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Q-method as a tool to facilitate meaningful public engagement with science

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Introduction

The pressure on researchers to participate in outreach activities is growing as research funding needs to be 'justified' to policy-makers and its relevance needs to be shown to tax-payers (Forrester, 2017). At the same time, pressure is also growing for researchers to include stakeholders in their research, conduct their project while engaging stakeholders, in an open manner following the EU's understanding of responsible research and innovation (Vom Schomberg, 2013).
Finding ways to use outreach activities to meaningfully engage stakeholders and record their point of view would be a way to combine the two while increasing the quality of the data collected from the stakeholders. Indeed, this data would be generated at a time where the stakeholders sought to engage about the research and as they have the opportunity to interact with researchers themselves, when their questions can be answered. However, our observations at science fairs are that researchers face three important barriers when doing this. Firstly, the stakeholders, or here citizens, do not come to science fairs or events to participate in research but to learn about research. They might not want to be 'used' to complete experiments or surveys. Secondly, the citizens at these science fairs might want to interact with researchers on a topic for a limited amount of time, and then move on to discover another topic. Thirdly, the organizers of such science fairs want researchers to present their research in an innovative, accessible, and enjoyable manner. This allows visitors to learn better about science and is in line with the history of science fairs and school science fairs (Bellini and Lilly, 1999).Traditional methods such as surveys do not seem to fit this criterion. Identifying research methods that can be applied in a sound manner in such circumstances can be challenging.
We suggest that Q-method, a qualitative method aiming to capture the point of view of subjects (individuals) on an object (topic or experience), can be used in order to facilitate meaningful engagement and produce data that can be shared with policy-makers. We describe our practice of Q in this context.

1. Engaging citizens with science

The idea of engaging citizens with science has become popular over the last decade. It becomes even more important as one is meant to conduct research following the principles of Responsible Research and Innovation (RRI; Vom Schomberg, 2013), which involves the idea of engagement, collaborative decision-making, and shared responsibility. Thinking about the methods needed for this engagement to take place is necessary (Groves, 2017) as the methods currently used, mostly consensus conferences, are costly and focus on the engagement of a limited number of individuals.

The literature allows to highlight desirable characteristics of these methods. Firstly, the methods chosen must go further than surveying opinions with traditional quantitative means as they ask for active participation and deliberation of the participants. Secondly, they should let citizens express their points of view, instead of answering their questions in a more top-down approach (Powell and Colin, 2009). Powell and Colin (2009) recommended that a reflexive dialogue is built and that the process is open-ended. Approaches that allow citizens to explore the topic and forge their point of view are therefore needed.

To choose the method they will use, researchers need to consider five elements: 1) the goal they ascribe to engagement; 2) the moment when they start the engagement process; 3) the efficiency and fairness of the method; 4) the sampling approach; 5) the possibility to create a dialogue and feedback that the method under consideration is allowing.
First of all, they must have a clear goal (Powell and Colin, 2009; Philips and Orsini, 2002). Public and citizen engagement is defined as "*the practice of consulting and involving members of the public in the agenda-setting, decision- making, and policy-forming activities of the organization or institutions responsible for such functions*" (Rowe et al., 2004: p.89). Kurath and Gisler (2009) suggest that informing, involving, and engaging can be different activities to perform. Rowe and Frewer (2005) look at different activities such as communication, participation, and consultation. These activities are characterized by different flows of information. As such, they might call for different methods. Ultimately, the goal must be to maximize the generation of relevant information from the participant (Rowe and Frewer, 2005).
Secondly, they must determine when to start citizen engagement processes. This could be upstream, for a more democratic research process (Kurath and Gisler, 2009). Or the engagement could be repeated at different stages of the research so as to address the different goals and scientific development embedded in a research project.
Thirdly, they must reflect on the efficiency and the fairness of the method (Rowe and Frewer, 2005). Researchers need to think of how their method of choice presents a fair burden and allows to restitute views fairly, is accepted and also accessible to individuals. Efficiency can be seen as the ability to transform the engagement into knowledge to be used for policy or research (Horlick-Jones et al., 2007).
Fourthly, the sampling approach must be considered (Rowe and Frewer, 2005): the selection can involve control or be random. While sample sizes are often looked at, it is not the only indicator to consider when sampling. For instance, one might want to privilege the consultation and involvement of specific individuals as they have an experience or expertise relevant to the topic at hand (Rowe and Frewer, 2005). Besides, the proportion of the sample which is actively engaged can be another factor to consider (Rowe and Frewer, 2005).
Fifthly, Forest (2013) suggests that public participation processes should enable feedback, rather than survey opinions. The method used should build-up the knowledge of participants, so they can have an informed opinion. According to Forest (2013), participants have prior knowledge of the topic to be investigated and can be self-prepared. It is necessary to recognize it in order to understand what information is needed to catalyze the debate or understand how opinions are formed.

Citizens engagement is also beneficial to the laypeople who participate in it. Powell and Colin underline, participants to citizen engagement activities can learn about scientific process and terms (Doble, 1995; Fischer, 2000; Guston, 1999; Hamlett, 2003; Kleinman, 2000), and they are more inspired to seek out further information or pay more attention to other information they come across (Guston, 1999).

Methods that allow participants to 1) build their knowledge on the topic; 2) deliberate with themselves; 3) collect rich data in a short amount of time; 4) are innovative and can be used creatively; are therefore needed.
Going further, Forest (2013) highlights that in order to apply the outcomes of the engagement process for decision-making, in particular policy-related, it is important to be able to identify the values underlying an analysis and to understand the context embedding citizens' analyses.

Q-method is proposed as a method which satisfies these criteria.

2. A brief presentation of Q-methodology

Q-method (see qmethod.org; Brown, 1993), was developed by Stephenson (1935; 1953) as an approach to capture people's subjective views of phenomena. To do so, one selects stimuli representing the phenomena under investigation and designs a matrix to rank these stimuli. The theoretical underpinning under the choice of stimuli arises from concourse theory, and the matric design comes from a methodological pillar centered around ranking called Q-sorting, and mathematical analysis which is the Q-factor analysis (Gauzente, 2013).

The concourse can be defined as the volume of available statements on a topic. Meanings exist for each individual and vary depending on circumstances but can also be shared with others. To carry out a Q-study, one starts by generating this concourse, using the literature, interview material, or a blend of these. The meanings included in the concourse can then be expressed in the form of pictures (Hawthorn et al., 2008 for an example), textual statements (Gauttier et al., 2016), sounds, objects, or all together (Blanc et al., 2018). The concourse constitutes the available list of elements on a topic, and as a consequence, it can be rather large. There is no magic number on the number of assertions to keep. Q-studies with as many as 1575 statements (Hilden, 1958) and as few as 14 statements (Manera and Wright, 1981) have been conducted. However, it is noteworthy that a bigger amount of statements decreases the chance of having random correlations. At the same time, one should consider the format of the assertion and the capacities of participants: children, patients with serious conditions, elderly, might not be able to rank as many assertions as other populations. Brown (1980) recommends a set of 40 to 50 assertions. Sets of 24 statements have been discussed as potentially not enough to cover the nuances of points of view even though they might be enough for a given topic (Gauttier et al, 2016). In essence, the Researcher is responsible for making sure the participants can express their point of view through the assertions proposed while maximizing the quality of data collection.

Then these meanings are ranked onto a Q-sort grid, i.e., respondents rank-order assertions according to the degree with which they represent their subjective view of one topic. The forced ranking distribution means that only a small amount of assertions can be selected as highly positively or negatively representative (see Figure 1). The majority of meanings will be neutral. This process forces respondents to choose and structure their point of view. The respondents are designated as the P-sample. Recruitment follows the idea of 'purposeful sampling', i.e. participants are characterized by certain elements or by having specific experiences identified.

Figure 1. Example of a forced distribution matrix

The process is the following:

1) Participants are asked to look the list of assertions entirely, so they have a holistic perspective of it.
2) Then, participants are asked to look at each assertion again and class it in one of three piles (agree, don't agree, no opinion). This helps participants to get acquainted with the Q-set and to proceed to a first sort of ranking, which should help them when they have to produce the detailed ranking demanded in the forced distribution matrix. Q-methodologists do not record this initial rough classification and participants are allowed to modify this classification ranking, for instance, an *'agree'* or *'no opinion'* as negative in the forced distribution matrix if they want to.
3) The third stage is ranking in the grid. Participants can modify their ranking as much as they want and the Researcher records only the last version of the grid that satisfies the

participants. All assertions must be ranked, and the grid must be respected. The order of the statements in a column is not important. Sometimes participants have more assertions they disagree with than ones they agree with, meaning that elements ranked under the longest column are not neutral. This is perfectly acceptable as it still means that the statements going to the middle are not the ones the participant focused on and that drives his point of view. Participants can rename the column if they feel they must to convey their idea.

4) Then, a post-sorting interview is conducted where participants have the possibility to explain how they proceeded to the ranking as well as the subjective meaning they give to the statements.

The result of the Q-sorting process by the participants is a Q-sort. Finally, a Q-factor analysis is performed to process the Q-sorts. As a result, one identifies Q-factors, which designate shared views across individuals. The results of the Q-analysis allow to identify in a transparent manner how the points of view are composed and what elements are shared, or on the contrary distinguishing. Indeed, it shows which individual Q-sorts compose a factor and which define it, as well as the correlation across these, and then the role of each item in shaping this factor. Q-method is a qualitative method and so is designed to deal with a small number of participants (Van Exel and De Graaf, 2005). Assessing the weight of each view is not the objective of Q-method and such a typological approach would be a misunderstanding of the underlying logic of the method. Comparing factors or views is thus possible, no matter how many people share the view (McKeown and Thomas, 2013).

Q is also used to map out stakeholders' points of view (Swaffield, 1996). The advantage of Q-methodology in such a context is that it allows to identify the shared points of view across stakeholders' in a transparent manner. The results can be used in order to facilitate negotiations, decision-making, and policy-making. Up to our knowledge, the method has however not been used to survey the attitude of citizens in an attempt at facilitating engagement and participation. It has however been used in order to facilitate the development of indicators together with laymen (Doody et al., 2009). This study, however, was meant to target invited participants for a regular research protocol, and not aimed at letting all interested people participate, as is the case on a science-fair as featured in our case-study.

3. Case-study: an application of Q-method to survey attitudes towards wearables at work

3.1 The use of Q at science fairs: research protocol

An application of Q-method was proposed at the Science is Wonder-ful! event organized by the European Commission for the European Researchers' Night. This event was organized so as to have citizens wander around and stop at stands they liked to discuss science. Typically, visitors do not spend more than 10 minutes on a stand as there are dozens of stands available, which requires that researchers can convey their messages clearly and in an entertaining manner if they want someone to stop by. Understanding this context is important to consider the methodological choices which have been made.

First, the researcher had to identify the concourse and then the Q-set. The Researcher has to identify the elements of the concourse that are the most significant to place them in the Q-set, which cannot be too big because of the limited time the individuals have to participate. This can be a good exercise for the researchers at it forces them to move from their understanding of intricate details about the topic to thinking about the elements that matter and should be communicated to the individuals. Colin and Powell (2009) mention the need for researchers to be trained in communicating with citizens and engaging them.

In this case, the researcher had proceeded to exploratory interviews in the workplace, which were the origin of the concourse. As the possibility to involve citizens occurred early on in the

research process, the amount of material was limited to 10 interviews of between 30 and 50 minutes. The notes resulting from the interviews were used to generate the concourse, as they highlighted the key concepts that had been mentioned during the interviews (about 20).
Then, the researcher formulated statements illustrating these concepts written from the first-person perspective and the citizen's position, so it was easier for them to forge their opinion about the statement. For instance, one could read 'I am worried that it makes nurses more stressed about their stress'. All statements were written as one sentence about the size of a tweet. 15 statements were retained, as it was estimated that they covered the main areas that could be conveyed during the science fair. Besides, having 15 statements was the minimal number that had previously been used for a Q-study (Manera and Wright, 1981), perhaps indicating it could be enough. Having 15 statements was also a way to minimize the time citizens invested into the experiment. It allowed to design the data collection procedure in a simple way. Indeed, it means that one can give less instruction on how to proceed to the sorting exercise (from the extremes and looking only at a couple of items at the same time, to reduce the cognitive load). Indeed, if there are only 15 items split in three categories (neutral, disagree, agree), then the participants can proceed to the sorting in easier ways: even if they do not distribute the items equally, the probability that they have more than half in one category is low. This means that the participants are facing a limited number of cards, which they can easily sort on the grid without additional instructions: they can handle 5-6 statements at once for each category. In that sense, the Q-technique (sorting) is preserved.

The Q distribution matrix was designed as going from -2 to +2, which also makes it easy for individuals to give meaning to each column. At the end of the Q-sorting process, the participants were asked about the statements they put in the extremes and also questions related to age and gender. The participants could proceed to the exercise on computers or by sorting the statements printed on cards.

Figure 2 represents the differences between an exemplary application of Q-method and the application we propose. It highlights that the main differences between a traditional application of Q-method and the case presented in this paper lie in the mode of recruitment and the reduction of items to be sorted (and array of the forced distribution matrix and instructions given to participants as a result). One difference with a regular Q-study is that sampling is now randomized as it is entirely dependent on who are the individuals visiting the fair, even if they are all stakeholders as citizens and share the characteristic of being interested in science and in the topic presented to them. All in all, 23 individuals took part in the experiment[1].

Figure 2. A visualization of a standard Q-study vs the adapted version proposed

3.2 **The application of Q: the case of wearables for nurses**

The statements (See Appendix A) were retrieved from the notes taken by the researcher during preliminary interviews with stakeholders, subjective assumptions, and reactions heard to the project. 15 were retained, and a forced distribution matrix of -2 to +2 was used. There were 23 participants. However, a principle of Q is to have less participants than statements (Watts and Stenner, 2012). 13 Q-sorts were randomly chosen.
The analysis was performed in KenQ, following a PCA and VARIMAX rotation. 4 factors, including one bipolar factor, were retained, as satisfying the eigenvalue criteria and scree plot test. Not all participants loaded significantly on a factor (See Table 1).

Table 1. Factor composition with defining sorts, and non-defining in brackets

[1] This low number is explained by the fact that most visitors were children and could not participate in the experiment.

The correlation matrix between factors is presented in Table 2.

Table 2. Factor score correlations

A synthetic Q-sort for each factor can be found in Appendix 1. The factors can be summarized as follows:

Factor 1 – Wearable technologies are to develop, but this raises many issues

The individuals on this factor agree with the idea to be treated by a nurse who uses this technology, they don't find it repulsive. They agree with the fact the technology will spread, but the outcomes of this development remain to be seen: they are neutral on how good, okay, or useful the technology is, while the statements depicting possible worries, be it in terms of management or changes in social relationships, are placed at the positive extreme.

Factor 2- Wearables at work are desirable

This view is an optimistic view. It is a view which does not find the use of wearables at work repulsive and focuses on its advantages. The statements in the positive extreme mention that the technology can be useful to increase the quality of the relationship with patients and to augment the autonomy of nurses. All statements describing potential issues and worries receive neutral appraisal, meaning they do not shape the perception of individuals, who decide to focus on a more optimistic outlook.

Factor 3 - A bipolar factor structured around managerial concerns

Factor 3 a – A rejecting view of wearables at work in the absence of regulations

The use of wearables at work raises worries because they can trigger stress and lead nurses to be reprimanded for it. The individuals on this factor do not want the technology to spread and would not use it. For them, it is different from other technologies used at work. The fact that this technology could be used out of personal initiative is not recognized.

Factor 3 b – A conditional accepting view of wearables at work

This view sees the potential improvement in the relationship between patients and nurses as a positive outcome of the use of the wearables, and wearables are seen as not different from other technologies used at work. Yet, their development calls for more regulation. Individuals on this factor would accept the use of wearables given these regulations. The main worries seem to be linked to the management of nurses with the wearables, which should be the object of the regulation.

Factor 4 – A fully rejecting view

Individuals on this factor reject the wearables at work in a very absolute manner: they want more regulations and believe that hospitals should not manage the nurses depending on their use of the technology. They also do not want this technology for themselves or at work in general. For them, the use of wearables at work is different from the use of other technologies. They do not agree with potential benefits such as improved relationships between patients and nurses and are not clear on conditions in which the use of such wearables would be okay.

5. Discussion

5.1 Using the results for further research

The different factors indicate the dimensions that are structuring both the accepting and rejecting attitudes, but also the conditions to which individuals might accept the technology and the issues raised. The latter seem to be mostly of managerial nature, indicating the need to work with organizations to understand how they see managing enhanced employees. Some participants signal the need for policy. Seeing as issues are related to management, these policies might need to take the form of agreements within different sectors, here the healthcare system. It must be also underlined that the participants had a consensus on the statements that pertained to the use of wearables being acceptable only if used as a personal initiative of

the nurse: this statement was classified as neutral, non-structuring. It appears that the participants accept the concept of organizational enhancement, i.e. the improvement of the performance of an organization through the improvement of the abilities of workers and teams with digital technology. This is in line with the reactions collected, which were underlining the need for research in the field and for policy purposes.

The integration of these views in the research process can be done in different ways. Firstly, such initial views can be conveyed to policy-makers in order to stimulate the allocation of funding towards understanding how to manage enhanced individuals and organizational enhancement. Secondly, and perhaps more importantly, they can be used to design follow-up Q-sets focusing on these specific issues of management and enhancement, so as to get a sense not only of the area that worries individuals, citizens, the most, but also to understand this issue of management in more details. Another Q-set could be designed to address the need for regulation. This can be done at a later stage of the project, when the elements to be regulated are identified and the form that the regulation can take needs to be discussed. Even though this method is not applied to gather large samples, it can be used by the researcher to explain what is being done and also to identify the elements that resonate with the curiosity or questions of the public, orientating the design of the research. Thirdly, for researchers who aim to communicate research to society, the results can also be used in order to inform from which angle they should communicate their work (in newspapers, blog posts, etc) in order to reach individuals. These three different paths are not mutually exclusive. On the contrary, they can be all performed.

Q-studies can therefore be used in order to bring elements onto the political agenda as other public engagement methods (Rowe and al, 2004) but also to impact the research process and to make decisions. In that sense, and even though the design of the Q-set by the researcher implies a strong element of top-down (the researcher decides a priori what is important and of interest), the use of Q for public engagement can be associated to bottom-up approaches to shape research under the condition that the researcher accepts to follow the interests of the public and explore them through follow-up research. Such remarks are in line with Doody et al. (2009) insight on using Q to develop indicators with the public. In some form, the reflexive dialogue mentioned by Powell and Colin (2009) is occurring in a new form, participants give some form of feedback (Forest, 2013). The input material discussed is traceable through the set of statements used, a set of statements that participants can eventually help forming, which would allow to encapsulate their prior knowledge, which Forest (2013) suggested to take into better consideration. Creating such a dialogue is however demanding a reflective period for the researcher to process the data and decide where to take the research and focus of the public engagement, so that the researcher engages with the public at multiple times on slightly different aspects of the research question. Q therefore helps to overcome the challenge identified by Powell and Colin in terms of deciding what to engage the public on over time.

5.2 Advantages to the use of Q as a tool for science communications and citizens' survey

The use of Q can be discussed in comparison to other engagement mechanisms and in regard to the dimensions and parameters that literature on public engagement identifies as of importance.

First of all, Q addressed the notion of efficiency and fairness put forward by Rowe and Frewer (2005). Indeed, it appears that Q is useful in eliciting views. The elements of the Q-set can be seen as a way to inform the participants in a structured manner of the different elements that compose a topic, so that they can produce relevant information. The process here is transparent, and so is the interpretation of the data as the qualitative points of view are aggregated through the Q-factor analysis, reducing researchers' bias. The influence of the researcher is minimal as the participants have agency in how they proceed to the ranking. The values underpinning the analysis are traceable: interpretation is rooted into numbers, which is important for future utilization of the results (Forest, 2013). The process is fair in so far as individuals accept, but also enjoy their participation. Applying Q-method is a way to propose a new experience to participants, leaving them with something which is hands-on and fun

(Wolf, 2018). This was also the case during our application of Q and shows that Q does not lead to feelings of fatigue and burden. It satisfies the criteria of creativity and innovation related to presence at science fairs and events. It involves citizens more with the research that is presented to them. The reactions observed are presented in Table 3. It shows that participation was seen as an interesting activity that participants wanted to share with others. Participants engaged with the research and the different statements proposed to them. Some reactions also show that the idea of manipulating cards physically was of interest to participants[2]. The experience could be materialized to higher degrees in the future. For instance, objects or pictures could be sorted by the participants. The impact of this materiality to convey research issues to citizens is in itself an area for future research. Indeed, playing with the materiality of a research topic opens up creative avenues while avoiding the pitfall of similar applications of the method which would lead to the fatigue bias that surveys suffer from.

Table 3. Observations about participating

Furthermore, by using Q at scientific events, one makes sure that the public has interacted with the researcher before proceeding to the Q-sort. The participants have the opportunity to ask questions and gain a better understanding of the topic before they proceed to the Q-sort. This interaction is a way to build their knowledge with the topic. So is the Q-set itself: it breaks down complex problems in a series of different concepts, made understandable separately in a sentence, and considered holistically through the Q-sorting process. In that sense, Q empowers citizens to build their knowledge and their ability to participate, elements deemed important by Powell and Kleinman (2008). The process of the Q-study is deliberative for participants: it gives them the possibility to forge their own point of view by deciding what is most and least important for them as they fill in the forced distribution matrix. For Doody et al (2009), using Q-method allows participants to discuss a topic in their own words and within their personal context. The consensus through participants is not obtained as a result of discussion, but rather as a comparison of all individual Q-sorts. It can be a preliminary step for citizens to get ready for group deliberations.

Citizens can become involved with the material and decide to use it for their own purposes (do it again, ask others to do the sorting exercise, organize discussions), which means that Q potentially has the potential of creating advocates amongst citizens, who will disseminate the research topic further. This means that Q citizens can forge their opinion on a topic and identify problems to be put on the political agenda, if potential whistleblowers take part in the Q-study or if the cards to be sorted are largely diffused. Such an effect of Q still needs to be demonstrated. However, the reactions of participants and their interest to use the material for debates or classes and have their friends do it, signals the potential of Q as a form of intervention.

Finally, while this application led to the participation of 23 individuals, this number is equal, if not superior, to the number of participants one could have at a consensus conference, while being potentially cheaper.

5.3 Limitations of this approach and future research

There are several costs of such an adaption of Q-method to public engagement.
Firstly, using fewer statements means that there can be a higher correlation between the statements. This means that less different viewpoints can be identified, and nuances usually captured with qualitative methods might not be grasped. Having a few statements also leads to a simplistic representation of a complex issue. Identifying minimum number of statements

[2] In the present case, participants were encouraged to do the q-sorting on computers as the software used allowed to capture in-depth data for experimental purposes. This explains why there are not many reactions on the format of the cards themselves.

for a topic could be a direction for further research. However, the randomized sampling and the large scale of science fairs leads to interrogating people with a wide variety of backgrounds, which introduces variety in the viewpoints captured as was shown in this example with 13 participants. Besides, Q is not designed for large samples. For analysis purposes, one would need to identify groups to analyse, and then run a second order analysis on the identified views, which is not a widespread practice (Gauttier et al., 2016). Future research should look at how sampling and the number of items could be optimized to allow sound results when doing a Q-study in a very short amount of time.
Secondly, the participants do like sorting the cards but might not desire to do the post sort interview. Indeed, observations show that they take time to sort the items carefully and are ready to move to another topic when they finish the grid. It might be advised to record or take note of the comments they make as they sort, instead of having an additional step as a post-sorting interview. This is in line with the observation of Besley and al. (2008), who asked what can be asked from interpersonal discussions after public engagement if anything, and pointed at moderate levels of engagement in post-engagement discussions.
Finally, one needs to find a solution to consider the point of view to those who did not load significantly on a factor.

Conclusion

Engaging citizens in science meaningfully at a somewhat large stage raises issues in terms of methodology, which Q-method can allow to overcome. This requires adapting the method and conserving the technique of the forced distribution matrix and sorting. However, it requires to have a restrictive Q-set so that individuals can participate rapidly. Q captures the narrow point of view that laymen can develop on a research topic in a short amount of time (similar to when they are briefly exposed to science in media). It highlights rough points of view that exist in society and does so in a transparent manner. Patterns can be identified. Such Q-studies can be used to inform the development of a research project, to be the basis of policy notes, or to trigger further research done with laymen participants. Further applications of Q in the context of science outreach and engagement could be conducted to refine the protocol to put in place so as to effectively use Q as a method and not only a technique, producing data of better quality.

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Appendix A – Synthetic Q-sort for each factor

Composite Q sort for Factor 1

-2	-1	0	1	2
**◀ I wouldn't want to be treated by a nurse who receives signals on her stress while	* I would not accept to use any technology collecting my personal data for my	It is useful if nurses can make changes in how they work and show the effect of these	I am worried that because of this device, nurses can be reprimanded for being too	I am concerned that such technologies will change how we related to one another,
I find the idea of using wearables for work repulsive	I don't want to see such practices (monitoring stress, health at work)	Hospitals should not make differences between those who use the device and	It's okay if the nurses only has access to their data (not the hospital or their direct	Seeing as this will develop, more regulations are needed to prevent abuses
	I don't see how that's different from other technologies people already	It's okay only if it's a personal initiative from the nurse	I am worried that it makes nurses more stressed about their stress	
		It's good if patients and their families end up having a better relationship		
		We should give such technology to patients before giving it to nurses		

Legend

✳ Distinguishing statement at P< 0.05

✳✳ Distinguishing statement at P< 0.01

▶ z-Score for the statement is higher than in all the other factors

◀ z-Score for the statement is lower than in all the other factors

Consensus statement

Composite Q sort for Factor 2

-2	-1	0	1	2
I find the idea of using wearables for work repulsive	I wouldn't want to be treated by a nurse who receives signals on her stress while	Seeing as this will develop, more regulations are needed to prevent abuses	I would not accept to use any technology collecting my personal data for my	It's good if patients and their families end up having a better relationship
We should give such technology to patients before giving it to nurses	I am concerned that such technologies will change how we related to one another,	It's okay if the nurses only has access to their data (not the hospital or their direct	Hospitals should not make differences between those who use the device and	✳✳▶ It is useful if nurses can make changes in how they work and show the effect of these
	I don't want to see such practices (monitoring stress, health at work)	I am worried that it makes nurses more stressed about their stress	It's okay only if it's a personal initiative from the nurse	
		I am worried that because of this device, nurses can be reprimanded for being too		
		✳ I don't see how that's different from other technologies people already		

Legend

✳ Distinguishing statement at P< 0.05

✳✳ Distinguishing statement at P< 0.01

▶ z-Score for the statement is higher than in all the other factors

◀ z-Score for the statement is lower than in all the other factors

Consensus statement

Composite Q sort for Factor 3a

-2	-1	0	1	2
I don't see how that's different from other technologies people already	I find the idea of using wearables for work repulsive	I wouldn't want to be treated by a nurse who receives signals on her stress while	I don't want to see such practices (monitoring stress, health at work)	**▶ I am worried that it makes nurses more stressed about their stress
We should give such technology to patients before giving it to nurses	**◀ Hospitals should not make differences between those who use the device and	It's good if patients and their families end up having a better relationship	I would not accept to use any technology collecting my personal data for my	I am worried that because of this device, nurses can be reprimanded for being too
	It is useful if nurses can make changes in how they work and show the effect of these	It's okay only if it's a personal initiative from the nurse	I am concerned that such technologies will change how we related to one another,	
		It's okay if the nurses only has access to their data (not the hospital or their direct		
		Seeing as this will develop, more regulations are needed to prevent abuses		

Legend

✳ Distinguishing statement at P< 0.05

✳✳ Distinguishing statement at P< 0.01

▶ z-Score for the statement is higher than in all the other factors

◀ z-Score for the statement is lower than in all the other factors

Consensus statement

Composite Q sort for Factor 3b

-2	-1	0	1	2
I don't want to see such practices (monitoring stress, health at work)	I find the idea of using wearables for work repulsive	I wouldn't want to be treated by a nurse who receives signals on her stress while	Hospitals should not make differences between those who use the device and	**▶ I don't see how that's different from other technologies people already
*◀ I would not accept to use any technology collecting my personal data for my	I am worried that it makes nurses more stressed about their stress	We should give such technology to patients before giving it to nurses	Seeing as this will develop, more regulations are needed to prevent abuses	It's good if patients and their families end up having a better relationship
	It is useful if nurses can make changes in how they work and show the effect of these	It's okay only if it's a personal initiative from the nurse	I am worried that because of this device, nurses can be reprimanded for being too	
		It's okay if the nurses only has access to their data (not the hospital or their direct		
		I am concerned that such technologies will change how we related to one another,		

Legend

✳ Distinguishing statement at P< 0.05

✳✳ Distinguishing statement at P< 0.01

▶ z-Score for the statement is higher than in all the other factors

◀ z-Score for the statement is lower than in all the other factors

Consensus statement

Composite Q sort for Factor 4

-2	-1	0	1	2
I don't see how that's different from other technologies people already	We should give such technology to patients before giving it to nurses	I find the idea of using wearables for work repulsive	I don't want to see such practices (monitoring stress, health at work)	Hospitals should not make differences between those who use the device and
I am concerned that such technologies will change how we related to one another,	It's good if patients and their families end up having a better relationship	I wouldn't want to be treated by a nurse who receives signals on her stress while	I would not accept to use any technology collecting my personal data for my	Seeing as this will develop, more regulations are needed to prevent abuses
	It's okay if the nurses only has access to their data (not the hospital or their direct	I am worried that it makes nurses more stressed about their stress	I am worried that because of this device, nurses can be reprimanded for being too	
		It's okay only if it's a personal initiative from the nurse		
		It is useful if nurses can make changes in how they work and show the effect of these		

Legend

✳ Distinguishing statement at P< 0.05

✳✳ Distinguishing statement at P< 0.01

▶ z-Score for the statement is higher than in all the other factors

◀ z-Score for the statement is lower than in all the other factors

Consensus statement

Factor	1	2	3a	3b	4
Participant	3; 9; 10	2; 7; 8; 11	5	6	12

Table 1. Factor composition with defining sorts, and non-defining in brackets

	Factor 1	Factor 2	Factor 3a	Factor 3b	Factor 4
Factor 1	1	0,3662	0,4366	0,1584	0,1419
Factor 2	0,3662	1	0,235	0,1433	0,2138
Factor 3a	0,4366	0,235	1	-0,3181	0,2728
Factor 3b	0,1584	0,1433	-0,3181	1	-0,2272
Factor 4	0,1419	0,2138	0,2728	-0,2272	1

Table 2. Factor score correlations

Before doing the Q-sorting activity	**After proceeding to the Q-sorting activity**
How long will it take? It's good we can give our opinion, of course I will participate Can I do it with the cards (instead of the computer)?	I want some of my students to do it / I will call my friend so he does it too I tried to explain well my choices It's interesting to see someone thinks about all these elements (on the cards) It's important that someone is doing such research We can use it to have debates in class / we will have a debate about the topic

Table 3. Observations about participating