduces a potential drawback; there is a possibility for the student to forget to list peers whom they work well with. However, it is possible that the individual forgotten may not have been of importance and the retrieval design thereby acts as a natural filter. Another way of approaching this would be by presenting the student with a list of their peers. In this recognition design, we arguably remove some of the workload of the student's memory because the student does not have to recall other students but only recognize them (Anderson & Bower, 1973). However, in this design students might rate peers whom they had not previously considered, thus possibly fostering negative relations that might not actually exist. Both designs have their advantages and disadvantages, and for further development, it remains a decision whether to maintain the current approach or switch to a recognition design.

In summary, with the extended product, we would hope to enable the teacher to ask this question of "why" and identify the underlying causes for the students' well-being. With this in mind, our primary focus on the extended product would remain to make it as intuitive, simple and useful as possible. The addition of these advanced techniques would be redundant if the experience of using the product resulted in the teacher feeling overwhelmed and confused rather than being able to utilize the tool for improving well-being.

4.2 Conceptual Challenges (LV)

One of the biggest challenges our product has faced regards conceptual originality. We have not invented sociograms, and we are not the first to see their potentially significant role in monitoring well-being. Throughout the product development, we discovered that we are not the only ones offering a product using sociograms to measure student well-being in Denmark; a product called *Klassetrivsel*, which is also centred around sociograms, has been on the Danish market for over a decade and currently has a user base of 900 schools as well as 700 schools in Norway. When we discovered this we chose, once again, to not abandon the project but instead to utilize *Klassetrivsel* as inspiration on what to do and what not to do in our own product, similar to how we have taken inspiration from the National Survey. We, therefore, invested a large amount of our conceptual development discussing how we could distinguish ourselves from *Klassetrivsel*, and what would be required for us to not only reach the same level of success as them but to surpass it too. As a part of this, we reached out to Lars du Jardin Nielsen, the CEO of *Klassetrivsel*, in the hope of finding a sparring partner and gaining insight into their experiences and challenges in creating and distributing *Klassetrivsel*. These sparring sessions inspired us in the development and retrospective critical evaluation of *Connected* and have influenced our contemplations regarding possible future directions, as we will return to discuss.

As we have already described, there are numerous advantages to expanding our product by implementing the AI and NLP features we have described. That is also why we believe this is where our product stands the strongest and where we stand out from the existing providers; these features are not present in *Klassetrivsel*'s service or any other on the Danish market. However, a big challenge related to this is that the balance in presenting large amounts of data while preserving user-friendliness becomes increasingly more challenging to maintain as we implement mentioned applications and add more data to the sociograms. For instance in the case of the implementation of a grading scale. Then both the nodes and the edges would be coloured - as seen in the picture - and this means that certain social patterns that might have stood out before now would blend in with the other colours, all possibly resulting in reduced interpretability (Huang et al., 2006). Therefore, if we were to launch our extended product, we would have to reconsider our visual presentation of the edges in this case of the grading scale; should all edges be one colour instead,

possibly with arrows? However, would this make it difficult to distinguish between the different overlapping edges in a class with 28 students? But then again, would it be worth it to gain this deeper insight into the students' well-being by using a grading scale, even at the expense of the general overview of the class? These are some of the considerations we would have to invest a lot of time in to properly address.

4.3 Ethical Considerations (SM)

Given the topic's sensitive nature, respecting privacy and emotional well-being is of paramount importance when using our product. As mentioned, we have provided an ethical guide on our website to ensure responsible usage of the platform and a positive experience for the students when engaging in the questionnaire. Our ethical guidelines have been conducted following the best practices as those outlined by ESOMAR and GRBN, 2018 (see ethical guidelines in Appendix 4).

Regarding asking negative questions about other individuals (e.g. "Are there any classmates you struggle to work with in group projects?"), we have had concerns about whether this is ethically correct. It is not customary in Denmark to single out peers with questions such as "Who is the bully?" (Red Barnet, n.d.), and in Norway it has previously been more prevalent to ask such questions but is currently being discussed whether or not this should change. Arguments against this include fostering a positive school environment for everyone while keeping in mind in situations with bullying, that there are multiple perspectives on the given situation (Lauvset, 2016). Regarding asking children to single out peers and ask for negative relations, some of the same concerns are relevant. Asking students to do so might create feelings of unsafety and insecurity. Klassetrivsel argues that when asking sociometric questions, one should ask for positive relations rather than seeking negative ones, in order to foster a positive class environment (Skolevisioner, 2019). So a potential issue with negative questions is the inadvertent priming of students to generate negative thoughts about their peers, which they might not have harboured previously (Tulving & Schacter, 1990).

The general heavy use of data-driven applications for measuring well-being in Denmark has also been criticized. One critique is the limited evidence that this quantification of social dynamics can be used to solve social problems (Khameneh, 2023). Additionally, an important consideration is whether or not the self-surveillance approach employed by these applications exacerbates self-awareness with ideals they cannot live up to, thus contributing to negative feelings rather than fostering positive ones (Khameneh, 2023). Another issue is the potential lack of complete honesty from students when answering the survey, particularly if they feel embarrassed or want to hide certain relations from the teacher.

A study in 2015 also found that the use of technology in schools had decreased returns in learning outcomes (Schleicher, 2015), and though technology and its use have changed a lot since 2015, it is important to consider if our tool actually contributes to solving the problem of declining well-being. As we have already voiced our worries about, by attempting to solve social problems through technology some might fall victim to relying excessively on the tool rather than conversing with students. With our product, we aim for it to be a supplement and not a replacement.

4.4 Data Collection and Processing (LV)

Seeing as we would gather a lot of information from the students and offer the possibility to view answers of individual students instead of only showing class-level statistics, it would be crucial to ensure that the collection and protection of this data, as well as regulations concerning children, would be in accordance with Danish legislation and the General Data Protection Regulation (GDPR) (*General Data Protection Regulation (GDPR) – Official Legal Text*, 2016). GDPR was implemented in Denmark in 2016 with the purpose to safeguard privacy and personal data within the European Union, and this regulation governs the collection, storage, processing, and sharing of personal information. Regarding children, there are also specific regulations within GDPR as well as within Danish legislation. Therefore, prior to a beta launch of Connected, we would have to ensure complete legal compliance in four aspects of Danish legislation and GDPR: consent, privacy policy, children's rights, and safety measures.

Consent is crucial when collecting data. Consent must be provided for the data processing to be lawful, according to GDPR, Article 6, and data subjects have the right to withdraw their consent at any time and be informed of this right prior to giving consent, as described in Article 7. Should consent be withdrawn, we would have to possess the technical infrastructure to effectively manage such cases. GDPR Article 8 establishes a minimum age of 16 years for children to provide their own consent, but in Denmark, consent can be given from the age of 13 according to the Danish Data Protection Act (Databeskyttelsesloven, 2018). Seeing as our product would target children in 7th to 9th-grade, we would expect the majority of students to be capable of providing their own consent. However, in the case of some students being younger than 13 years old, or if we were to expand our product to younger classes, obtaining guardian consent would become necessary. In such cases, we would need to modify our technical infrastructure accordingly to accommodate this requirement.

Privacy policy refers to how information about data processing is presented to data subjects. According to GDPR, Articles 12, 13, and 14, data subjects - the students - must be informed clearly and understandably of how their information is handled i.e. the types of personal information collected, user rights, processing methods, data access and storage duration. The students must be provided with this information before answering the questionnaire by for example being presented with an informative document when they click access questionnaire on the website. In a similar fashion, the student's rights need to be communicated clearly, in accordance with GDPR legislation regarding the rights of the data subject. This refers to the rights that pertain to the data subject regarding the information they have provided. Article 15 grants data subjects the right to access their information, while Article 16 ensures their ability to correct any inaccurate personal data. Article 17 guarantees their right to have their information deleted, and Article 21 grants them the right to object to certain types of data processing, such as profiling and direct marketing. It would be crucial to communicate these rights to the students and inform them about where they can submit requests. Furthermore, we would need to establish an effective process for handling and responding to these requests, ensuring that the student's rights would be respected and their requests would be addressed promptly and appropriately.

Safety measures refer to the importance of implementing appropriate technical and organisational measures in order to protect the data subject's personal data from loss, leaks, and unauthorized access. Article 32 mandates safety measures such as data encryption, ongoing confidentiality, availability, and resilience of processing systems, the ability to restore and access personal data in case of incidents, as well as regular systems monitoring of these safety measures. The current state of the website fails to meet these safety mandates. Anyone with login credentials can view sociograms for all classes, the website is not resilient against breaches, and the data is currently being stored on a local CSV file instead of in an encrypted system.

It would therefore be crucial to prioritize the improvement of our security systems moving forward, by implementing different levels of permission to access the sociograms and possibly by acquiring high-security servers from an external provider and by considering Transport Layer Security (TLS). TLS is a protocol that establishes a secure and encrypted connection between users - e.g., web browsers - and internet servers, rendering data unreadable to unauthorized individuals (Rescorla, 2018). Additionally, utilizing a government-provided login system like UNI-login (Styrelsen for IT og Læring, n.d.), which already uses password encryption, would further enhance data security. This solution would be desirable, as it would not only guarantee enhanced security and legal compliance with Danish legislation and GDPR, but it would also make Connected an appealing choice for the vast number of schools that are already utilizing UNI-login systems, thus expanding our potential user base.

4.5 Iteration - What Would We Have Done Differently? (LV)

Upon reflection on our product and the development process, there are certain aspects that, in hindsight, we would have approached differently. While our research on well-being prior to the conceptual and practical development of our product provided a theoretical foundation, and we greatly appreciate the valuable insights gained from consulting Maria, it would have been advantageous to obtain a broader perspective on the exact needs of primary school teachers by for instance conducting a survey ourselves. Gaining this insight from our target group could have aided us in the ideation phase, especially in

regards to understanding the tipping point of this balance between collecting large amounts of data and presenting the data in an easily interpretable fashion. Additionally, we could have considered surveying our target group of primary school students - 7th to 9th graders - to gain insights into their preferences for well-being measurements and their opinion on possible improvements to already existing surveys such as the national one. If, for instance, many students expressed a desire to elaborate on their answers through free-written text, this technical feature would have received heightened priority in the development of our product.

Continuous contact with our target group would also be essential in the future development of Connected. To ensure consistent optimal user experience, we would envision periodically conducting surveys on both the students and teachers who use Connected to address the challenges we have discussed in this paper. Teachers would be asked about the functionality, user-friendliness and relevance of the product, and this feedback could give us insights to reevaluate certain decisions regarding the product's concept and visual design. Additionally, it would help us determine the best course of action for further product development, while also shedding light on any technical or computational limitations we would need to address. A success measurement for us would not be to only increase our customer base, but that our customers actually would use Connected and find it helpful in the work on improving student well-being.

On the ethical matters we have discussed, it would also make sense to ask the students about their experience with filling out the questionnaire and whether they had suggested changes to the questionnaire - this could be especially relevant in addressing the issue concerning negative questions. Additionally, they could voice their feelings regarding the teachers having access to information about their well-being and having a simplified visualisation of the social dynamics in their class. In this regard, the teacher could also shed light on which, if any, effects it had on the classroom dynamic to have the students perform a survey on well-being in the first place. All this would be a part of our effort to continuously address the many potential strengths and weaknesses of Connected.

5. Future Directions and Conclusion (LV)

We have two primary future directions to go in. The first is to continue our independent development and strive to launch our extended version of Connected. Immediate challenges to this would be the task of computationally building our extended product, the conceptual and ethical considerations, and the data-related issues we have discussed. Additionally, we would need to address the more business-related aspects of our product development such as creating a solid business plan for potential partnerships, making company registration prior to profiting, and establishing the necessary resources for continuous monitoring and improvement of the product. Managing these aspects would be crucial for the long-term success and scalability of Connected. However, in terms of distribution and implementation in primary schools, Klassetrivsel is way ahead of us with its well-established service and substantial user base, which is why they undoubtedly would be our main competitors, were we to continue our independent development of Connected.

An alternative future direction would be to collaborate with Klassetrivsel instead of competing with them. As previously mentioned, we reached out to them with the hope of gaining inspiration and finding a partner to discuss the challenges associated with developing a product for measuring well-being. After e-mail correspondence and a couple of meetings, Klassetrivsel has offered all of us working on Connected student positions within their company. Our role would be to contribute to expanding their service by implementing the features we have described for our extended product, such as NLP, AI and machine learning. This would be a unique opportunity to use the experience we have gained throughout the entire development process and continue our work on conceptualising and creating the most optimal well-being measurement tool for both students and teachers. And a significant advantage of becoming a part of Klassetrivsel, an already well-established company with an extensive user base, would be that the aspects concerning legal compliance, data management, and business planning would already be handled. By collaborating, our ideas could be practically implemented in primary schools and hopefully serve as a valuable tool in enhancing student well-being - the very purpose behind the development of Connected.

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7. Appendix

7.1 Appendix 1: The Website

<https://connected-f4xn.onrender.com/index>

When the website is inactive, it enters an idle mode. This means you have to wait approximately 2 minutes before the website is up and running.

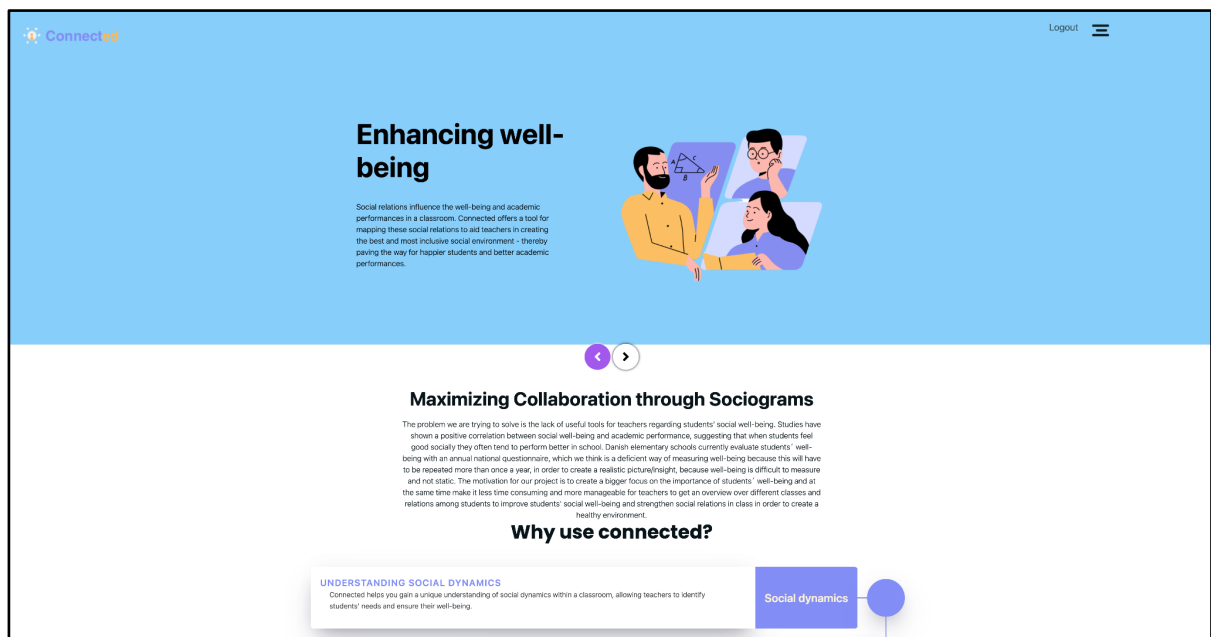
If you try to access either the practical guide or the sociogram you will be prompted with a login site. Here are the credentials:

Username: roberta

Password: awesome

To see a sample sociogram, go to the navigation bar, click “show test results”, and enter the class name: “1a”

7.2 Appendix 2: Front-Page of Website



7.3 Appendix 3: Current Questionnaire

Please answer the questions



When asked to name persons, use first names, separated by a comma e.g. Søren, Laura, Liv, Freya

Name:

Class:

Gender:

How well do you feel socially (from 1-5 where 1 is not so good 5 is great)

Are there any classmates you struggle to work with in group projects?

Is there anyone in class, you would like to work more with on a group project?

Who do you most enjoy talking with in class?

Is there anyone in class you find it difficult to talk with?

Is there anyone in class you would like to get to know better?



7.4 Appendix 4: Ethical Guidelines on the Website

- Confidentiality: Emphasize the importance of maintaining the confidentiality of students' responses. Ensure to handle the data with utmost care and that data of students are not shared with anyone without their consent.

-
- Privacy: Encourage flexibility in how students can fill out the questionnaire. A possibility to increase comfort for them when answering the questionnaire is to provide options for them to answer in a comforting environment such as at home or a quiet place. Avoid situations where students can see each other's answers.
 - Patience: Allow students to take their time when answering the questionnaire. Rushing students may lead to hasty responses which may lead to inaccurate representations of social dynamics. Encourage an environment where students can reflect and answer their questions thoughtfully and let the students take the time needed to fill out the questionnaire.
 - Support: Ensure that students are aware of available support if they feel distressed or overwhelmed during or after answering the questionnaire. Emphasize that students can seek support and guidance from their teachers or school counsellors.

7.5 Appendix 5: Draft of the Questionnaire for the Extended Product

Questions for the standard sociograms:

Questions related to social relations:

- Who do you most enjoy talking with in class?
- Is there anyone in class you find it difficult to talk to?
- Is there anyone in class you would like to get to know better?

Questions related to academics in class:

- Who do you work well with in group projects?
- Are there any classmates you struggle to work with in group projects?
- Is there anyone in class you would like to work more with on a group project?

Questions for the graded sociogram:

Questions in cursive represent the possibility to provide a free-written answer.

Scaled questions (from 1 to 5) related to social relations:

- How well do you feel socially?
 - *Please elaborate.*
- Do you feel comfortable talking to your teachers about difficult topics?
 - *why/why not?*
- Do you feel comfortable talking to your classmates about difficult topics?
 - *why/why not?*
- How satisfied are you with your class as a whole?
 - *why/why not?*
- How much do you like the breaks between classes?
 - *Please elaborate and explain how you typically spend them.*

Scaled questions (from 1 to 5) related to academics in class:

- Do you take initiative in group projects?
 - *why/why not?*
- How much do you enjoy group work?
 - *why/why not?*
- Do you view group projects as primarily social or task-oriented?
 - *why/why not?*
- How comfortable are you with presenting in front of the class?
 - *why/why not?*
- How do you feel when your teacher assigns groups for a project?
 - *Please elaborate*
- How do you feel when your class has to organize their own groups for a project?
 - *Please elaborate*

Questions related to individual well-being:

- Do you experience that your well-being differs depending on which subject you attend?
 - *Why or why not do you experience a difference? And which subjects do you generally like to attend and which do you not? Please elaborate.*
- Do you experience discomfort when you are at school such as stomach pain, trembling etc?
 - *How often do you feel this? Are there particular subjects where you feel this? Please elaborate.*
- Before going to school in the morning, how motivated are you to go?
 - *Why/why not?*
- How do you like making presentations in front of the class?
 - *Why/why not?*
- Imagine a ladder. Step ten represents "the best possible school life" for you, and step zero represents "the worst possible school life" for you. Where do you perceive yourself to be on the ladder at present?
 - *Why do you perceive yourself on that specific step on the ladder?*
 - *Describe what your step zero looks like.*
 - *Describe what your step ten looks like.*