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REPORT

Fostering inclusive access

to analytical instrumentation

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1 PROJECT SUMMARY

Chemistry should be for everyone, which includes accessibility of laboratory infrastructure and operability of analytical instrumentation, such as software but also hardware (e.g. mass spectrometers…).

Within this project, we aim at evaluating support strategies for promoting accessibility and operability of disabled scientists to analytical instrumentation. This includes a critical evaluation of barriers and difficulties currently in place. In close dialogue with disabled chemistry students and scientists and in cooperation with instrument manufacturers we would like to elaborate on possibilities on how to remove barriers to analytical instrumentation for operators with disabilities, e.g. including visually impaired individuals or persons using a wheelchair.

This may include changes of the instrument hardware but software, modifying, adapting, or re-writing laboratory protocols for the inclusion of existing assistive technologies, to enable chemists with disabilities of different nature to undertake laboratory experiments independently.

2 PROJECT DESCRIPTION

People with disabilities are often limited in access to critical parts of instrumentation, which are difficult or impossible to reach, with current laboratory infrastructure and instrumental setups, ranging from simple benchtop instruments to more sophisticated analytical equipment.
Therefore, we aim to (1) identify the barriers and difficulties currently in place in strong collaboration with both disabled chemistry students and scientists and instrument manufacturers as well as laboratory designers, (2) work on possible solutions to improve the situation and (3) provide manufacturers with the elaborated strategies.

The project duration was one year, which allowed planning and setting up a web-page and a questionnaire to evaluate the needs and to find possible strategies in the first half of the project duration. After that, the questionnaire was open for active participation. Furthermore, intermediate results of the questionnaire were presented at internationally recognized conferences to engage with the scientific community on a personal level. Eventually, recommendations were formulated and compiled to a report, both addressed at any interested reader as well as specifically to laboratory and instrument suppliers and designers.

The PI of the project with her team are based at an Austrian university, embedded in the national and international science community, especially focusing on analytical instrumentation (mass

spectrometry, spectroscopy, sample preparation, microwave digestion, etc.). The project was carried out both online in virtual meetings and remotely as well as in-person. The project was independent on the actual physical location of the PI, but on her network in science and academia. Therefore, the project was built on a strong network which formed the basis to recruit stakeholders to support the project, both from the target audience (analytical science students and analytical scientists with disabilities) and from the industry (instrument manufacturers and lab suppliers). Furthermore, the project was supported by global chemical societies (IUPAC, ASAC, GÖCH, RSC) with D&I strategies in place.

2.1 NOVELTY

To our knowledge, this project aims for the first time to bring together the target group of analytical scientists with disabilities and instrument manufacturers into the direct dialogue. With this, we fostered a discussion practice that addressed needs and possible solution strategies directly, without intermediate process steps via e.g. company PR, political evaluation plans, etc. We believed that only direct personal dialogue could make people understand what was needed to make analytical instrumentation more inclusive – and we have the feeling that this was a correct assumption.

2.2 EVALUATION

The primary objective of the project to improve accessibility to analytical instrumentation (both related to software and hardware) was evaluated by the actual stakeholders with and without disabilities as the direct target group.

3   REPORT

3.1 OUTREACH ACTIVITIES

At the very start of the project, a questionnaire was developed to compile information about disabilities in the laboratory and while using analytical instrumentation. The survey was provided online on the project webpage (https://icpms-leoben2022.at/inclusion-in-lab) (see **Fig. 1**), which was created to establish an online presence and minimize excess barriers (note that the webpage was created under consideration of minimizing visual impairments). However, further input was generated from in-person interaction with students (on basis of the diversity committee of the students' union at Montanuniversität Leoben (ÖH Leoben)), the scientific community and industry at provided opportunities to the project team.

To conduct the survey, an online survey provider was chosen, which specifically ensured the data privacy of all participants. The webpage worked as a platform to inform about and promote the project and questionnaire. Furthermore, it imbedded a direct access to the questionnaire. For further direct interaction with people in this field, a poster was presented at international recognized conferences.

Fig. 1: Landing page of project webpage

3.1.1 PARTNERS

To facilitate and to ensure a high public visibility of the project and a success rate of the questionnaire, the authors contacted a variety of academic (non-profit) institutions and industrial organizations to establish a network for the distribution of project information. Some organizations with closer collaboration and support were listed as partners also on the webpage, including The Royal Society of Chemistry (RSC), the Montanuniversität Leoben, ÖH Leoben and the Österreichische Chemische Gesellschaft (GÖCH). In addition to that, we had the chance to promote the project during a conference (on mass spectrometry) hosted by the project team. Exhibiting companies further promoted the project on their social media (LinkedIn, Facebook, Instagram, and Twitter).

3.1.2 WEBPAGE (https://icpms-leoben2022.at/inclusion-in-lab)

The webpage represented the primary representation of the project. It was established by webservice.or.at. Hereby, the webpage should foremost promote and give access to the questionnaire, but it also presented the partners and team of the project by providing information and links. The text of the webpage was online since the beginning of May 2022 and only in English.

3.1.3 PROMOTION

Besides the webpage and the research engagements, several activities for promoting the project and specifically the questionnaire were performed. A variety of academic institutions, companies, and other organization were contacted for promotion by their public-relation channels to reach a bigger

audience, including social media promotion. In addition to that, the authors facilitated personal promotion. A flyer (see **Fig. 2**) was created to engage people in chemistry and academia, young people as students and scientists especially. It consisted not only of an QR Code to be linked to the questionnaire, but also presenting the senior partners of the project, The Royal Society of Chemistry and Montanuniversität Leoben. The flyer was handed out at conferences with a poster presentation, and also distributed at other scientific conferences.

Fig. 2: Project flyer

The project and questionnaire sparked also feedback of individuals with disabilities or which encountered people with disabilities in the laboratory, as the authors hoped and intended. One story, pointed out to the authors, in particular serves as a positive example to overcome disabilities in the laboratory, see (Babechuk 2018; Foss 2019).

3.1.4 QUESTIONNAIRE

The aim of the questionnaire served (1) to gather information about disabilities in the laboratory and with analytical instrument and (2) to raise awareness for people in the scientific community and industry. Henceforth, the questionnaire supported to reflect and contemplate about disabilities and its difficulties in the work environment. Therefore, the questionnaire was open to everyone and not limited to people with disabilities. On the contrary, the questionnaire was designed and open for everyone to assure not only an inclusive outcome but also an inclusive participation to collect all potential input.

The methodology was based on a general and already existing disability survey model and with respect to the subject-matter. For the survey, the authors designed the questions after the Brief Model Disability Survey (Brief MDS) released by the World Health Organization (WHO) (World Health

Organization 2017). The survey was divided into two parts according to the topics and themes of interest. The questions were organized and grouped together in modules after their intent for gathering information. At the end of each module open questions were asked for further input, which was not covered by the questions of the authors.

Part 1 – Tracking and tackling disabilities – targeted the current general status of disabilities in laboratory and with analytical instruments. To ensure a full and comprehensive survey, the term disability was interpreted and used as open and wide as possible to include all available information. Both disabilities with an awareness and potential disabilities without any awareness at all were the target of the questions. As a result, raising awareness of disabilities for other people was one goal. Second, we wanted to provide the opportunity for each individual participant to reflect on their own possible limitations during work. To make sure to obtain comparable results, most of the questions were created in a way to agree or disagree with the stated premises within a scale between 1 to 5.

Part 2 – Advancements for equal access – aimed to find specific actions and support strategies, which can be applied and used in routine work in the laboratory and with analytical instruments, to improve the situation of people with disabilities. Hereby, the questions were formulated in an open way and different type of questions were used to generated creative answers of the participants. These suggestions can be used and provide possible solutions for a more inclusive work environment.

The questionnaire could be taken in English and German. The survey was officially launched online in May 2022 and promoted immediately online as well as during the UN Diversity Month, which initiated the local university project #Diversity@MUL (https://diversitaet.unileoben.ac.at/diversity-month).

3.1.5   POSTER

The project was presented and introduced in a scientific poster (see **Fig. 3**) at the following conferences, namely: Geoanalysis 2022 in Freiberg, Germany (6th to 12th of August 2022) (Irrgeher et al. 2022a) and 28th ICP-MS Anwender*innentreffen 2022 in Leoben, Austria (5th to 8th of September 2022) (Irrgeher et al. 2022b). Besides presenting the poster to an audience and to engage in individual discussions, participants of the conferences could give anonymous feedback through post-its. Intermediate results of the questionnaire were presented during the still running survey.

Fig. 3: Project poster

3.2 OUTCOME

3.2.1 QUESTIONNAIRE

The complete results of the questionnaire for all individual question are listed in the Appendix. For further interest, readers can fully examine the questions of the authors and answers of the participants (see **Appendix**). The questions are stated consistently in English. However, some answers of open questions are in German and were not translated for the sake of authenticity. A condensed summary of the questionnaire is given by the authors in the following text.

SURVEY – PART 1

Part 1 of the questionnaire was viewed by 231 people. 67.53% (156 people) actively participated by answering at least one question. From 156 people, 36.54% (57 people) submitted actively their answers at the end. The average duration of participation was 5 minutes and 44 seconds.

The first part of the questionnaire had **three modules**: **1-Basic** (9 questions), **2-Physical Barriers** (8 questions, 2 follow-up questions), and **3-Non-Physical Barriers** (9 questions, 1 follow-up question).

At the beginning of the **1-Basic module**, the participants were asked two general questions to validate the input of the questionnaire. First, they were asked how many considered themselves to have a disability. From 137 participants at this question, only 2.19% (3 people) considered themselves to have a disability. 16.79% (23 people) answered to have at least some disability and the majority of 81.02% (111 people) announced not to have a disability. As a result, the questionnaire was taken by a majority of people, who do not have disabilities or do not identify with the term disability. Although the specific target group of the questionnaire were people with disabilities, the provided open and inclusive access for all people showed an outcome in participation by people, who feel not individually impacted by disabilities. Second, participants were asked about their work experience in the laboratory and with analytical instruments. 82.35% (112 people) stated to have experience and 17.64% (24 people) answered to have at least some experience in the laboratory and with analytical instruments. From 136 people, no participants gave the answer to have no experience. Therefore, the questionnaire was taken by people with work experience in the laboratory and with analytical instruments. This underscores that the questionnaire was taken by experienced people with an interest in the issue of disability in their work environment.

Regarding the work environment, a majority gave good feedback about the laboratory management, infrastructure, and colleagues. Only in case of one question, the answers were mixed. Being asked about, if the company or institution made any changes to ease participation for you, 34.26% (37

people) of 108 people said changes were not made (see **Fig. 4** and **Appendix**). This indicates a discrepancy between the employer and employee for the realization of equal and easy access and participation.
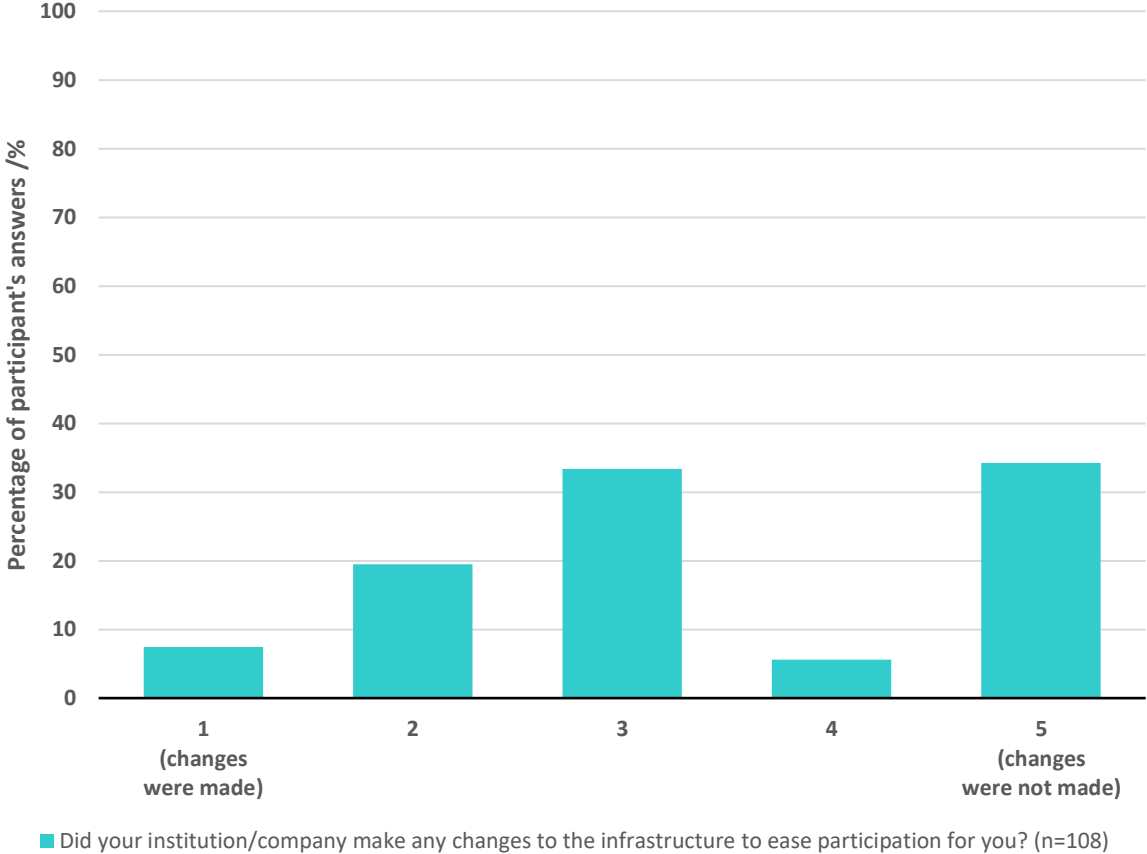
Fig. 4: Results to question 4 of Part 1

In another question about how the laboratory infrastructure makes participation very easy or very hard, the answers were rather positive. However, the majority 48.62% (53 people) of 109 people voted only for the second positive answer (see **Fig. 5** and **Appendix**). This indicates most infrastructure is considered sufficient, but still not viewed as completely barrier-free.

At the end of the Basic module, the participants were asked if the felt limited in their work. This question was designed by the authors as a loop question in regard to the first question, if they considered themselves to have a disability. The intention of the authors was to ask in a different way, if people have the feeling to do their regular work without any barriers. Because the question at the end is reformulated and not identical with the question at the beginning, the meaning is not identical and can be interpreted differently. The authors are aware of this discrepancy. However, by comparison of the answers of the two questions, a possible indication regarding the topic disabilities is given. Either the awareness was increased with all further question of the module after the first question for the

participants, which indicates that the function of the questionnaire to create more awareness for disabilities is achieved, or people are unaware of possible disabilities or do not want to identify personal limitations with the term.

■ Does the usual laboratory infrastructure that you have experienced (e.g. installations, instruments, …) make it easy or hard to perform your daily work routine? (n=109)
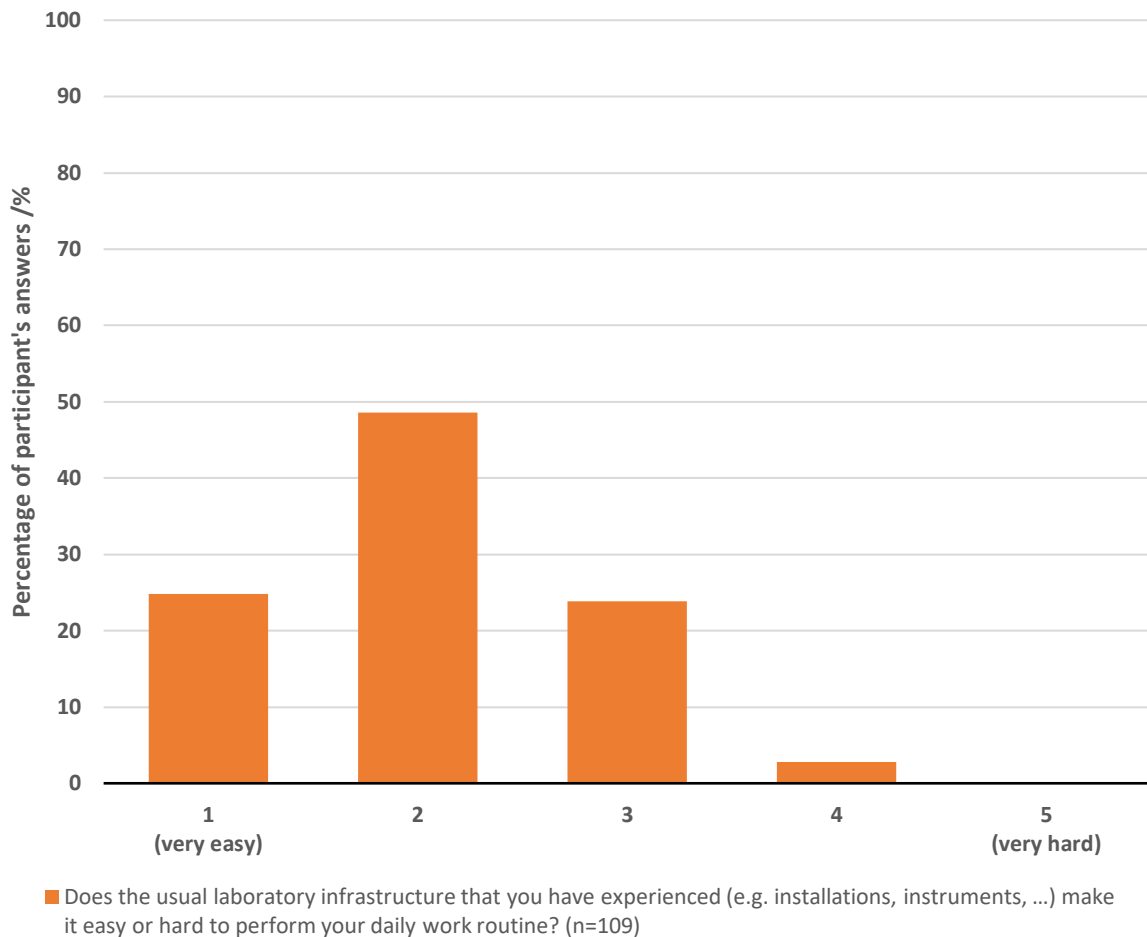
Fig. 5: Results to question 3 of Part 1

In contrast to question 1, where a majority of 81.02% of people considered themselves not to have a disability (*n*=137), the answer to the question 8 was different. Only 43.69% of people stated that they did not feel limited at all, and further 38.83% answered not to feel limited to some extent (*n*=103). This discrepancy indicates that there might be a perception towards the term disability in the context of laboratory work and analytical instruments, especially when considering oneself (see **Fig. 6** and **Appendix**).

The final open questions for further feedback substantiate the indication that difficulties to identify with and to subscribe to the term disability exist (9 responses). We observed, that forms of possible disabilities are displayed and interpreted in a wide range, which illustrates the shifting borders of the term disability. Surprisingly, one person did not really consider his red-green-visual impairment as a disability and only noted some difficulties to interpret plots. Another person shared that since the birth

of her/his daughter, the available time for work is more limited compared to the colleagues in the context of a university as work environment and that it appeared sometimes to her/him to be excluded from the co-workers, although she/he felt supported and was encountered with empathy. Both examples raise the further question of how and at which point or threshold measures for equal and easy access have to be taken by the employer and when an individual work-around by the person is sufficient. In both cases the individual circumstance limited their potential and changed the conditions to their assigned work, which resulted in the inability to perform on the same level by providing the same resources compared to an assumed regular employee or colleague. Because of partial visual impairment (e.g. color-blindness) or more private responsibilities, the situation in work is different to them than to others and needs more effort of them than from others; otherwise they are not able to fulfill the regular assignments.

Fig. 6: Comparison of question 1 and 8 of Part 1

Other participants raised different issues in regard to infrastructure. Laboratory rooms and entrances as well as positions and height of instruments have to be recognized for disabled personnel. Especially, more time should to be accounted for disabled people to fulfill their laboratory work and operating
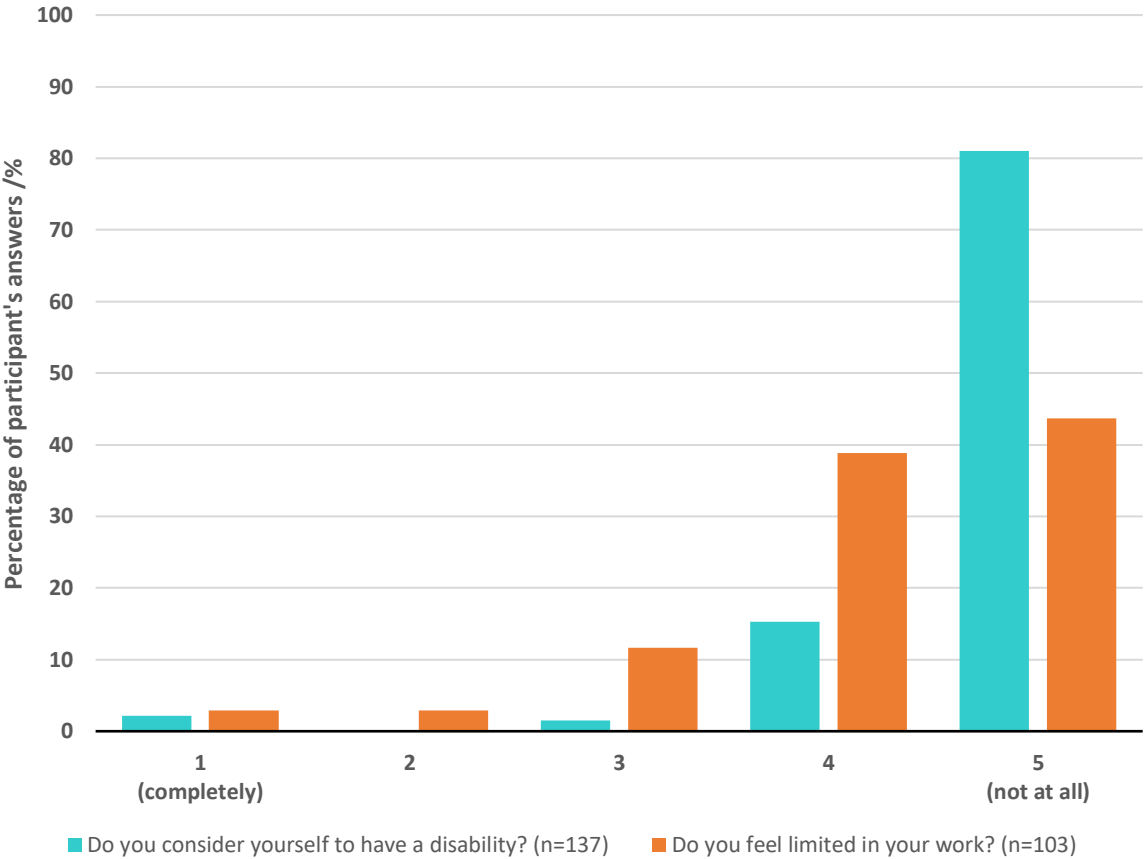
instruments. Furthermore, emergency plans for people with disabilities should be provided and older laboratory infrastructure should be recognized for its more limited access.

For the **2-Physical Barrier module**, a majority of all participants stated neither to have a physical disability at all (82.19% – 60 of 73 people), nor to have difficulties or problems because of their physical capabilities (72.97% – 54 of 74 people). In accordance with these results, only a percentage of approximately 25 to 35% of participants stated to have physical problems in their work, ranging from some difficulties to a full disability.

For two questions, an open follow-up question was free to answer. First, participants were asked if they used any supportive tools to compensate for physical challenges (11 answers). Three main features and tools were named: equipment for compensation of individual height or to reach objects out of reach, tools to lift heavy objects, and gadgets to help visually impaired people. Second, it was asked, if everything can be accessed, which is needed for work or in case of an emergency (10 responses). Especially for instruments, the entrance to the (inner) parts and emergency or on/off buttons are often not accessible due to position and height. Other participants mentioned that equipment and knowledge are sometimes necessary to reach and access everything necessary.

A loop question was asked to validate the awareness and self-assessment of physical disabilities. In accordance with the first question of the Physical Barrier module, 73.53% (50 people) stated not to face physical limitations and 20.59% (14 people) answered to experience some limitations (n=68). The answers for the open question at the end focused on two topics for further input (7 responses). On the one hand, should a full, partial, or temporary physical disability not hinder you to work and, on the other hand, adaptions in laboratory infrastructure from rooms to software are necessary to achieve full and easy participation.

For the last module, **3-Non-Physical Barrier module**, two general questions were asked first. Again, a majority (71.60% – 58 of 81 people) stated not to have a non-physical disability. Furthermore, a same majority (71.60% – 58 of 81 people) answered not to need additional guidance to work on their own. In accordance to the results of the Physical Barrier module, a majority did not consider themselves to have a or to be influenced by a non-physical disability. Nevertheless, these results differ compared to the Physical Barrier module.

Being asked, if any negative effect happened to the participants as a result of their appearance, identity, education, or status in society. Only 50.65% (39 people) of 77 people replied not to have suffered at all from some negative prejudice. In addition, only 43.59% (34 people) stated that their work environment provided an open and safe space for their needs and development in the work place, although 34.62% (27 people) rated it with the second-best possible value (n=78). By taken into

account that a majority of people did not consider themselves to suffer from non-physical disabilities, the results must be more striking for people with disabilities, although it is leaning more to the positive side in the replies. It indicates a more exclusive than inclusive work environment and reveals potential for institutions and companies to improve. Furthermore, only 42.31% (33 people) of 78 participants felt that they were not limited by misjudgment from their colleagues and supervisors.

A majority of 74.03% (57 people) of 77 participants had no troubles to understand instructions, guidelines, and regulations. By identifying problems in this area, a follow-up open question about specific difficulties in this matter was asked (9 answers). One issue raised was that many instructions, guidelines, and regulations are not fulfilling their intent. They are created and accessible, but do not serve the purpose to educate the personnel for independent work. Additionally, these are written in a language hard to understand for newcomers and untrained staff, using unexplained and unclear terms, and overwhelming the reader with too much information as instead to give a condensed version with only the essentials to avoid confusion. Other aspects mentioned were the low quality in language and translations, and the low amount of time considered to read the necessary information to conduct the work. In regard of software, too much options can be confusing for one participant. Furthermore, by asking, if the used language is clear and easy to understand, only 43.59% (34 people) of 78 people declared that it is easy and clear. 34.62% (27 people) stated the next best value. Equal access to and transfer of knowledge are clearly an issue for people in an environment of laboratories and analytical instruments. It indicates an even harder situation for people with disabilities.

For the question, if people felt limited in their work due to non-physical disabilities, 68.83% (53 people) of 77 people answered not to have at all limitations. This is in line with the previous first questions of the Non-Physical Barrier module. The open question about missing aspects triggered 4 responses, but only one substantial response, which pointed out that innovation is hampered by using none open-source software.

SURVEY – PART 2

Part 2 was accessed by 147 people. 51.02% (75 people) answered at least one question. Only 56.00% (42 people) submitted their questions in the end.The mean time of participation was 11 minutes and 13 seconds.

Part 2 had **two modules**: **1-Physical Improvement** (9 questions, 3 follow-up questions) and **2-Non-Physical Improvement** (12 questions, 5 follow-up questions).

The first question in the **1-Physical Improvement module** addressed the measures that should be taken for an easy access and participation regarding laboratory and instruments (26 answers). Hereby, three main issues were in focus for the participants: accessibility, reachability, and visibility.

For accessibility, many participants stated a barrier-free access for, in particular, people normally otherwise immobile (e.g. people in wheelchairs, with crutches, …). This included a free access to the laboratory itself at the beginning, which needs for some not fully mobile people an elevator or a door easy to open. One participant, for example, pointed out the difficulty to open a door, if an extra button has to be pushed. Another aspect was to offer enough space for free movement and without any barriers. This is most important to attain all space in the laboratory and to guarantee full and free access to all parts of the instrument. An example of unnecessary and avoidable barriers pointed out are cables on the ground.

Reachability was emphasized foremost in the aspect of height. Laboratory furniture, workspaces, and instruments should be accessible for all people, regardless of their body height or physical impairment. As a result, participants pointed out to consider this in designing the infrastructure and to install equipment at smaller heights. Several participants recommended – in an ideal case – laboratory benches and tables with adjustable heights, not only for free access but also for comfortable participation to achieve best work performance. In the case of smaller personnel, the participants were insisting on equipment that helps to reach everything placed on a higher level. Another necessary adjustment – in the view of one participant – was to place the on/off switch and other buttons in a reachable distance for everybody and not at the back of an instrument. Furthermore, the serial number and part number should also be in front, to get easier information about the instrument, if necessary. In summary, this would – according to the one participant – benefit users to be safer and helpful to them. Similar things were pointed out by another participant in regard of low placements of controls and read-outs.

Another disability addressed was visibility. Some participants of the open questions, emphasized in their answers the necessity of good visibility and readability for disabled workers, because of color blindness and visual imparity. Especially in regard of software (e.g. font style and size) as well as visual signs.

One participant emphasized the change of regulations like, health and safety protocols specifically in regard to limited work hours for people with private obligations, and another to raise more awareness by providing workshops.

29 participants responded and answered to the question regarding an optimal height to perform work in the laboratory or on an analytical instrument. Although clear instruction to submit the height in meters, 7 answers were outside of a reasonable height between 0 to 2 meters. However, 6 answers could be re-interpreted to values in the former range. The average optimal height was 1.09 meters

according to 28 answers. This can be taken as a rough estimation for a benchmark value in the future, which could be considered for planning and building new laboratory infrastructure or creating and designing new analytical instruments.

The next question asked for an alternative color-code of green-red. Participants had to choose a color representing positive/yes and one color representing negative/no. Hereby, they could choose among offered colors and suggest colors by their own. However, 7 participants from 45 and 44 people chose the red-green color-combination despite the premise of the question. The positive color had 39.47% (15 people) for blue, 15.79% (6 people) for white 13.16% (5 people) for green from 38 participants. For the negative color, 27.03% (10 people) stated black, 21.62% (8 people) red, and 21.62% (8 people) yellow from 37 participants.

Being asked if the importance of an information is represented appropriately by text size and highlighted accurately, 29.55% (13 people) of 44 people answered "no". Almost one-third felt that text is not accurately depicted and 9 participants gave feedback in a follow-up about examples. Most criticized a small font size for chemicals and samples. Other issues stated were hazard warnings, instructions in software and on instruments, and manuals/SOPs. Besides the critic to use only one and small font size, it was criticized that important information is not highlighted in a recognizable way.

According to the participants' answers regarding difficult to access parts of instruments, a variety of different specific responses (22 people) depending of the instrument used by the participants were collected. Most answers included not easy to reach switches and buttons as well as connections located at the backside of the instruments. One participant declared that screws are sometimes to small, some areas of an instrument are hard to reach and can only be accessed with mirrors or require multiple hands, and more instruments need to be sound-proof.

Similar answers were obtained from the question about possible improvements of access based on changes of hardware and software (18 participants). Several participants provided suggestions for a more ideal construction of instruments. The hardware of an instrument should be built in a horizontal, not in a vertical fashion, and important features should be at the regular working height (the height of the instrument should be changeable) and less important features should be placed below or above. Furthermore, hardware should only use standardized parts for easy replacement. Software wise, other ideal implementations were requested by the participants. Most prominent, the font size and highlighting should be changeable. In general, an individualization of software for each user should be possible. Other aspects of interest with software were: easy copy and paste functions of data from and to the instrument for time and error saving and application of a systematic naming (nomenclature) and language. As for hardware and software, the instrument should use an easy and understandable language for people of different scientific fields and backgrounds. Software should be structured in a way for intuitively understanding, and information and concepts for instruments should be provided

to users from the point of view of a user. We consider the answers to these questions as a mixture of real need to reduce barriers as well as a wish list that is partly difficult to fulfill by keeping the functionality of instruments in place.

78.95% (30 people) of 38 people answered that they can use all products of instrument provider. In regard to warning signs of instruments, the authors asked participants to rank signals after their personal impact to capture their attention (42 participants). The ranking was: 1. Pop-up window in software, 2. Audio signal, 3. Visual (color) signal, and 4. Others. Among alternative or unknown possible signals, a notification directly on the phone seems the most desired warning signal.

For the **2-Non-Physical Improvement module**, first the authors asked the participants, if raising awareness for disabilities is vital for equal access on the workplace. A large amount of 93.02% (40 people) of 43 participants answered with yes. In a follow-up question, participants were asked for suggestion to raise awareness of disabilities; 17 people answered. Many comments suggest facilitating an active discourse about disabilities and with disabled colleagues via discussions, workshops, and training together. A respectful environment for sharing the experience of disabled personnel was recommended. One person emphasized to employ more disabled people to raise awareness in the workplace. One participant's comment sated the following:

> *"Examining barriers to actually entering the lab (width of doorways, distance between obstacles in the lab). Open discussion among workers to determine if they are experience difficulties with access instead of assuming that everyone is doing okay."* (see **Appendix**)

Another participant issued the importance of not only to speak within a company or institution, but also in the industry and scientific field about disabilities and share experience with others in the communities. The participant wrote:

> *"Highlights on scientists that have worked in lab environments with a disability (assuming the[y] agree to this) - representation can go a long way. Often accessibility issues are solved by individuals on an as-needed basis, but we don't share these stories. Why repeat efforts? Spread the experience. Save others time. Show others some disabilities don't need to be a barrier if they can be worked around."* (see **Appendix**)

A majority of participants were fully or at least to some extent positive in regard to the importance of the commitment of leadership to inclusion and to have a person or point dedicated to diversity and inclusion (3 questions with 42 participants each) (see **Fig. 7** and **Appendix**). However, they did not value the commitment of the leadership that much in comparison. Indicating that such a commitment in leadership position is a must, but does not actively impact the reality in changing the workplace to be more inclusive. Nevertheless, 30.23% (13 people) consider workshops about impairments important, 32.56% (14 people) consider these to be of some importance, and 34.88% (15 people) were

neutral. For the participants workshops must be more attractive and develop a higher impact to change the work environment.
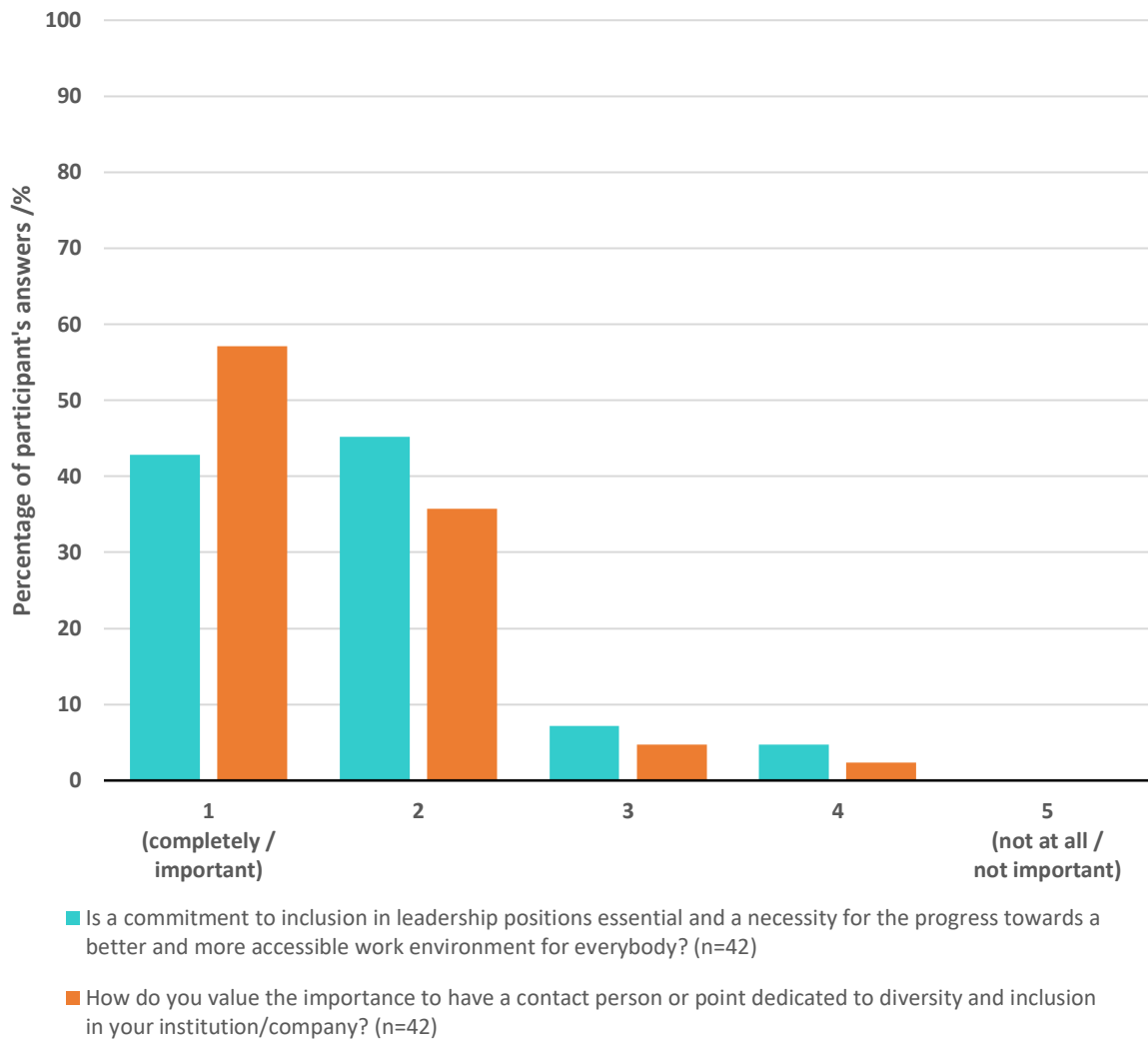

Fig. 7: Comparison of 12 and 13 of Part 2

The next questions were arranged around the topic of disambiguation and language. First, the authors started with the topic about avoiding confusion and misunderstandings in hardware and software of instrument designs (13 replies). For hardware, one participant emphasized not to use the same form of buttons for different actions and always to indicate on which position of function the button is currently on. A direct labelling or description of the button should be a given. Furthermore, in software the design should be again simple and avoid any ambiguity, also in symbols and names for functions to operate the instrument. Therefore, in combination of hardware and software one, simple, disambiguate language should be used, which labels and names parts and everything for its operation in the same manner. In an ideal case, terminology should also be the same between vendors. Another

issue of participants were error messages, which are unclear or not understandable for users in information and the high rate of them compared to vital error messages.
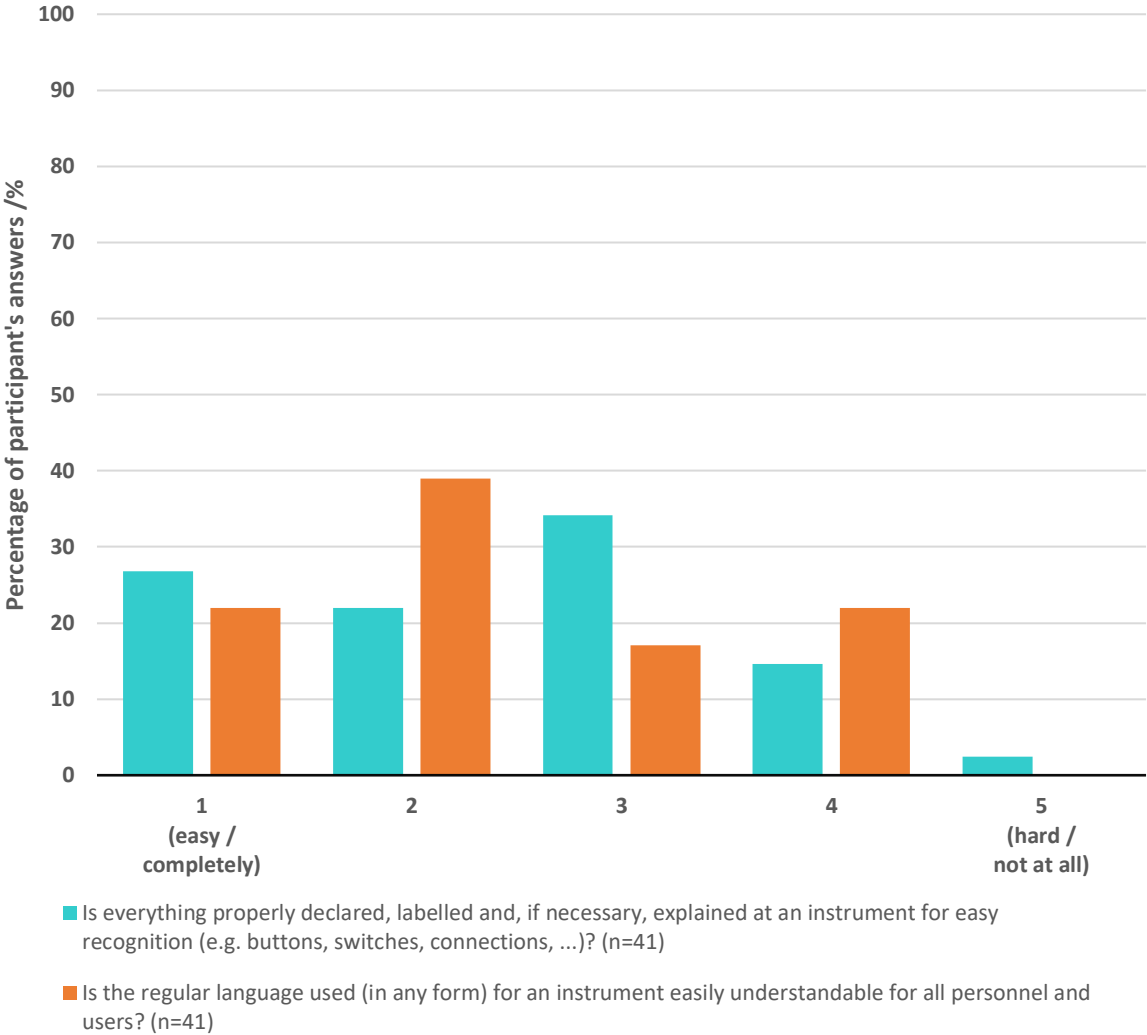

Fig. 8: Comparison of the question 16 and 17 of Part 2

Specifically labelling, declaring, and explanation of parts on an instrument for easy recognition was not well received by the participants. Although 26.83% (11 people) find it sufficient and 21.95% (9 people) to some extent sufficient, the highest voting with 34.15% (14 people) of 41 participants was neither complete positive or negative towards it. In a follow-up question for examples (10 participants), some participants remarked that information provided in manuals or other guidelines is too broad and common and not specific and clear to the special type of instrument in use. Others stated that there is no explanation about the instrument and no form of labelling buttons on the instrument. For the question how easy the regular language of an instrument can be understood, the highest percentage in responds was only 39.02% (16 people) from 41 participants for a good understanding (see **Fig. 8** and **Appendix**). Participants remarked in a follow-up question (11 participants) that the language is either

too scientific or too technical and one added some warning alarms are not understandable for the normal user and cannot even classified by them as important or unimportant regarding some instruments. One participant stated about the unnecessary language used by vendors:

> *"Most people need to have proper training to use specific analytical instruments. Most of the instrumentation software is brand specific and different softwares use different definitions for the same thing, so it becomes specific to that instrument and not to the technique."* (see **Appendix**)

Another participant raised the issues that manuals are written from the point of view of an instrument constructor and not for an instrument user:

> *"Manuals are often written from the perspective of the individual that built/designed the instrument, not a typical user in the field. Some language not understood universally, some operating details discussed without any context or background knowledge shared with the reader."*
> (see **Appendix**)

Much appreciated is every effort to facilitate and transfer knowledge by description, graphs, or videos. The situation in language even worsens, when participants were asked about the clarity and intuitive understanding of technical details for explanation. Again 39.02% (16 people) only have a good understanding and 34.15% (14 people) have a regular understanding from 41 participants. When asked about examples (13 comments in total), many answered that this depended on the vendors and no standard is recognized. One participant recommended to have an interactive manual with supplementary information for further explanation and guidance (which is in place for some instruments). A good description of the issue of clarity and intuitive understanding of details gave a participant as follows:

> *"[The situation is] often surprisingly poor. Help files, for example, are typically terrible. They'll tell you that the 'plasma on' button turns the plasma on. Help files should be much more process-oriented. E.g. the user wants to achieve task X, the help file should describe how to do the task rather than what the buttons do."* (see **Appendix**)

Similar to the two former questions, the result was for the next questions. When asked, if instrument providers define and well explain terms for easy understanding, 40.00% (16 people) of 40 participants only gave a good rating. Complains from participants in a follow-up question (7 replies) were that no or complex definitions or explanations were provided for used terms. Furthermore, names from vendor, brand, or patent specific are often terms misunderstood or open for interpretation – considering another open question with 6 replies.

At the end of the second part of the questionnaire, general further feedback was asked for the Non-Physical Barrier module (4 comments). It was emphasized from one participant to keep in mind phycological problems and issues as temporary sources of disability.

3.2.2 POSTER

The poster had the dimensions of A0. It promoted with the webpage text and QR Code the participation of people to the questionnaire. Recent results of the still running questionnaire were presented to engage with conference attendees. Feedback was gathered from some anonymous comments on post-its. Abstracts of the project-poster can be read in the Book of Abstracts of the two conferences.

4   CONCLUSIONS

The goal of the questionnaire on reflecting the term disability was not restricted to disabled people but also on how everyone in general should deal with the topic. Disability, in its widest sense, defines the inability by a person to achieve the same expected outcome of a task for a regular or usual person under the same circumstances. The answers showed that some participants struggle with certain aspects in this environment, but would not count this as a disability. What is clear from the answers was, that there is the perception of a clear demarcation between people with disabilities and people with other issues in certain aspects. However, what is also clear for the authors is that there is no clear demarcation and simply a fluent transition. Therefore, a full and easy barrier-free access depends on what is considered and recognized as a disability and how much effort will be taken by all stakeholders to change the existing and adaptable circumstances in a laboratory and for analytical instruments.

The authors recommend a bottom-up approach for employers and vendors. Therefore, disability should be defined for the employer by interaction and occurring problems between the equipment and personnel. For vendors, the interaction of company and its products with customers has to be in focus to anticipate disabilities. This approach would benefit in two aspects. First, the word disability would be interpreted free and open that the identification with the term is applicable to all people. By using this approach, everybody engages with the term disability and experiences the meaning, which helps to destigmatize the word disability. However, employers can choose to avoid the term, if necessary or felt needed. Eventually, the term brought from a label of a specific group to all employees would also benefit to uncover hidden or unaware limitations in general. Second, the approach would allow individual adaptation to the circumstances of the laboratory and instruments as well as by employees. Most importantly, employers should change their attitude towards disabilities from a passive orientation with engaging only after complains about participation to an active orientation with engaging beforehand. Therefore, employers should hold meetings, workshops, and other gatherings were all employees should participate with their equipment to experience limitations of their own and others to interpreted the term disability for themselves. The handling of disabilities should be guided by empathy, empiricism, and practicality.

A commitment of the employer and vendor to diversity and inclusion should be the first step to make laboratories and instruments more accessible and usable for people with disabilities. Of course, a responsible person or company cannot consider everything. Nevertheless, it should be provided everything to change what is possible and to work-around where it is necessary. This has to be gained by experience of real interaction with people and adaptations have to be made considering circumstance like frequency of disabilities, costs, and impact. However, in focus should be on the one hand, the individual situations of the employees and, on the other hand, the knowledge about disabilities. Therefore, it has to be accounted for what the employees need to be fully successful and what in general needs to be established for a full and free participation of a majority of publicly and legally recognized disabled people. In general, disabilities have to be kept in mind all the time during planning laboratory infrastructure and constructing analytical instruments to ensure the anticipation and decrease of possible limiting factors for users. More details can be found above and in the appendix.

The recommendations for physical disabilities focus predominately on general aspects rather than specific changes. For already established legal recommendations, the authors do not add further comments. Besides a barrier-free access to the laboratory for more immobile people, the answers of the questionnaire showed two general aspects of urgency. On the one hand, the height and, on the other hand, space were an issue. The height was important in terms of reachability, a sufficient work height, and a maximum height for storage was recommended. In the same way, wide and enough space, without any obstacles, should be provided for free movement. Furthermore, enough barrier-free space has to be recognized around analytical instruments. Other aspects in regard of instruments were the arrangements of operation panels, height of installments and connections, and access into the instruments.

To achieve a barrier-free usage of a laboratory, the space should be wide enough for free movement of a wheelchair, as biggest support assets for not fully mobile people. No barriers should be placed in the free space. As a good height for conducting work and reach all necessary parts, an average height of approximately 1.09 meters should be sufficient. In addition, the access into an instrument and for an operational panel should be at the same height. Therefore, benches for work surface and placement of instrument should ideally adjustable in height for easy access and comfortableness. However, instruments should be designed horizontally not vertically, although laboratory space is lost, accessibility for physical disabled people are won. Inherently, enough space without obstacles around the instruments is necessary as for the laboratory. An important matter is the positioning of a control and operational panel in front and connections on visible and reachable places of the instrument. Even though, if it is visually not feasible, it is for people with physical disabilities vital.

In regard to non-physical disabilities, it is clear that much limitations are not considered or associated as disabilities in general. Nevertheless, it still creates an impact on the work performance of individuals. Most striking and vital is this in a natural-scientific or academic community with respect to language for laboratories and instruments. In an output orientated work environment for natural-scientific results and data using interdisciplinary machinery, language can function as a barrier of understanding and limits work efficiency. Another factor is the construction of an instrument with its explanation of parts and operation. Hardware and software of an instrument should be designed and display information in a way to give an easy entrance point and to create a disambiguate understanding of instruments. Hereby, any form of support material should be used to illustrate and help to increase understanding. The work environment as itself can be function as a potential barrier, if management misfunctions.

In specific actions, laboratory designers and instrument providers have to use an easy understandable, coherent, clear, and disambiguate language, which is used and applied for all parts of the instrument and its associated support material. Parts and functions of hardware and software have to be uniquely identifiable through concrete design, marks, or labelling. Control panels like buttons should be distinguishable in form and design from each other and give a clear indication of their status. Furthermore, their appearance should give a clear indication of their function for an institutive recognition and understanding. Sufficient explanation of all parts has to be provided in this language and illustrations helping to understand has to be used in support. A work environment should be cultivated, which bridges educational barriers and supports personnel development and problem solving of induvial limitations. Psychological limitations should be openly discussed and recognized for improvement.

5 OUTLOOK

The gathered specific and general information about disabilities with laboratory infrastructure and analytical instrumentation is provided to stakeholders to improve hopefully the situation of personnel and used as a starting point of change for employers. The recognition of disabilities in the recommended approach benefits not only the disabled people, but also all people by raising awareness of their own limitations and possible inabilities. This impacts the individual and its personal capabilities or career development, but it also impacts the institution or company. Most inaction against disabilities is caused by an estimation of high costs and expense imbalanced to low profit-return and public recognition. However, consciousness planning and anticipation of potential problems facing the personnel results in lower costs in money and time compared to later inadequate and insufficient solutions. Moreover, an inclusive and cooperative work environment fuels a greater satisfaction

among employees, which benefits work moral, and reduces time and money by a sufficient support system.

The authors will use the gathered information to continue already arranged project-related engagements and to facilitate possible new projects. It is planned that the authors attend the EWCPS 2023 in Ljubljana with a poster including data from the questionnaire. Finally, the project should give the first input to create a first workshop for disabilities in the laboratory and with analytical instruments. Hereby, disabilities should be made visible for all people by empirical confrontation and personal experience, raising awareness for disabilities and limitations of others and oneself. The importance and success of the project was 2022 already publicly recognized. The Montanuniversität Leoben was honored with the diversitas2022-award by the Federal Ministry of Education, Science and Research Austria due to holding the Diversity Month. Hereby, the project for fostering inclusive access to analytical instrumentation was specifically mentioned (https://www.unileoben.ac.at/en/newsdetail/diversitas-2022/).

Eventually, the authors hope that with this report the awareness for disabilities within the community and industry is elevated. Foremost, it is most important to show and illustrate the real impact of barriers but also of support on an individual level. Therefore, individual stories and experience are hopefully more shared and visible with this work. A free mind with great abilities, should not be imprisoned by others inabilities.

6 BIBLIOGRAPHY

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Irrgeher, J.; Schober, M.; Lancaster, S. T.; Trimmel, S.; Wagner, S.; Prohaska, T. (2022a): Fostering inclusive access to analytical instrumentation. In *Book of Abstracts: Geo Analysis 2022 – The 11th International Conference on Analysis of Geological and Environmental Materials, 6-12 August 2022, Freiberg - Germany*, Article S2-P3, A 18.

Irrgeher, J.; Schober, M.; Lancaster, S. T.; Trimmel, S.; Wagner, S.; Prohaska, T. (2022b): Fostering inclusive access to analytical instrumentation. In *Book of Abstracts: 28th ICP-MS Anwender*innentreffen 2022, September 5-8, 2022, Montanuniversität Leoben, Austria*, Article P6.1.CL, p. 107.

World Health Organization (2017): Brief Model Disability Survey (Brief MDS): Implementation Guide - September 2017. WHO/NMH/NVI/18.19. Available online at https://cdn.who.int/media/docs/default-source/documents/disability/disabilities-mds-implementation-guide-en.pdf?sfvrsn=c85872db_1, checked on 1/2/2023.
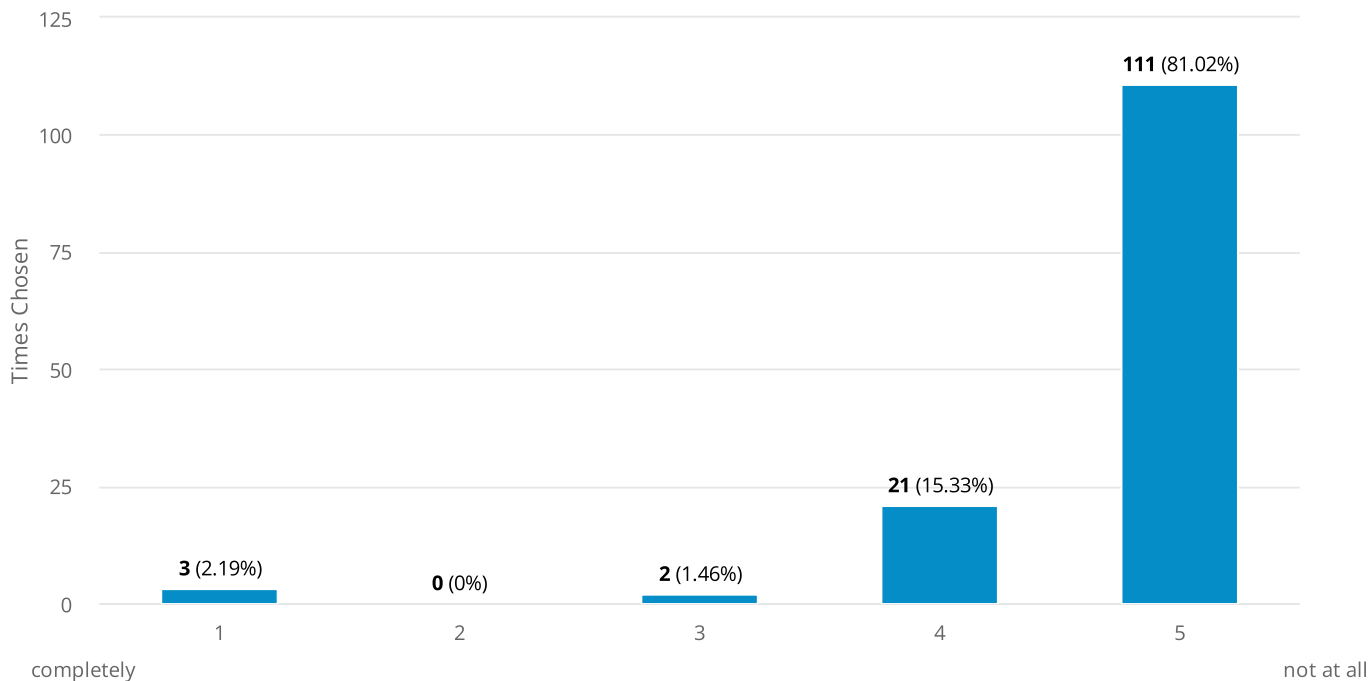
7 APPENDIX

All questions of the survey with full answers and raised data are listed here in the order as they were presented to the participants.
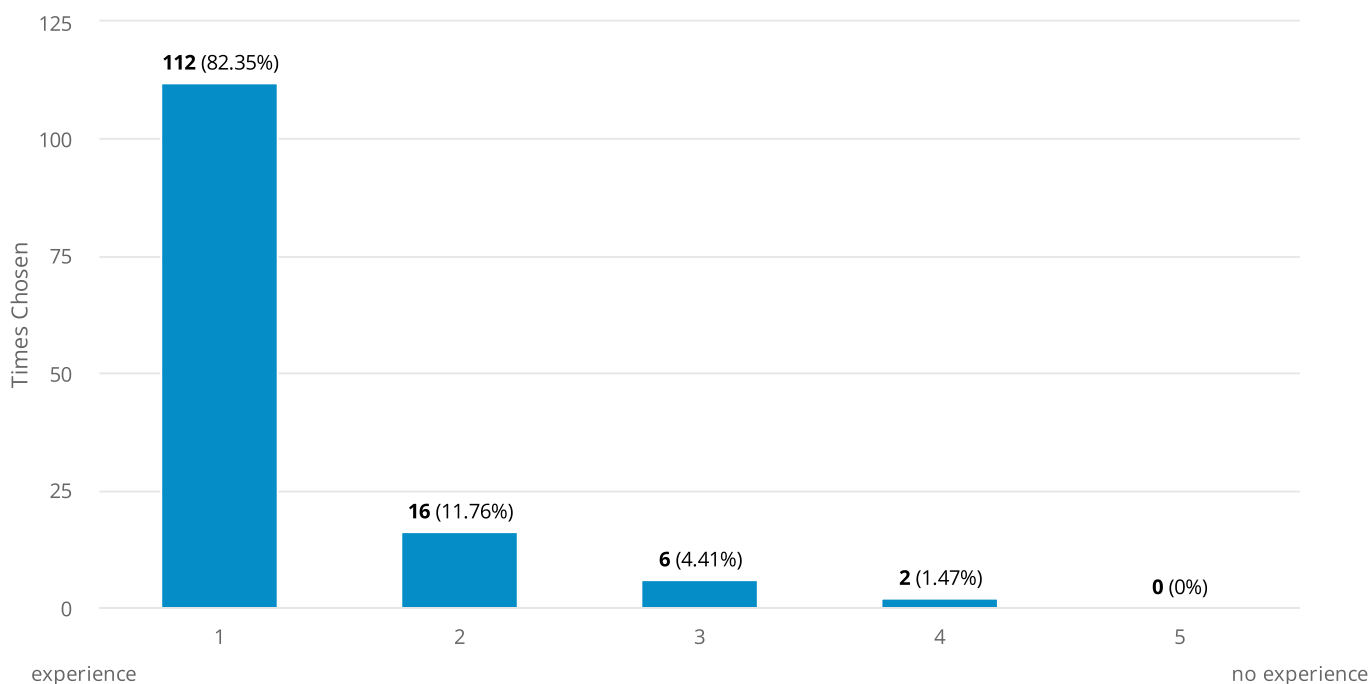
D&I in the lab - Part 1

Do you consider yourself to have a disability?

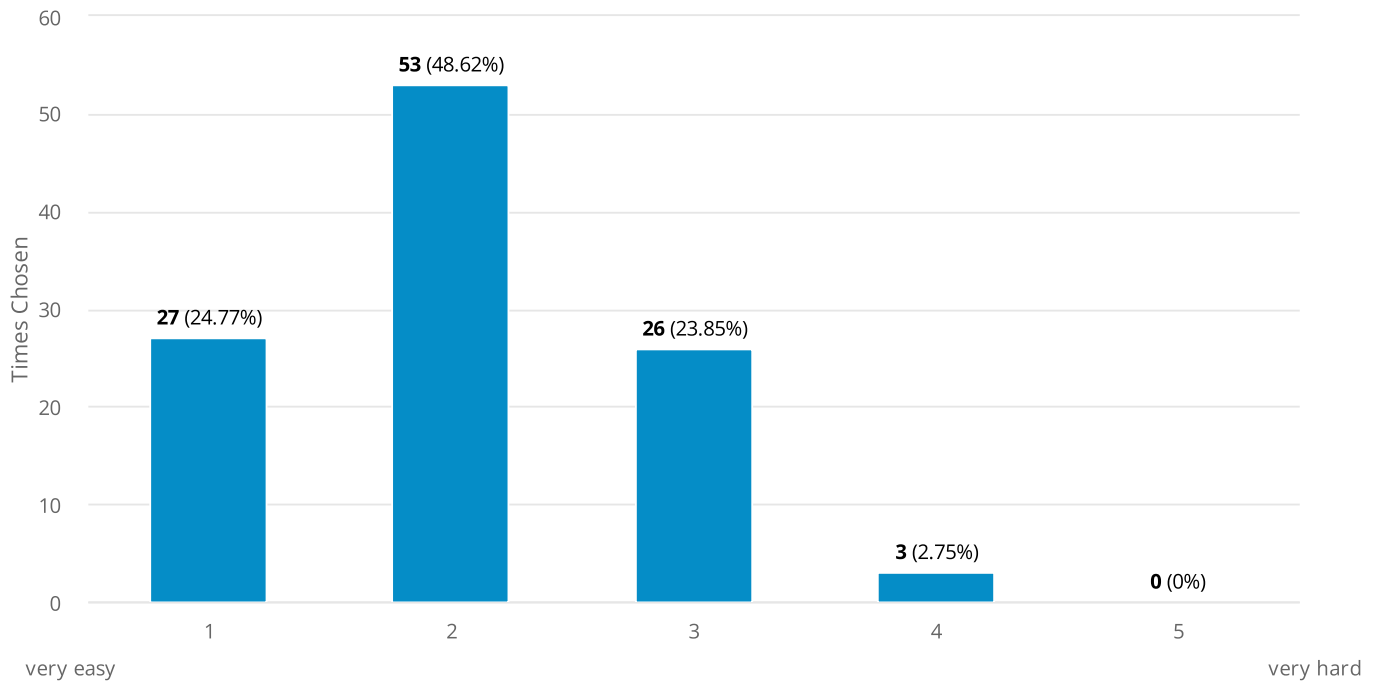Number of responses: 137

Do you have experience in chemistry, laboratory work, and/or with analytical instruments?
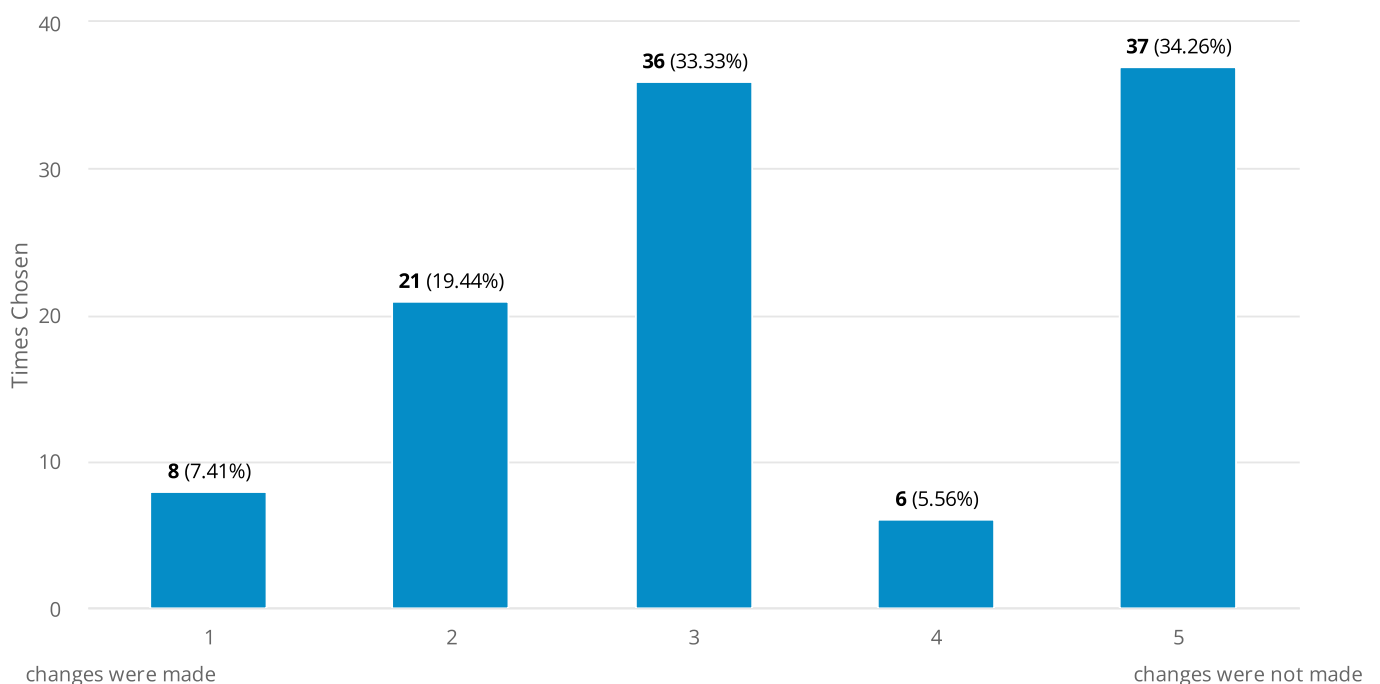
Number of responses: 136

Does the usual laboratory infrastructure that you have experienced (e.g. installations, instruments, ...) make it easy or hard to perform your daily work routine?
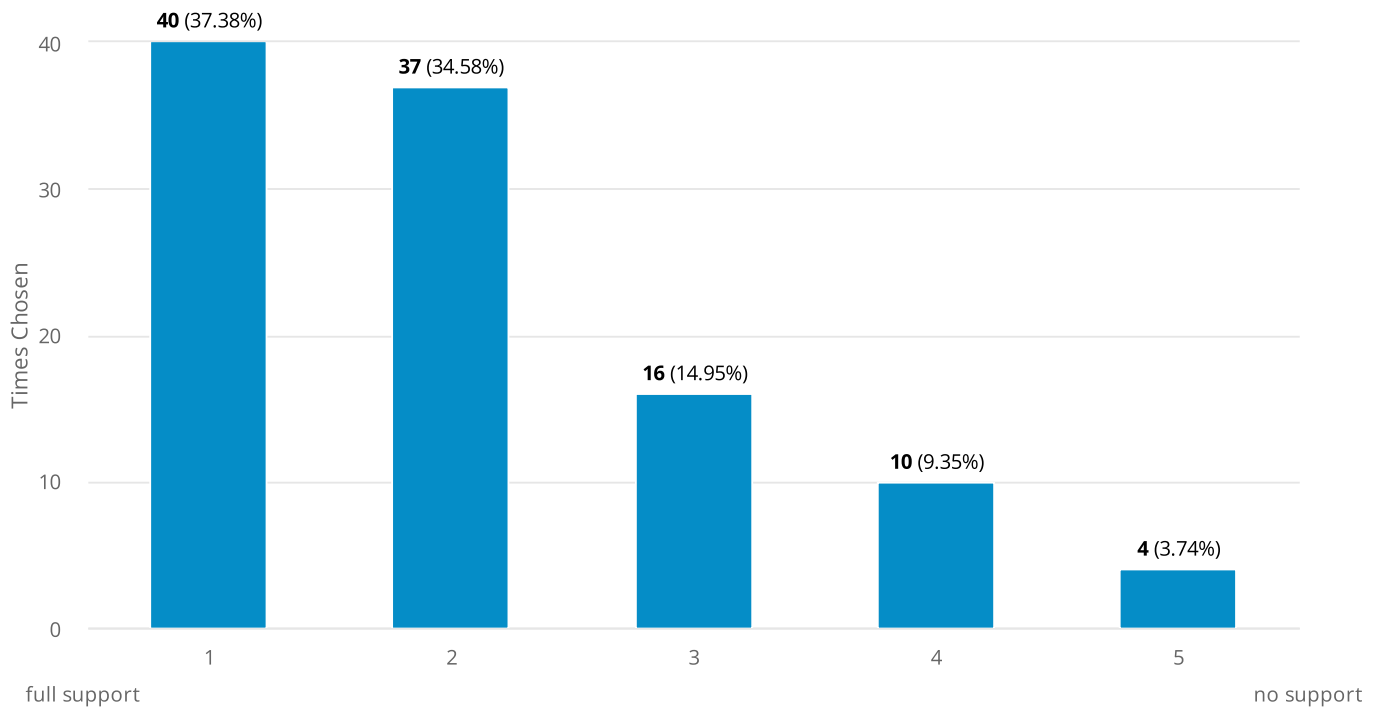
Number of responses: 109

Did your institution/company make any changes to the infrastructure to ease participation for you?
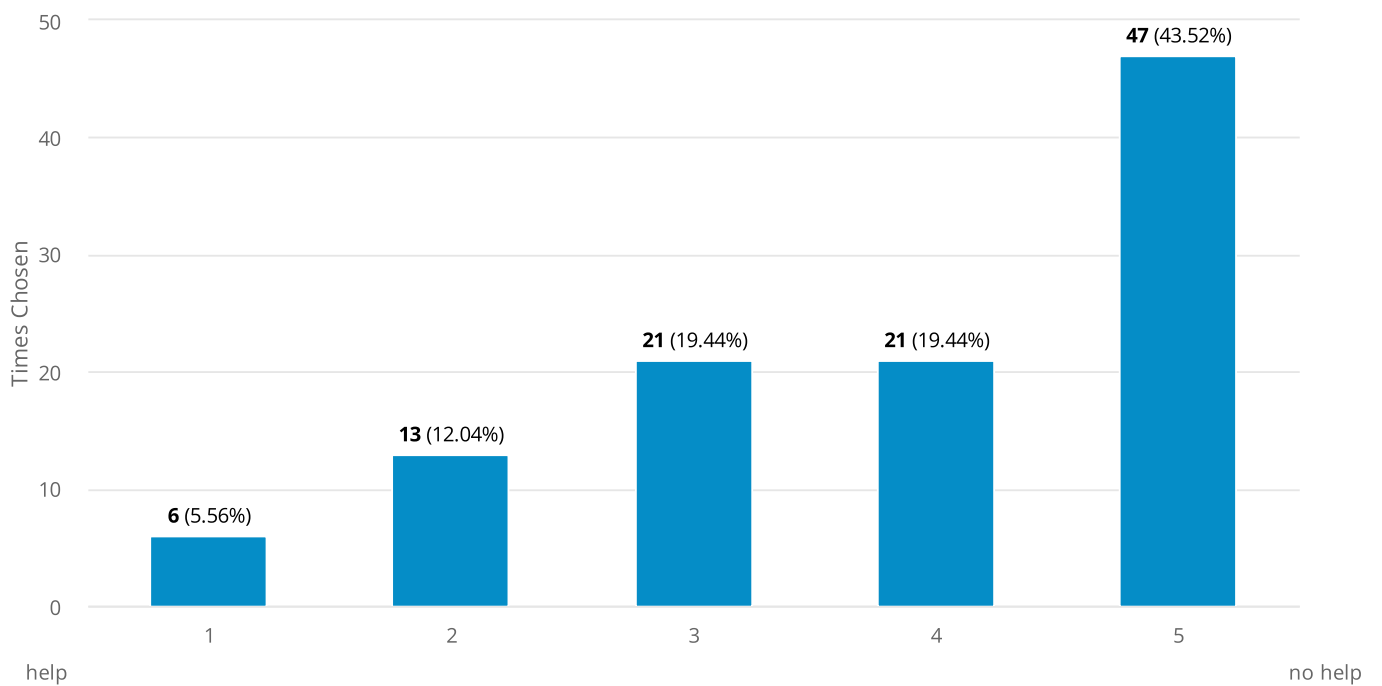
Number of responses: 108

Do you get enough support by the laboratory management to fulfill your normal duties?
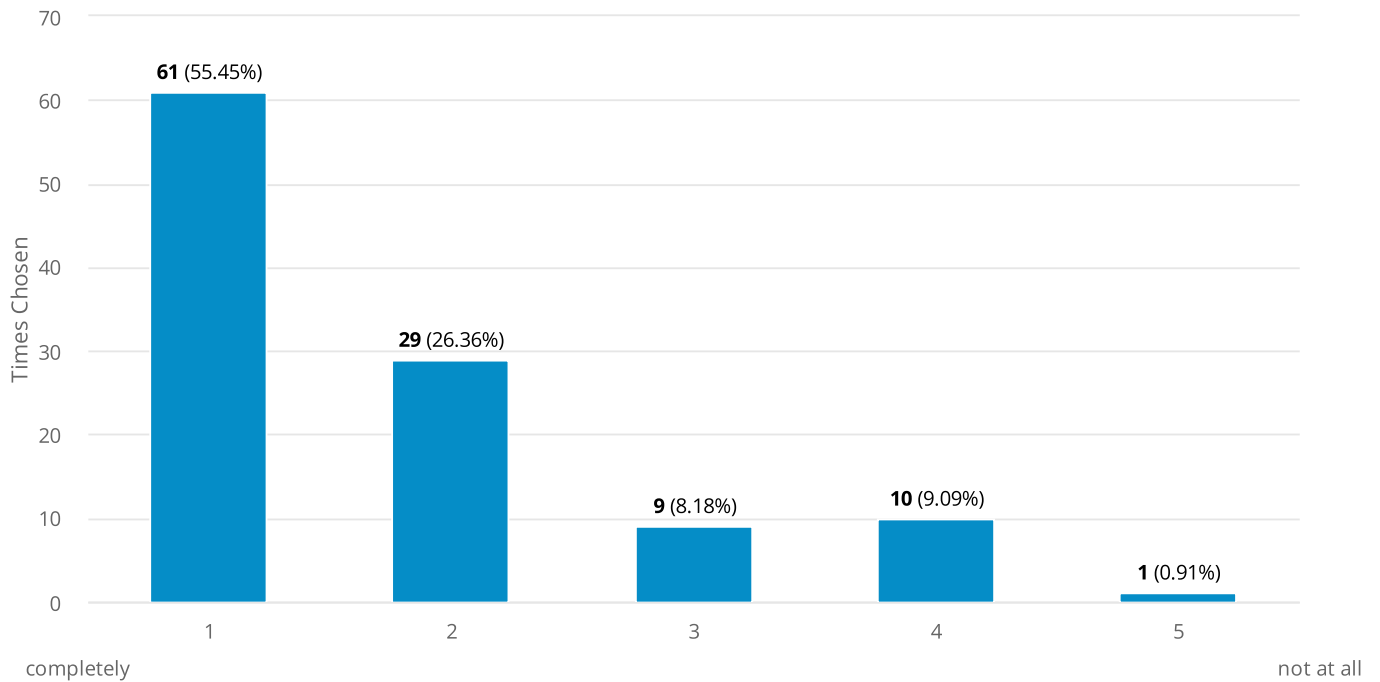
Number of responses: 107

Do you need help or assistance from colleagues to accomplish your regular work?
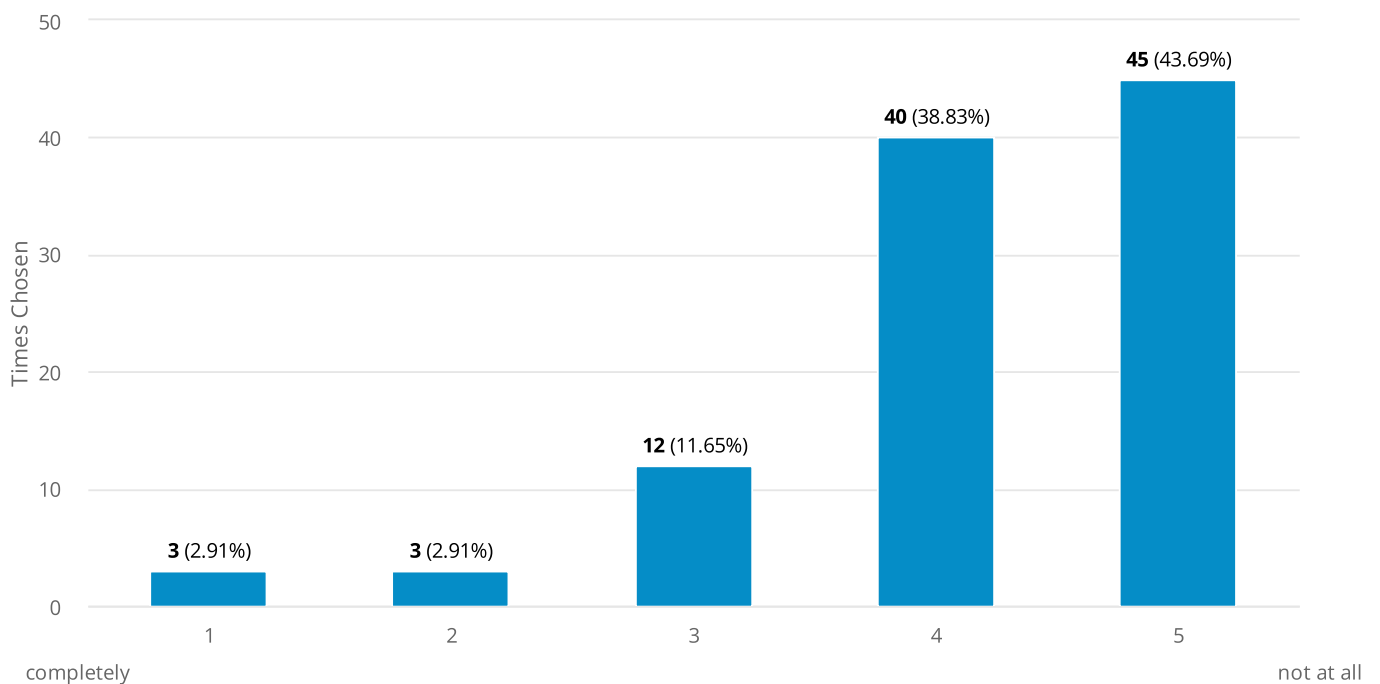
Number of responses: 108

Do you feel valued and respected as a competent person by your colleagues and employer/supervisor?

Number of responses: 110

Do you feel limited in your work?

Number of responses: 103

Did our questions, in your opinion, miss an important aspect of limitations?

Number of responses: 9

Text answers:

Schwierig zu behaupten ob es wirklich eine Behinderung ist, aber meine Rot-Grün Sehschwäche war leider schon öfters ein Problem bei der Interpretation von Plots.

no

No

Just a general comment: the North American Standard for which end of the Likert scale is 1 and which 5 is opposite to what you use here. Not a problem, but you might watch out for survey responses that mix up the two ends!

The age of a laboratory could be significant. Modern designs/refurbishments have had to take account of access for less abled/mobile people for at least 10 years. So, older labs may not be so accessible and this info could be useful.

Nein, es scheint alles dabei zu sein. Räumlichkeiten, Zugänge zu Laboren und die Lage und Höhe der Instrumente sind sehr relevant.
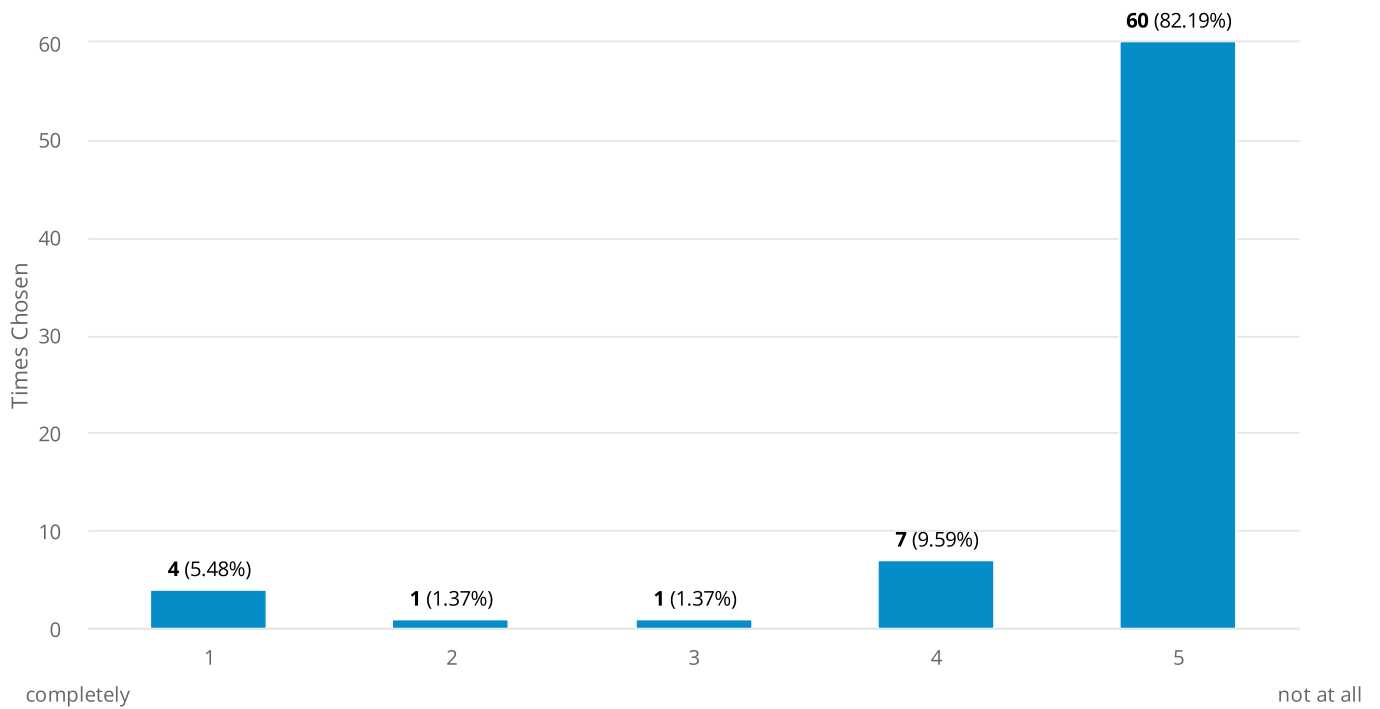
Notfallplaene fuer Menschen mit Einschraenkungen, (Feuer, Evakuuierung, ..)

Break down of instruments and thus time-consuming, in either getting the instruments fixed or get the lab work done.

Seit der Geburt meiner Tochter verfüge ich im Vergleich zu meinen Kolleg*innen über ein sehr knappes Zeitbudget, wofür die Arbeit (Prozesse und Organisation) an der Universität im Allgemeinen nicht ausgerichtet sind. Meine Vorgesetzte und Kolleg*innen gehen recht einfühlsam damit um, manchmal komme ich mir außßen vor gelassen vor. Insgesamt fühle ich mich gut unterstützt.
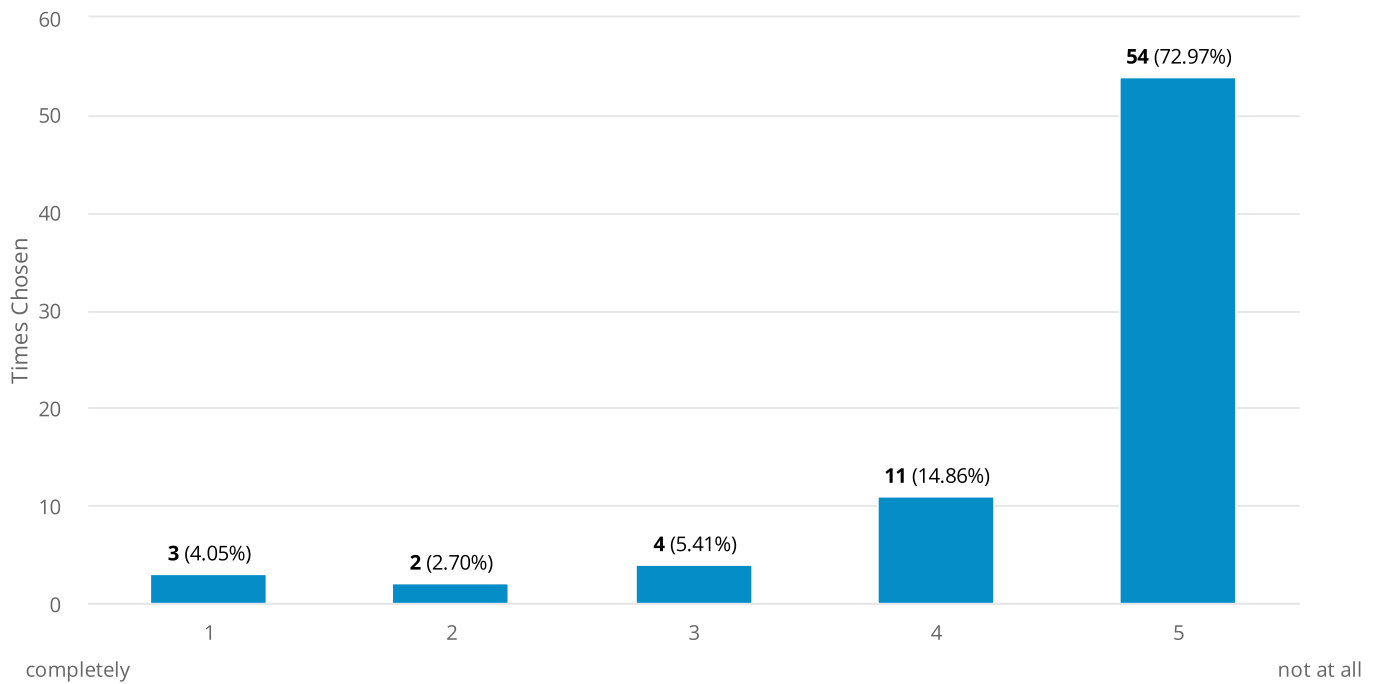
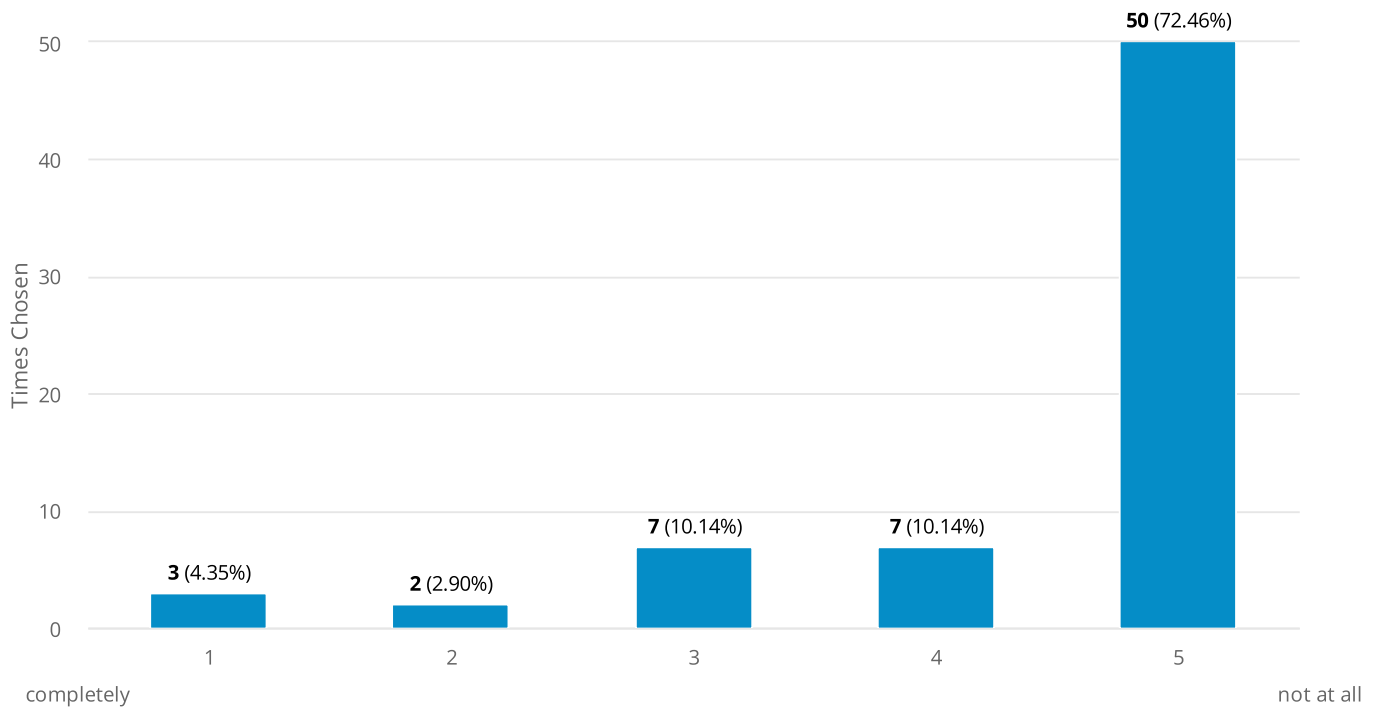## Do you consider yourself to have a physical disability?

Number of responses: 73

Times Chosen

- **4** (5.48%) — 1
- **1** (1.37%) — 2
- **1** (1.37%) — 3
- **7** (9.59%) — 4
- **60** (82.19%) — 5

completely ← → not at all

Do you experience difficulties or problems as a result of your physical capabilities?

Number of responses: 74

Times Chosen

- **3** (4.05%) — 1
- **2** (2.70%) — 2
- **4** (5.41%) — 3
- **11** (14.86%) — 4
- **54** (72.97%) — 5

completely ← → not at all

Do you need help from a colleague or do you use technical aids to compensate for challenges?

Number of responses: 69

Chart: Bar chart showing "Times Chosen" (y-axis) across options 1–5 (x-axis), where 1 = "completely" and 5 = "not at all".

- 1: 3 (4.35%)
- 2: 2 (2.90%)
- 3: 7 (10.14%)
- 4: 7 (10.14%)
- 5: 50 (72.46%)

If you use supportive equipment, which are these?

Number of responses: 11

Text answers:

Stairs to reach something and tools when my strength is not enough to open something like gases.

Magnifiers, lamps, screen magnifiers, screen readers, talking camera app, high contrast settings, increased fonts are a few that come to mind

Leiter

Trittleiter für hohe Regale

Elefantenfuß um zu hohe Regale zu erreichen

A larger screen to accommodate the zoom feature to see smaller text or features.

Ich muss sitzen oder Beine hochlagern; kann nicht stehen. Also Stühle, Stockerl, Kisten, Tische als Hilfsmittel

Trittleiter
Kanisteröffner
Hilfe beim Heben schwerer Dinge

optische Laborbrille

Bei manchen Arbeiten benötigt man Hilfe von Kolleg*innen, wenn etwas schweres zu heben oder tragen ist.

Transportkarren für schwere Pakete/schwere Kanister usw; Trittleiter weil Kästen zu hoch sind

Can you access everything you need for work or in case of an emergency (e.g. part of an instrument or installation, …)?

Number of responses: 67
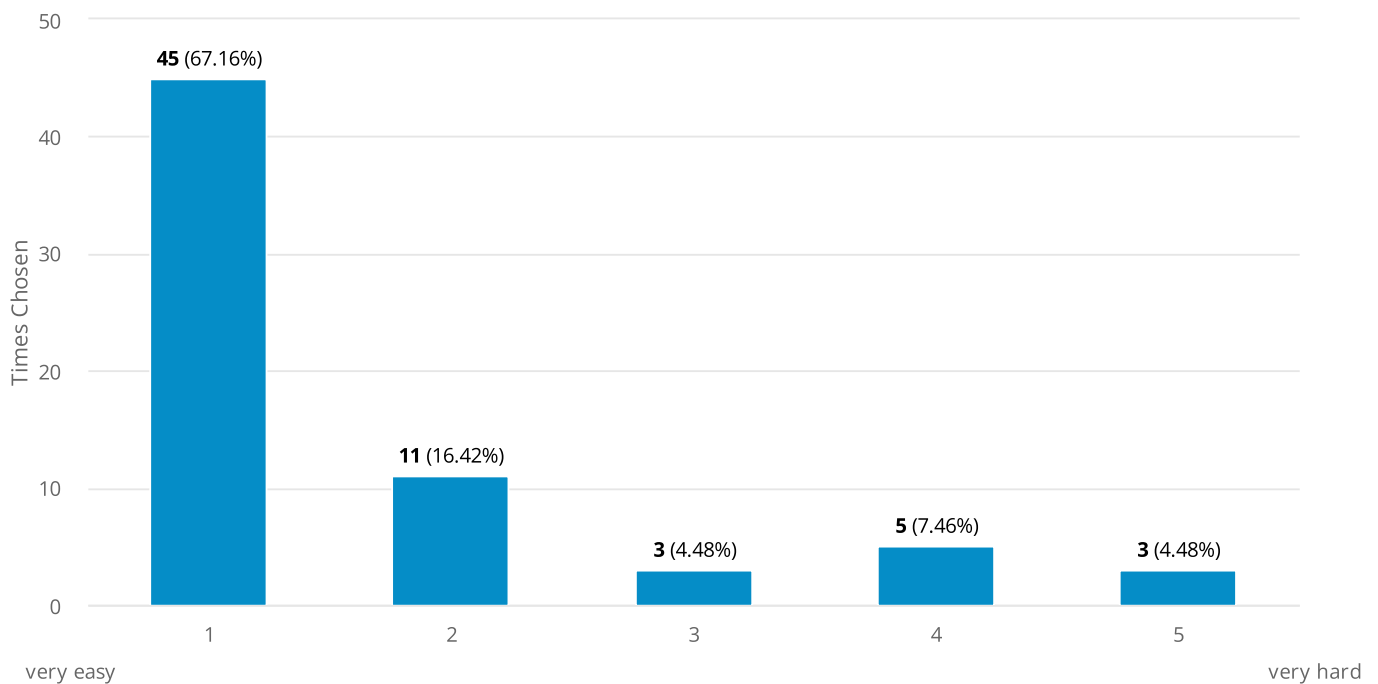
If not, which things are these specifically?

Number of responses: 10

Text answers:

some equipments has their back inaccessible.

Haven't encountered emergency situations but imagine it would be difficult

Einige Teile bei uns im Labor sind relativ hoch oben, da ich eine eher kleine Frau bin, benötige ich immer einen Elefantenfuss um dazu zu kommen.

Hoch gelagerte Dinge
Schwere Sachen

geringe Körpergröße ist manchmal hinderlich

Some instruments or autosamplers have the on/off on the back or near the back, depending upon bench placement, can be difficult to reach, especially for shorter people.

heights of benches make it difficult to shut down instruments when switches are located at the back

MS-parts,

Just thinking about equipment design like how I am not familiar with opening up my large equipment to get inside. If a fire started inside the device or something like that I would have no clue how to access it to stop it, or how to access it to instruct fire crews how to get in if ever necessary.
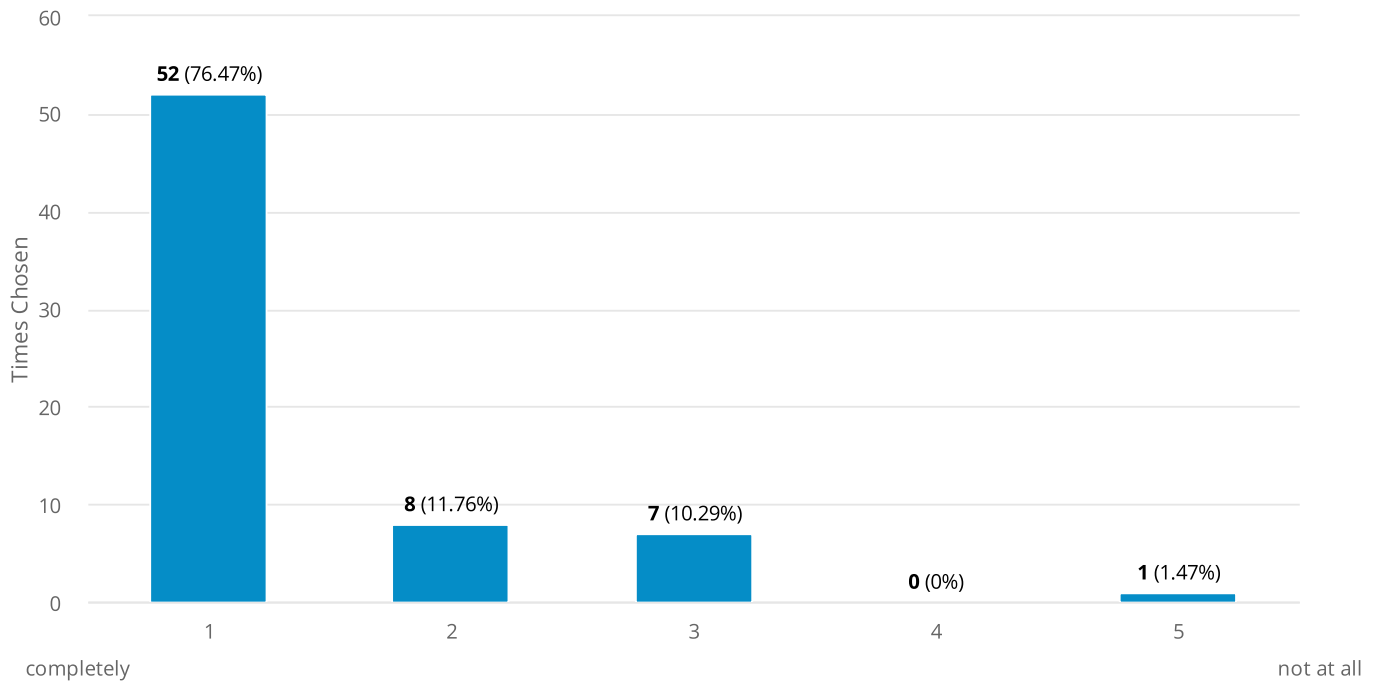
Abzug, Autosampler

Do you recognize warning signals, emergency alerts, and instructions (e.g. in instrument software, ...)?
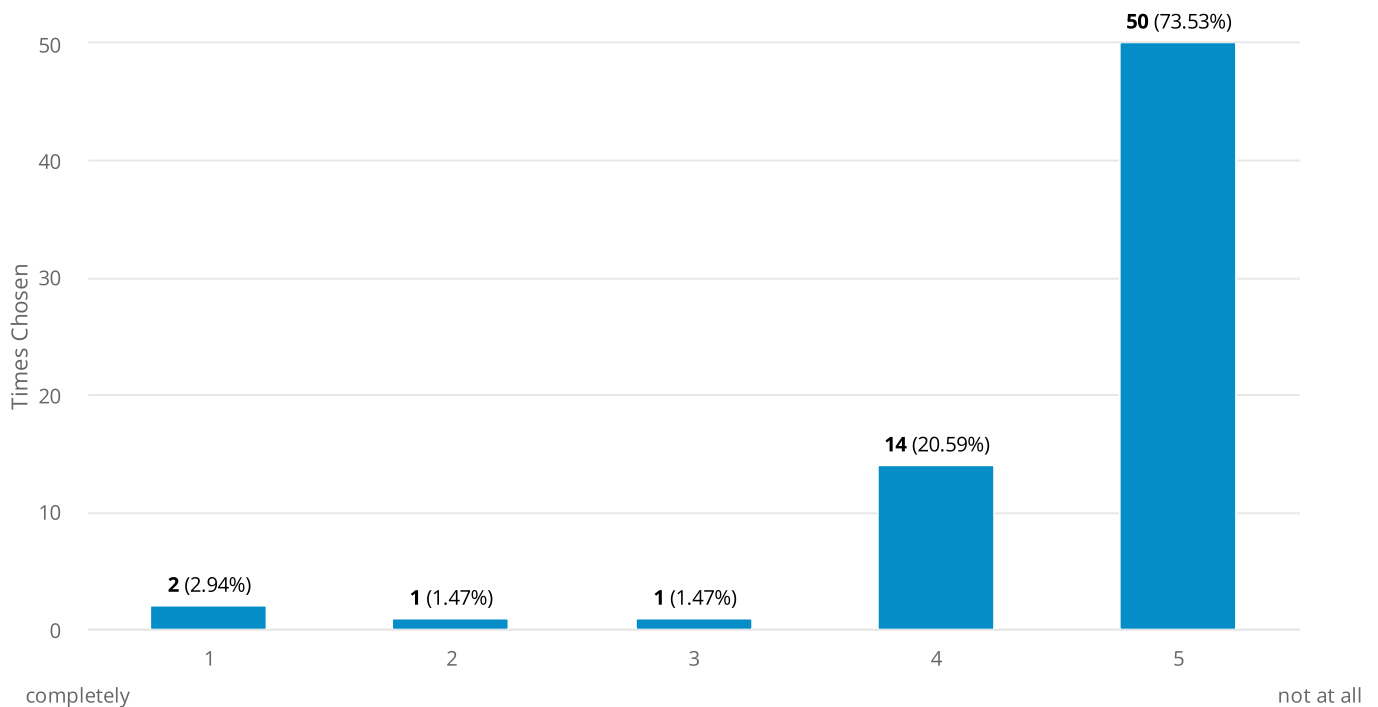
Number of responses: 67
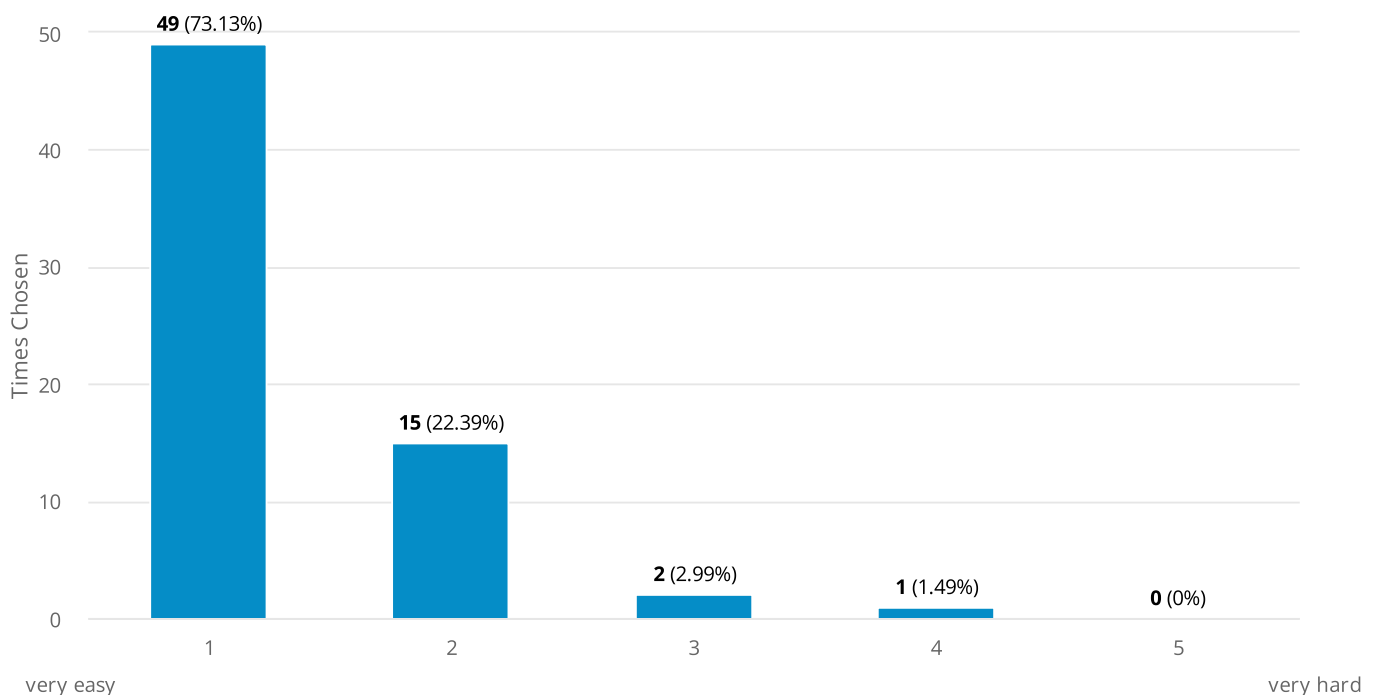
Do you have the capability of rescuing yourself or others in case of an emergency without any support by people or technical aids?

Number of responses: 68

Do you feel physically limited to do your work?

Number of responses: 68

Did our questions, in your opinion, miss an important aspect of physical limitations?

Number of responses: 7

Text answers:

It's complex, lab equipment and software is not accessible enough or at all this means people need to step in to help and myself to share a lot of sensitive information about myself

Ich frage mich in wiefern Grösse und Brillentragen eine körperliche Einschränkung darstellen, da diese ja auch von dem Durchschnittsmensch abweichen, jedoch sehe ich persönlich diese nicht wirklich als eine physische Barriere, da sie leicht mit Hilfsmittel umgangen werden können

no

No

kurzfristige Einschränkungen wie z.B. gebrochene Arme/Beine, Bewegungseinschränkung durch Krücken sollte nicht vollkommene Arbeitsunfähigkeit bedeuten

Ich habe Rückenprobleme, was aber nur für lange Arbeiten beeinträchtigt, aber nix im Vergleich zu körperlich benachteiligten Mitarbeiter:innen.

Baulichen Einschränkungen, wie tiefere Arbeitsflächen für Rollstuhlfahrer, oder Personen, die nicht so lange stehen können
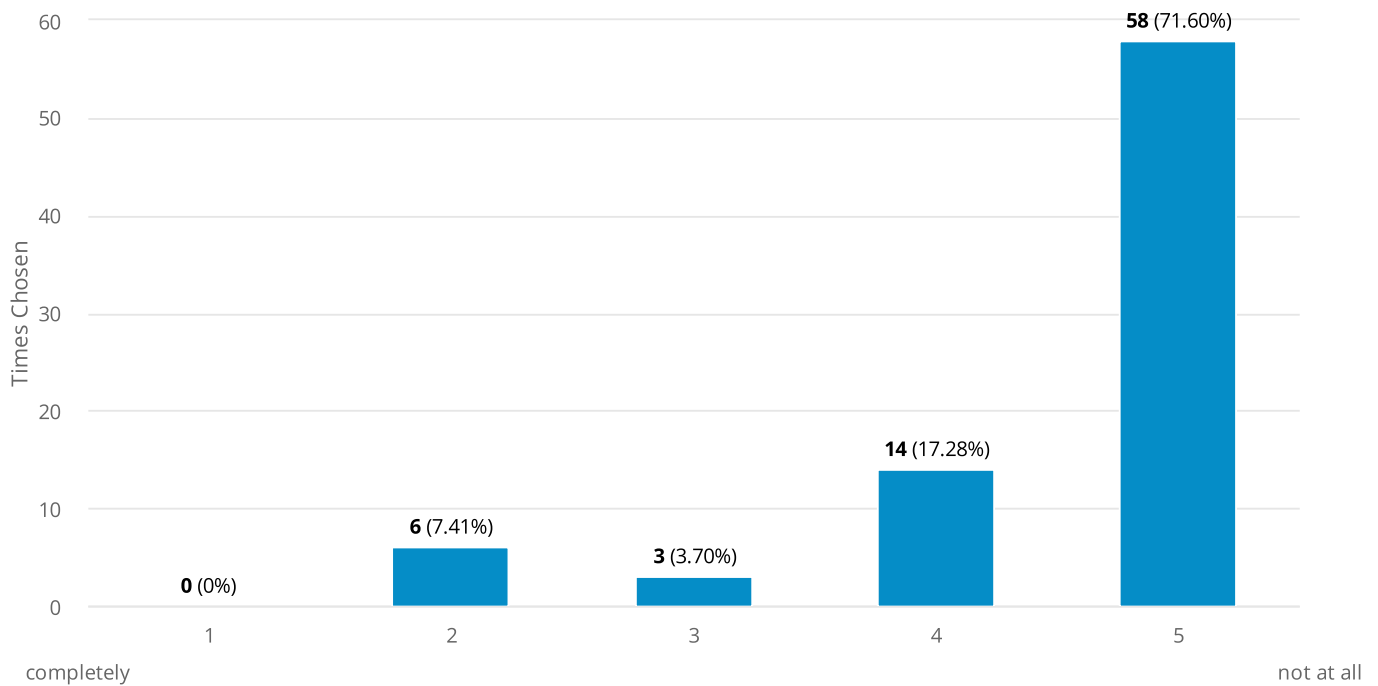
Do you consider yourself to have a non-physical disability?
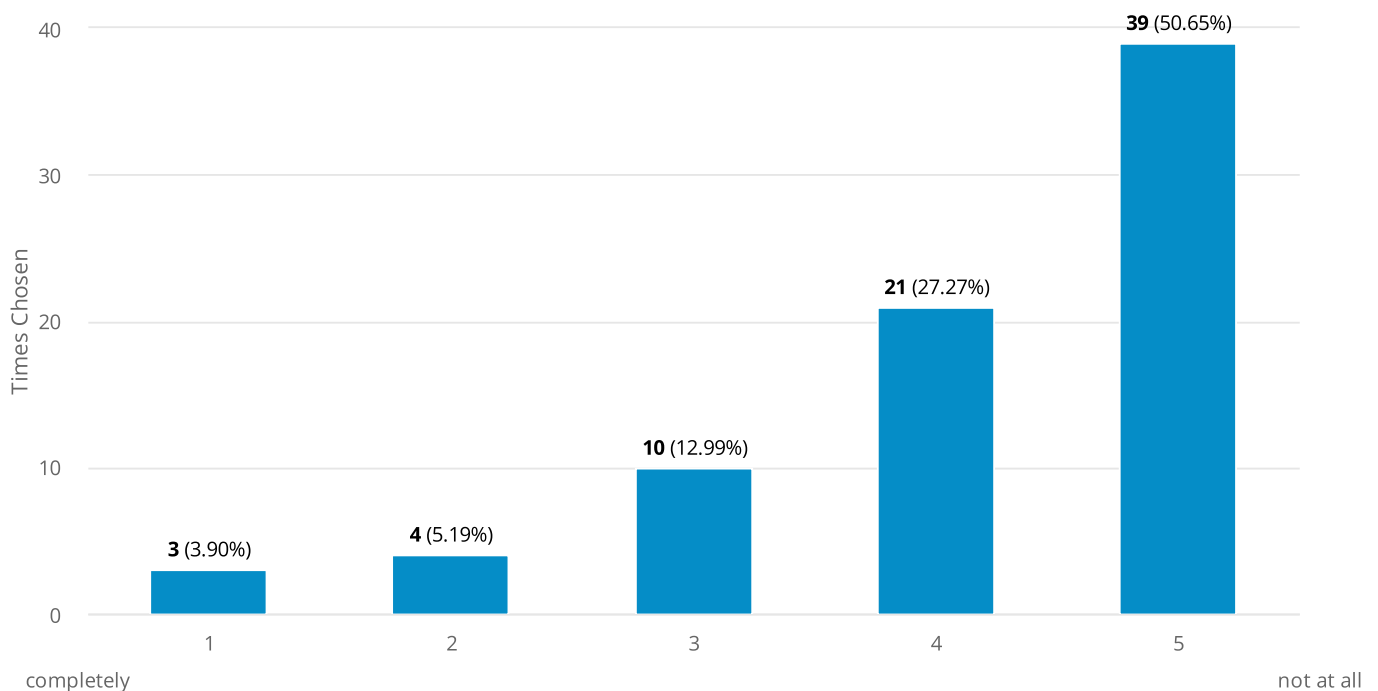
Number of responses: 81
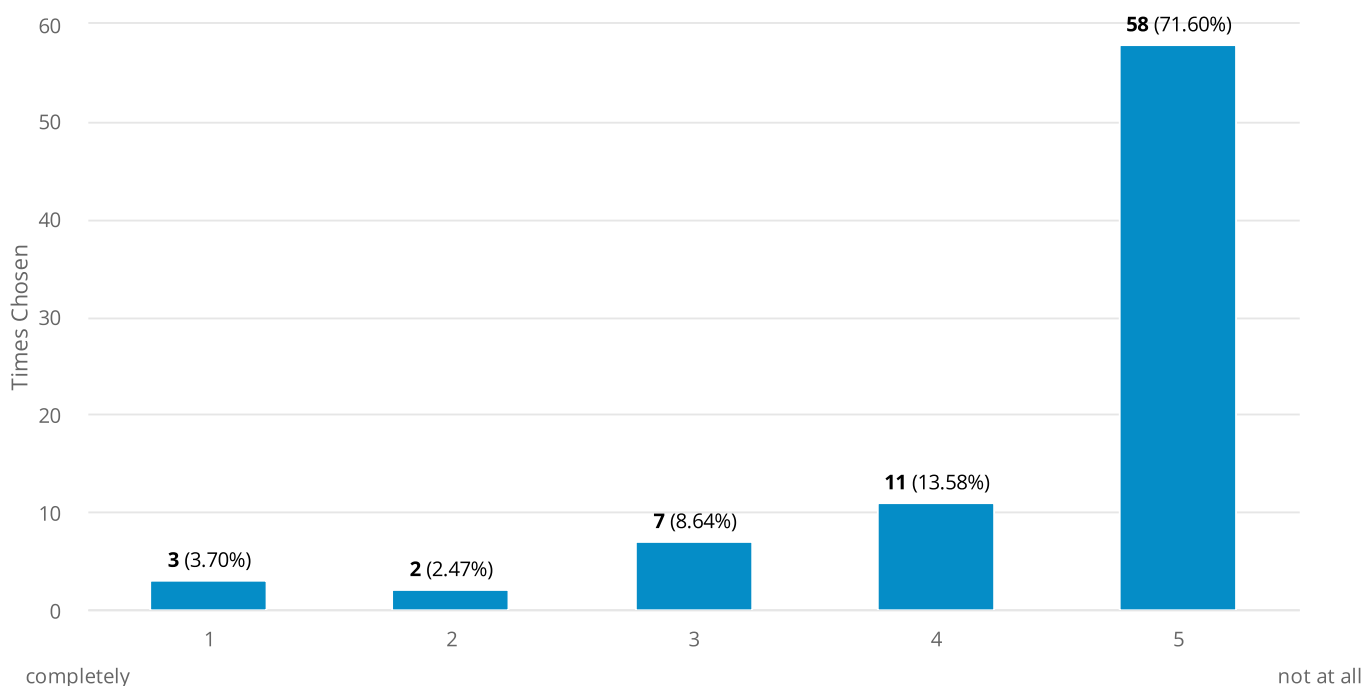
Do you need additional guidance to be able to work on your own (e.g. in the laboratory, on a technical instrument, ...)?
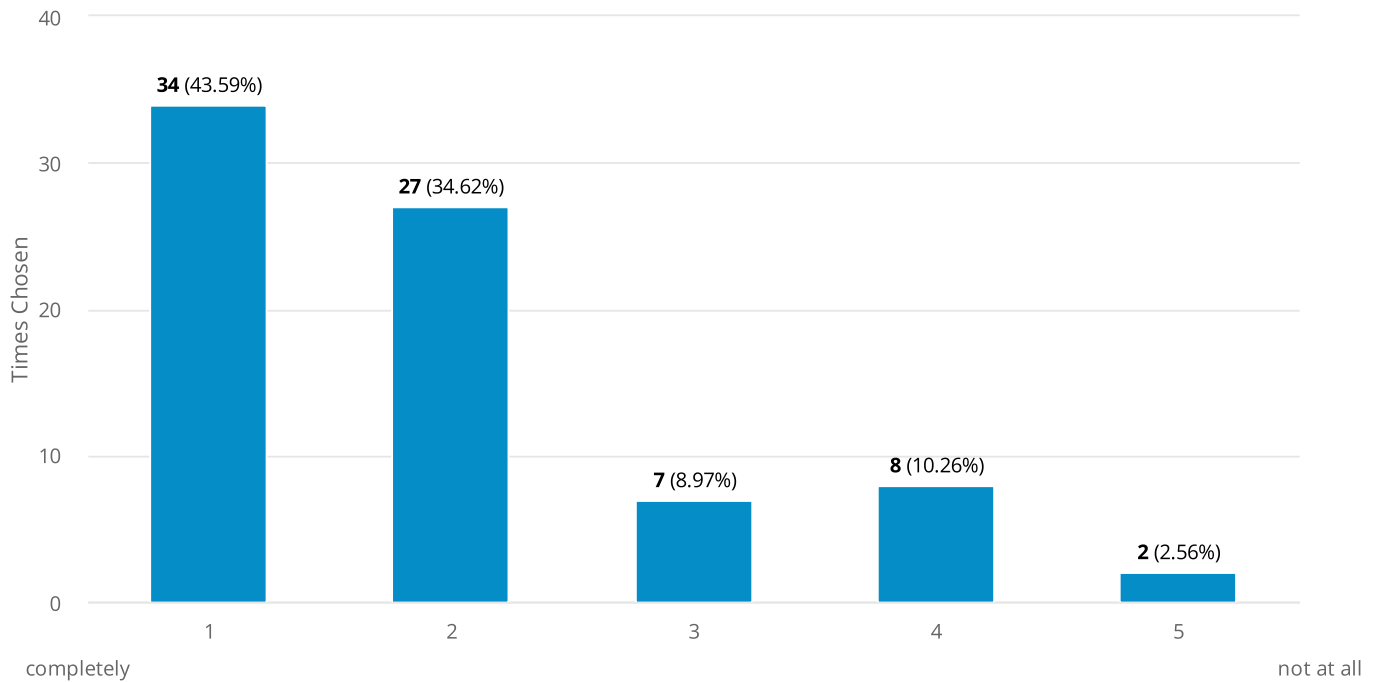
Number of responses: 81

Do you consider yourself to be discriminated, hampered or to have a disadvantage due to your appearance, identity, education, and/or status in society?
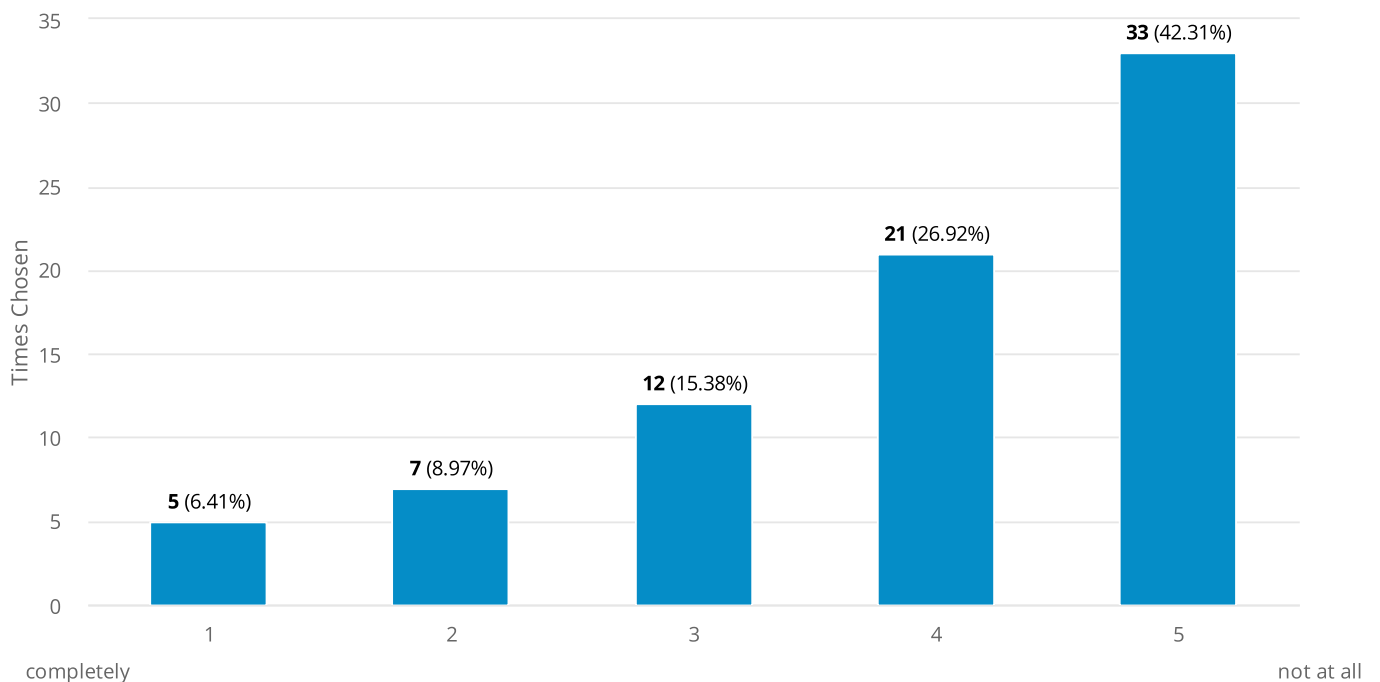
Number of responses: 77

Does your work environment provide a safe atmosphere, which is open for your needs, allowing errors, and enables innovations to advance your capabilities?
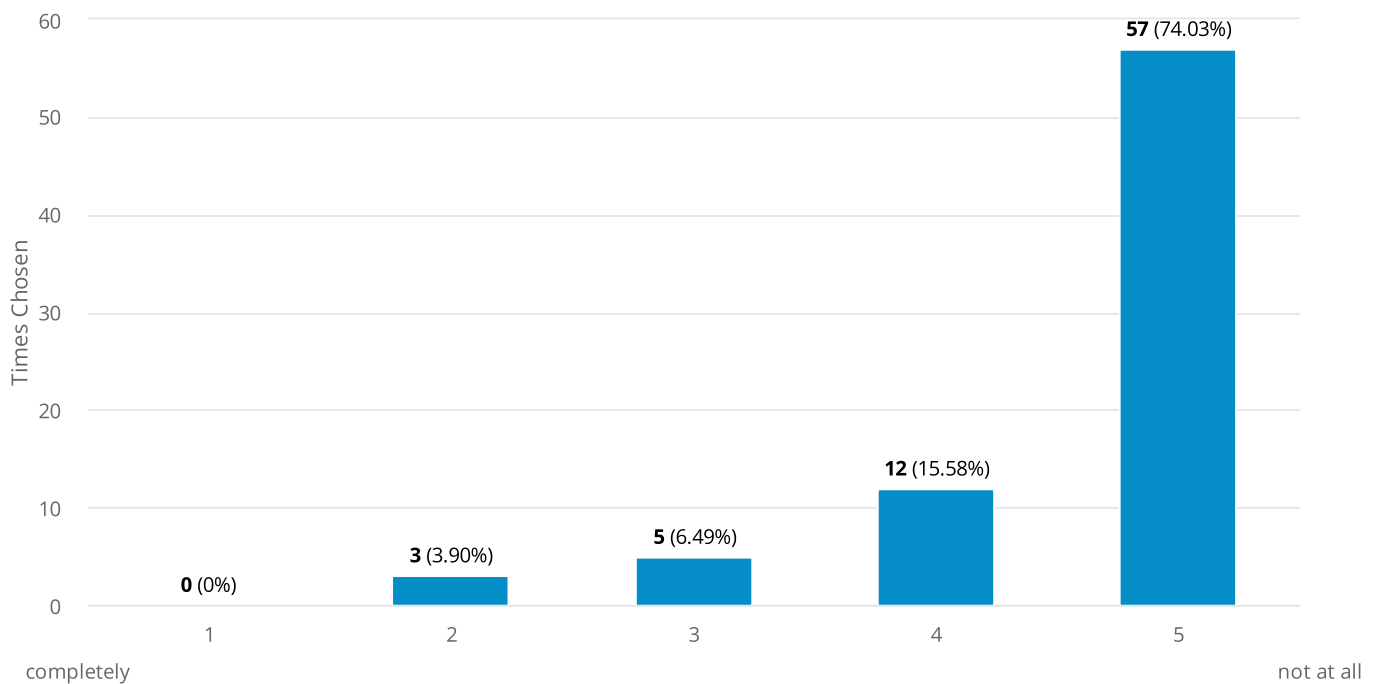
Number of responses: 78

Do you feel limited in your work due to misjudgments of colleagues and supervisors regarding your personal skills?

Number of responses: 78

Do you have difficulties understanding instructions, guidelines, or regulations?

Number of responses: 77

If you have difficulties, which are these?

Number of responses: 9

Text answers:

Manche Sicherheitsvorschriften/Richtlinien sind meiner Meinung nach nicht zielführend

Unclear translation and explanation of contractor jargon - never volunteered as information and then had approval of a 850-page document full of this jargon (needed to progress on lab renovations) used against me later as having approved a specific detail buried in this jargon.

unnachvollziehbare Vorschriften die "schon immer so waren" und nicht an ein neues Zeitalter adaptiert werden

Read slower than others, needs repeated instruction

my manager's English language is awful, yet she thinks it is good and blames others for not understanding.

Laborarbeit in Mikromaßstab

Usually software has too many options that are vry seldom used. A too crowder GUI makes me nervous. Regulation are often too verbose. They saturate me. I think guidelines or safety instructions should be much shorter or supressed completely, in exchange of a comprehensive training

Is the used language in your work clear and easy to understand (e.g. in software, application notes, ...)?

Number of responses: 78
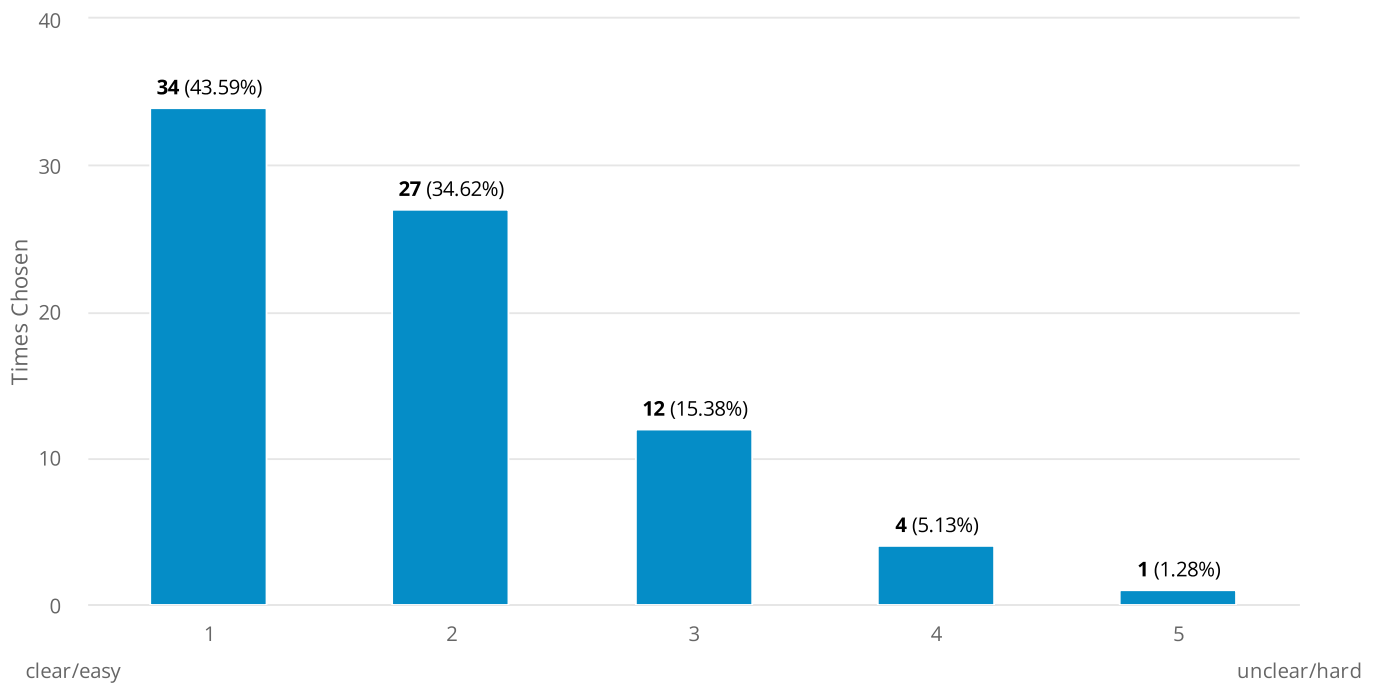
Do you feel limited in non-physical work?

Number of responses: 77

Did our questions, in your opinion, miss an important aspect of non-physical limitations?

Number of responses: 4

Text answers:

no

No

The non-open source or softwares with license are limiting innovation

nope, all good

D&I in the lab - Part 2

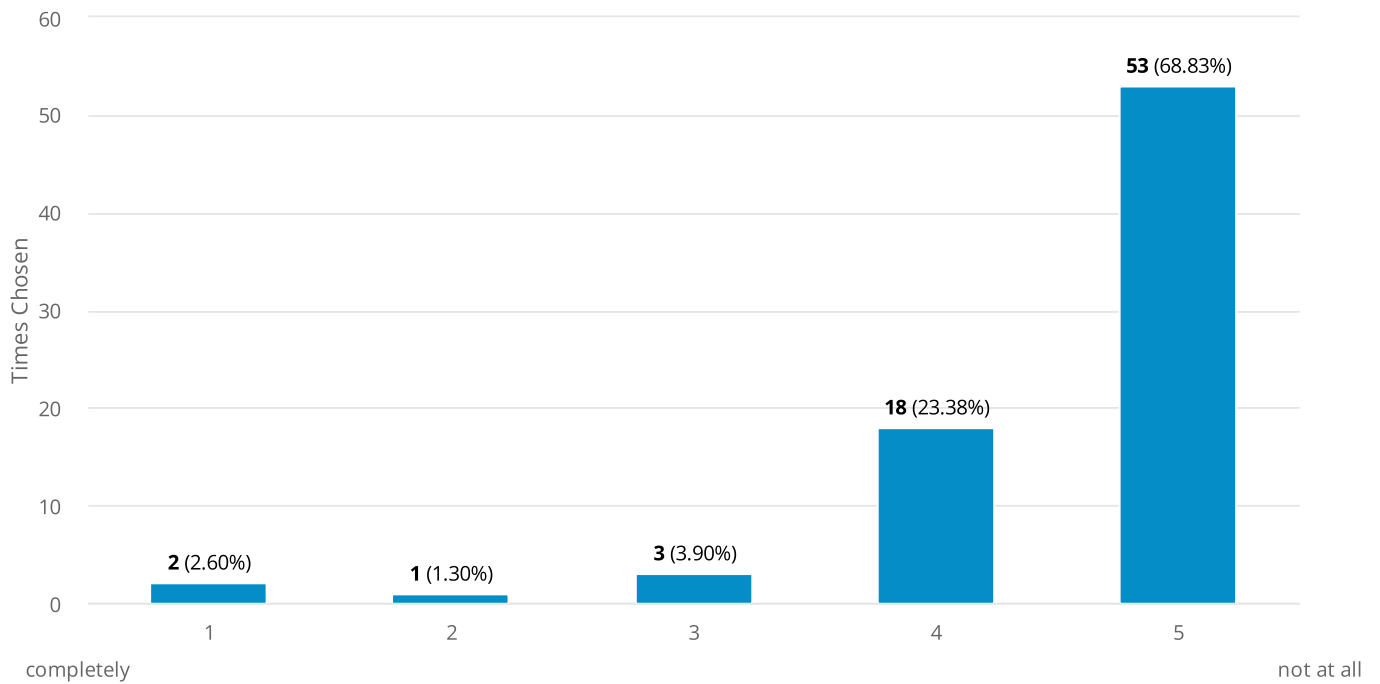## What measures should be taken to ease the access for all people to the laboratory and an instrument?

Number of responses: 26

Text answers:

Bereitstellen von Elefantenfüssen für kleine Leute, Anschlüsse nicht zu hoch installieren, Möglichkeit die Textgrösse zu ändern (für Personen mit Sehbeeinträchtigungen)

Höhenverstellbare Arbeitsplätze (Tische, Stühle, Abzüge, etc)

Keine Gegenstände auf dem Boden stehen lassen. Keine zu hohen Kästen anbringen

laboratory spaces wide enough and furniture that allows for easy maneuvering and accessibility with wheel chairs or other mobility apparatus. Step-stools to allow to reach higher benches or instrumentation.

Modified health and safety protocols compatible with the ability to work outside of 9-5 hours (not always possible for those with other work or family responsibilities); clean room compatible (dedicated) crutches/canes/wheelchairs; specialized infrastructure designed for those with vision disabilities.

In answer to the question below, I put in 1 m, but I don't think there really is an optimal height for a workspace. There should be an option always for seats with adjustable heights relative to hood height, and either platforms in front of instruments or hoods or height-adjustable benches used more frequently.

uneingeschränkter Zugang auch für Leute im Rollstuhl
bei Neuplanung Menschen mit Behinderung einplanen
höhenverstellbare Tische

Space to move around instrumentation and furniture. Counters at an appropriate height.

Instrument controls/readout should be located relatively low down on the instrument, and on the front.

When building new lab or renovating, consider adding one adjustable height lab bench.

On/Off buttons or switches near the front of the instrument, and especially autosamplers. The other thing that needs to be easily accessible and readable is the serial number and part number. Many times it is on the back of the instrument in very fine print. To instrument manufacturers, things like this on or near the front of the instrument may not "look" the most appealing, however, for most analysts it would be safest and helpful.

Should have at least 1.5 meter wide access routes and all of these should be flat. Benches and instruments should be at accessible heights to all. Possible use of variable height benches. Variable intensity lighting

maybe. Some form of noise reduction systems as well maybe. Benches should have nothing underneath where possible to allow e.g. wheelchair access to chest level.

*Alle wichtigen Bedienungselemente müssen auch mit einem Rollstuhl erreichbar sein.
*Höhenverstellbare Tische/Abzüge/Laminarboxen wären optimal.

wheel chair access via lift

höhenverstellbare Tische für Steuerungscomputer; Möglichkeiten mit "Barhocker" stehend zu arbeiten

Keine Kabel am Boden, schwere Türen zum aufmachen, zu hohe Arbeitsflächen, etc.

I think is a long term run. They have to be trained, as in a course. 'Guidelines' are from my point of view a waste of time and saturate with useless information

adjustable height benches

Labortüren (Schleusensysteme) lassen sich oft nur manuell und mit beiden Händen öffnen (gleichzeitiges Drücken eines Tasters beim Öffnen), viele Farbcodierungen sind nicht behindertengerecht (rot/grün etc.), oft sind die Höhen von Arbeitsflächen nicht adaptierbar

Signal-Licht an Insutrmenten verwendet oft rot/grün/gelb/orange. Das ist für Menschen mit Farbsehschwäche mitunter nicht leicht zu erkennen.

In my institution, the workbench does not have a place to put the legs (instead there were cupboards) during long pipetting this caused back ache and one needed to pull out the cupboards so one can sit like sitting at a table.

Tiefere, unterfahrbahre Laborbenches und Abzüge, damit auch sitzende Personen arbeiten können

Schnuppertage oder Initiativen, bei denen Einblicke gewonnen werden können.

Rollhocker als Aufstieghilfe.

ramp or stools?

Vorallem in älteren Gebäuden ein Problem: barrierefrei

entsprechende Laborausstattung

Laboratorien in denen man von einem Rollstuhl aus arbeiten kann

In your opinion, what is the optimal height in the workspace to perform work in a laboratory and directly on an instrument for both a sitting and a standing person?

Number of responses: 29

	Σ	∅
Sitting/Standing person	724.41	24.98

Which two colors do you prefer for a binary color-code (not consisting of the red/green combination) that clearly represents positive/negative or yes/no?

Number of responses: 45
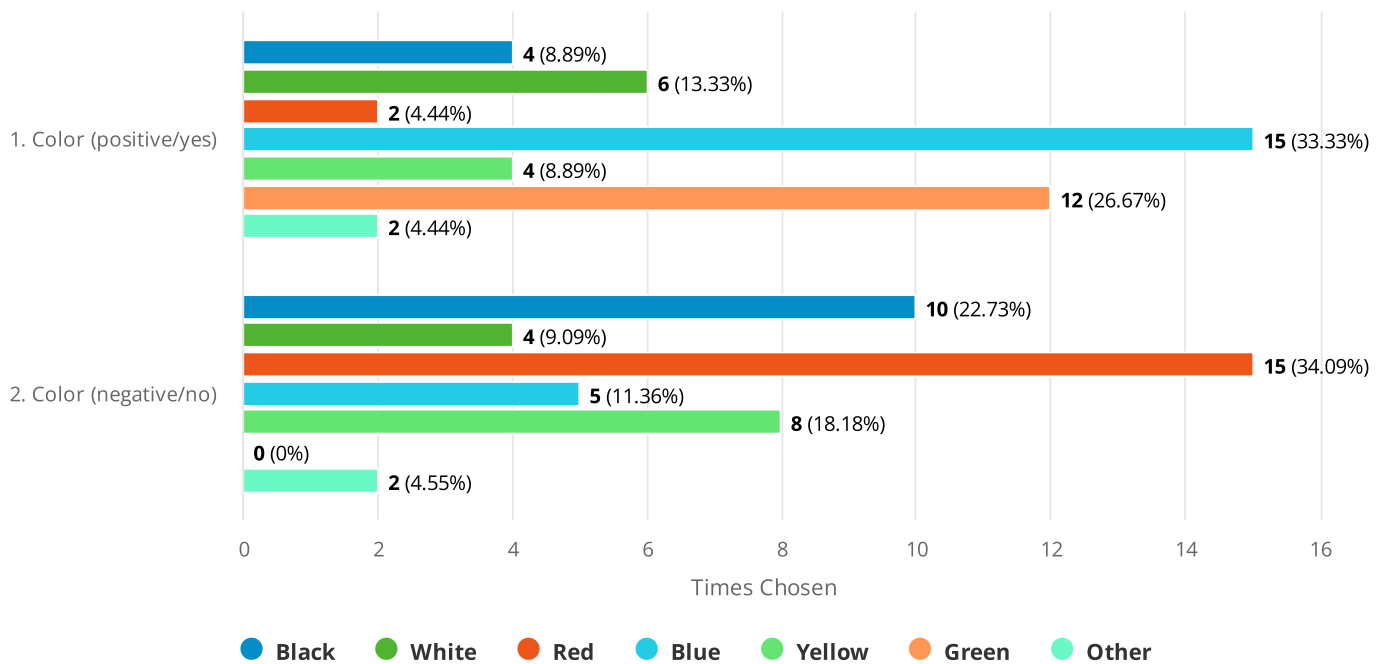
Which other color or color code do you propose?

Number of responses: 2

Text answers:

Positive = Pink Negative = Olive green

Orange

Is the size of the text always appropriate for the importance of the content and highlighted in a way to represent it accurately?
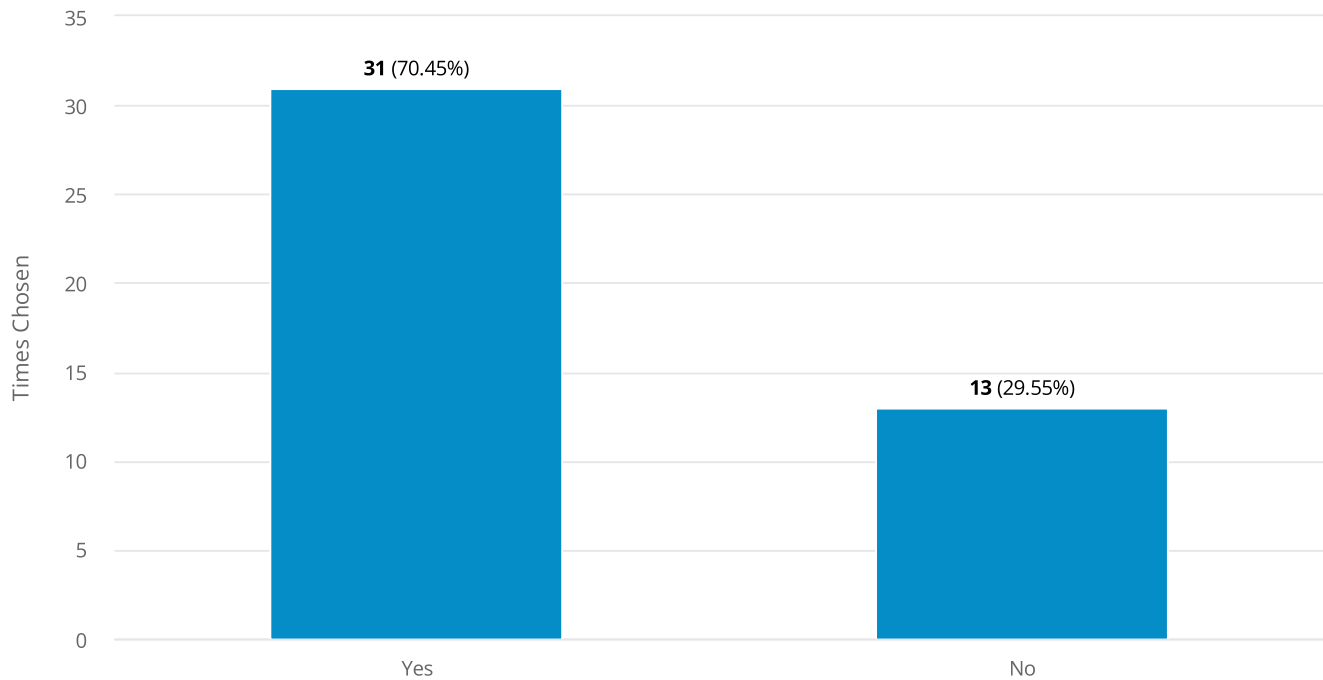
Number of responses: 44

If no, give examples.

Number of responses: 9

Text answers:

In Computersoftware sind oft alle Einstellungen gleich gross geschrieben, ebenso in Manuals sind alle Informationen gleich gross anstelle von Schlagwörtern Fett oder etwas grösser

Do you mean in this survey? Or in the lab space in general? I try to use a system of borders around information that correspond to importance and provide digital copies for review at different text sizes if possible.

Gefahrenhinweise
Anweisungen auf Geräten
Zutaten/Inhaltsstoffe

Font size in instrument help files, for example, is almost always one size.

Schrift ist meistens zu klein

Our bottles of reagents have very small text that cannot be read. To much unusefull info. If you want to work with a dangerous reagent, you have to be trained. There is no sense in looking for a MSDS datasheet when the accident already happened

Auf den Chemikalienflaschen

Die Beschriftung einer Probe kann klein sein aber der Inhalt wichtig.

Typische Pharma SOPs. Voller Inhalt, keine Nuancen.

In your opinion, what parts of an instrument are often not accessible for all people (e.g. regular maintenance by the operators, ...)?

Number of responses: 22

Text answers:

Ölwechsel der Pumpen am Boden, Entsorgung der Abwasserflasche, sowie Auswechseln von Gasflaschen

Laufmittel auf den HPLCs

Sometimes screws are too small, areas needing access are built into hard to reach areas that can't be seen without mirrors or require multiple hands. Sound-proofed casings should be standard on more instruments (e.g., over loud rotary pumps).

the sample loading parts can sometimes be quite high

Mikroskope sind oft einfach auf einem nicht höhenverstellbaren Tisch angebracht

Back of fume hood can be hard to reach

In most cases, ALL of the instrument are not fully accessible for all people.

Often, full access to the sides and /or rear of the instrument is needed before the cover is lifted off upwards. None of that is easy for a physically disabled operator (e.g. from sitting position)

Liquid fill points on an NMR magnet. Access for bench top instruments depends on the height/adjustability of the bench and the space around it so this is the key are and not the instrument itself.

*Gashähne

vacuum, high voltage, fast moving parts, laser, radiation sources, toxic/irritant gases

Hintere Teile des Geräts. Ist aber meist Problem von Platzmangel.

switches are always at the back of an instrument - high benches mean this is not easily reachable for all

Anschlüsse von HPLC oder Massenspektrometern

Power Switch an Thermo iCAP ICP-MS ist für kleine Menschen schwer erreichbar.

the parts where the company likes to earn money by maintaining themself. All instruments should come with full explanation for self repairing.

Säulenofen, Autosampler, Ultraschallbad, Lösungsmittel

none comes to my mind

Display, Power Button

Oftmals durch Höhe limitiert (beispielsweise bei Rollstuhlfahrern oder kleineren Personen), Wartungen teilweise an Hinterseiten von Geräten, welche nicht leicht zugänglich sind

einige Pumpen in komplizierten Geräten

Die Rueckseite, div. Anschluesse dort

Netzstecker, Schalter von Pumpen

What improvements in hardware and software of an instrument are necessary to ease access and use?

Number of responses: 18

Text answers:

weniger oft benötigtes kann tief unten/ hoch oben sein, jedoch häufig verwdetes sollte eher in der Mitte der Arbeitshöhe sein
software sollte personalisiert werden können (schriftgrösse & Farbe)

Höhenverstellbare Tische

Easier hoover-over-text enlargement of specific cells/numbers/information, consider making systematic language (wording)/colouration for start and stop style operation choices. Avoid linking nomenclature to patents between instrument vendors. Making common maintenance areas more accessible from macro scale

(front of instrument, not behind many screws) to engineering with access in mind (e.g., size of screws, if possible).

Schriftgröße individuell einstellbar

Software: Context specific help written from the viewpoint of a user, not the engineer that built the instrument.

Software should allow bigger font

Software, autosampler tables: ability to copy and paste items within table, as well as rows of table. Consistency, Enter = down not across, tab = across. A scientific keyboard with a second number pad on the left hand side, the same as the one on the right for ease of entering data and or manually entering for autosampler table.

For most users it is the sample introduction/autosampler area that needs to be readily accessed. Not always possible with e.g. gas chromatographs.

*Grafische Erklärungen und Beschreibungen unterstützend zum Text:

emergency off bottom

Software ist meiner Meinung nach nicht intuitiv gestaltet. Es benötigt bessere Dokumentationen, wie man was macht. Das sollte in einer möglichst nicht-technischen Sprache geschrieben sein, damit Leute aus verschiedenen Disziplinen (Physik, Chemie, Biologie, etc.) die Anleitung verstehen.

Hardware should be stardardized. Often different companies have different configurations for same instruments, or even the same company for diferent models e.g., HPLC pump. Homogenizing it would be nice, could accelerate the training of an analyst. Same with software. Software also tends to have too many options that are never used. Too much information

text/font/screen colour/background colour options/text to speech

Good usermanuals, licence less software, open source software and the acquisition data musst be a csv data with very clear explanation.

Geräte weniger vertikal, sondern horizontal bauen, damit möglichst alles auf einer Höhe ist

Bei Datenblättern von Geräten nicht nur die Info der Dimensionen vom Gerät selber, sondern für Wartungsarbeiten dringend benötigte Dimensionen rund um das Gerät

Häufig fehlen Anwenderbücher (welche Funktionen wie bedient werden) sowie INformationen zur Hardware (wo sind welche elektronischen Bauteile verbaut und wie interagieren sie miteinander?)

Heb-/senkbare Tische, zugaenglich von allen Seiten

Can you use all the products that an instrument provider recommends?

Number of responses: 38
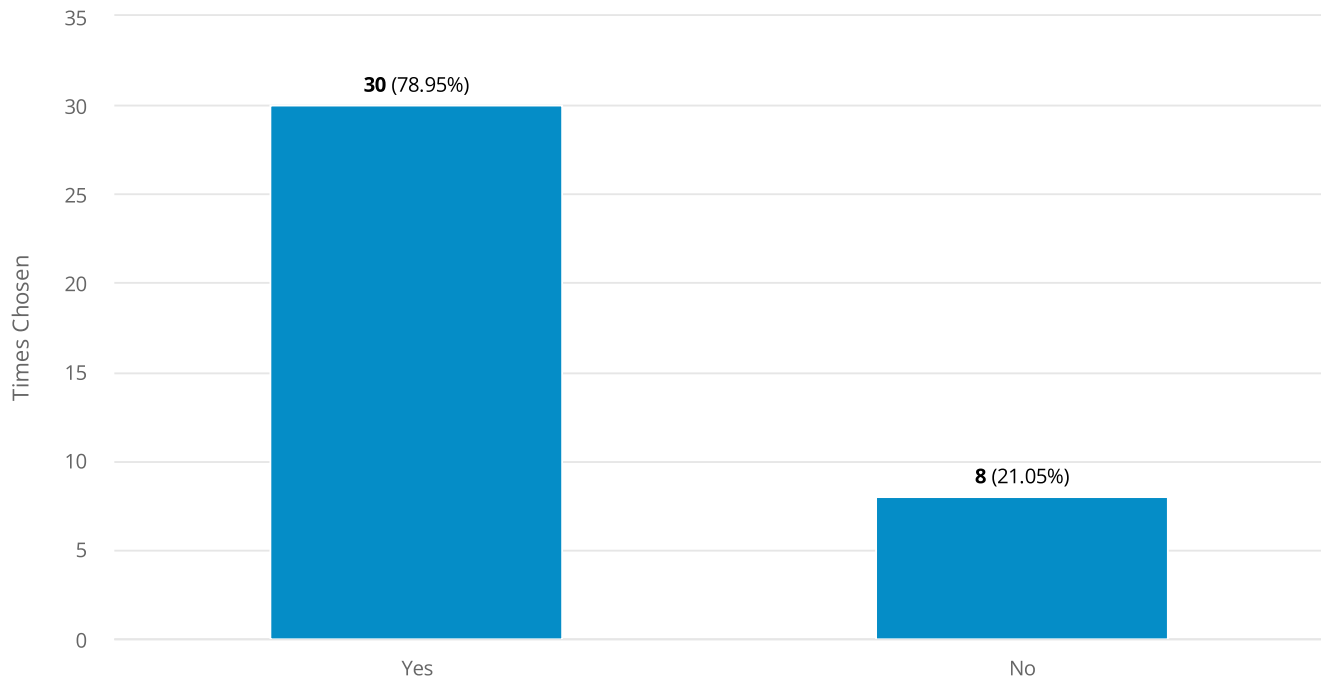
If no, give examples.

Number of responses: 5

Text answers:

Kästen lassen sich manchmal schwer öffen, va mit einer Hand

Sometimes use alternative sample introduction products (e.g., nebulizers for ICP-MS).

zu wenig Labormaterial vorhanden
Material ist zu hoch gelagert

consumables are often same quality but more affordable from other suppliers

Frage zu allgemein: es gibt so viele unterschiedliche Geräte... Ogtmals werden lange nicht alle möglichen Funktionen benötigt

What warning signs should occur to guarantee your attention if a fatal error emerges in your instrument?

Number of responses: 42
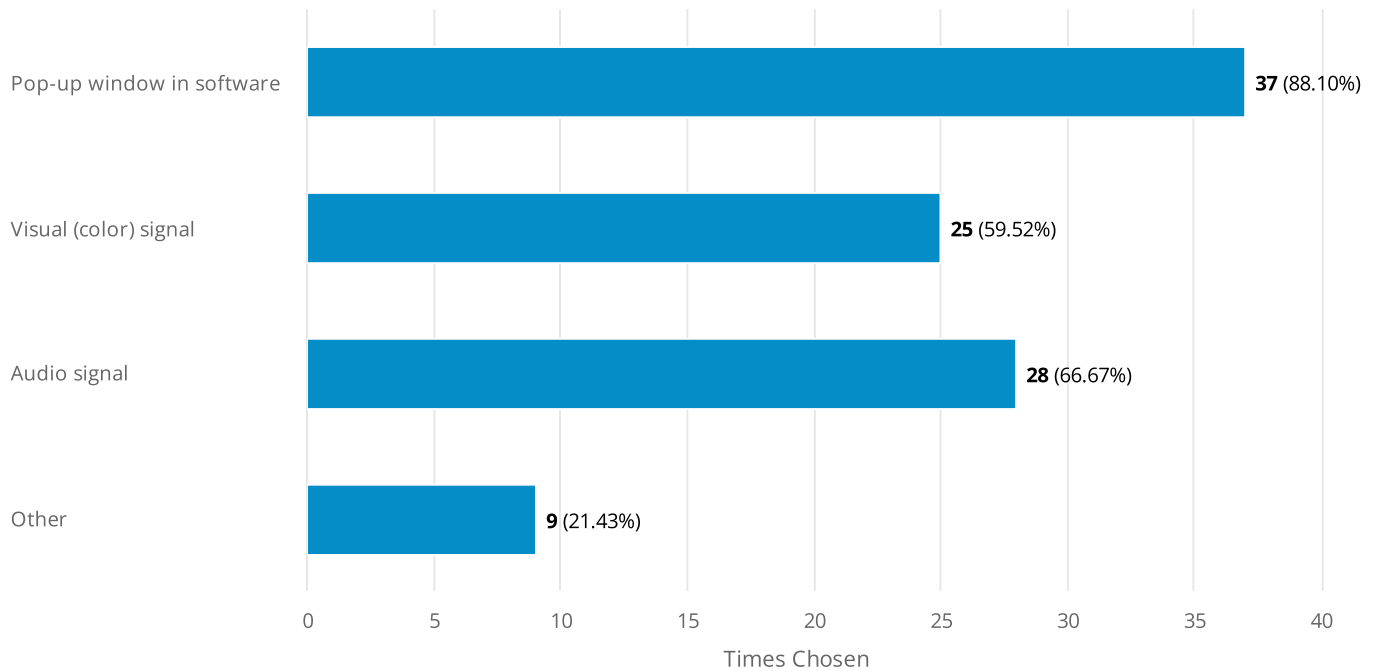
"Other" text answers:

Nichts anderes Klickbar, bis Warnung betrachtet und gelesen / akzeptiert wird

Vibrationsalarm

Smell

SMS!

For visual, the entire screen background should change color i.e., glow red

Textnachricht/SMS

an alarm in the phone (since we are not long hours at the acquisition computer during a measurement)

in remote operation mode, direct message to phone?

falls nötig: Not-aus

Did our questions, in your opinion, miss an important aspect of physical limitations and possible improvements?

Number of responses: 8

Text answers:

I'll send a separate email with some of my experiences. Thank you for doing this survey and thinking about these areas of science accessibility!

no

The need to use very specific tools and the ease of operating the tool. For example, could "quick disconnect" type fasteners be used instead of screws/bolts? Is the instrument designed with regular maintenance in mind or does routine maintenance require significant disassembly to access important components?

Note that lab safety equipment (safety shower, eye wash station) are often not easily accessed by persons with physical limitations.

Not that I can think of at present
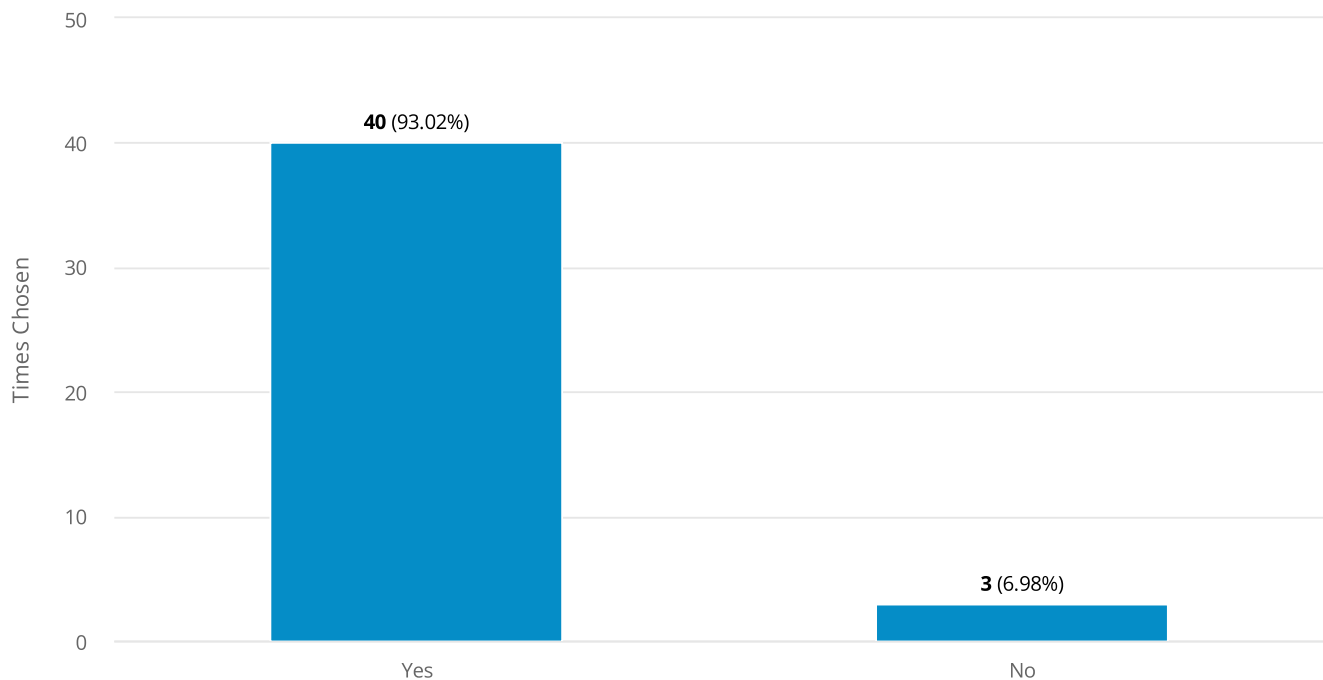
maybe the question would be relevant.
Can you combine instruments from different brands for measuring easily? like thermo fisher lc with agilent ms etc...

Nein

Senkung des allgemeinen Geraeuschpegels

Is raising awareness for disabilities in the workplace vital for a workplace with equal opportunities for everyone in your opinion?

Number of responses: 43

If yes, give suggestions to raise awareness.

Number of responses: 17

Text answers:

Bewusstwerden, dass es viele Arten der Behinderung gibt und diese besser kennelernen, da man oft nur von diesen Beeinträchtigungen hört, sie aber nicht wirklich kennt.
mehr über diese Beinträchtigungen kann helfen, solche Personen besser zu verstehen und zur sensibilisierung führen

Simply by actions, make changes that enables the required disabilities. Just talking about awerness is not the key to change.

Highlights on scientists that have worked in lab environments with a disability (assuming the agree to this) - representation can go a long way. Often accessibility issues are solved by individuals on an as-needed basis, but we don't share these stories. Why repeat efforts? Spread the experience. Save others time. Show others some disabilities don't need to be a barrier if they can be worked around.

Trivia/bingo night with questions/answers or suggestions for both raising awareness and making changes for disabilities in the workplace. Maybe some small free prizes for winners or even for participants

Einbindung der Personen in alles
Ihnen die Chance geben ihre Probleme zu erklären und danach daruf eingehen gemeinsam

Examining barriers to actually entering the lab (width of doorways, distance between obstacles in the lab).
Open discussion among workers to determine if they are experience difficulties with access instead of assuming that everyone is doing okay.

Encourage collaboration instead of emphasizing on production

Train and educate users, designers and of course management in the approaches needed to ensure access for all.

* Der/die Behinderte sollte niemals als solcher bezeichnet werden. Leute, die sich darüber lustig machen wollten aufgeklärt werden (kein Wegschauen).

ongoing staff training

Fortbildungen wie z.B. zum Thema "Barrierefreie Texte gestalten". Schon mit altersentsprechend nachlassender Sehkraft kann man die ppts junger Kollegen oft nur mehr schwer lesen....

In z.B. Gruppenmeetings über Behinderung nicht unteilend sprechen (i.e. es ist nicht abnormal eine Einschränkung zu haben).
Das Wort Behinderung ist sehr negativ besetzt. Meiner Meinung nach könnte man es z.B. durch Einschränkung ersetzen. Diese bezieht sich nciht nur auf körperliche Einschränkungen sondern auch psychische.

Workshops

In unseren Laboren wäre Arbeiten im Rollstuhl unmöglich. Abzüge, Gerätearbeitsplätze, Schränke sind nicht erreichbar. Ich wüsste aber ehrlich auch keine bessere Lösung, weil es schlicht nicht möglich wäre, alles auf entsprechender Höhe zu installieren. Schwieriges Thema.

Einen Aktionstag, an dem erfolgreiche Menschen mit Behinderungen Inklusionskurse mit den Beschäftigten im Labor machen, da zu wenige Bürger mit solchen Personen in Berührung kommen

hire more "disabled" colleagues, then all limitations become apparent and solutions can be implemented

Model appropriate behavior in the face to face discussion
Open discussion about the misconceptions and stereotypes about the people with disabilities

How much do you value the commitment of the leadership in science, in laboratory management, and from instrument providers to change the workplace to be more inclusive?
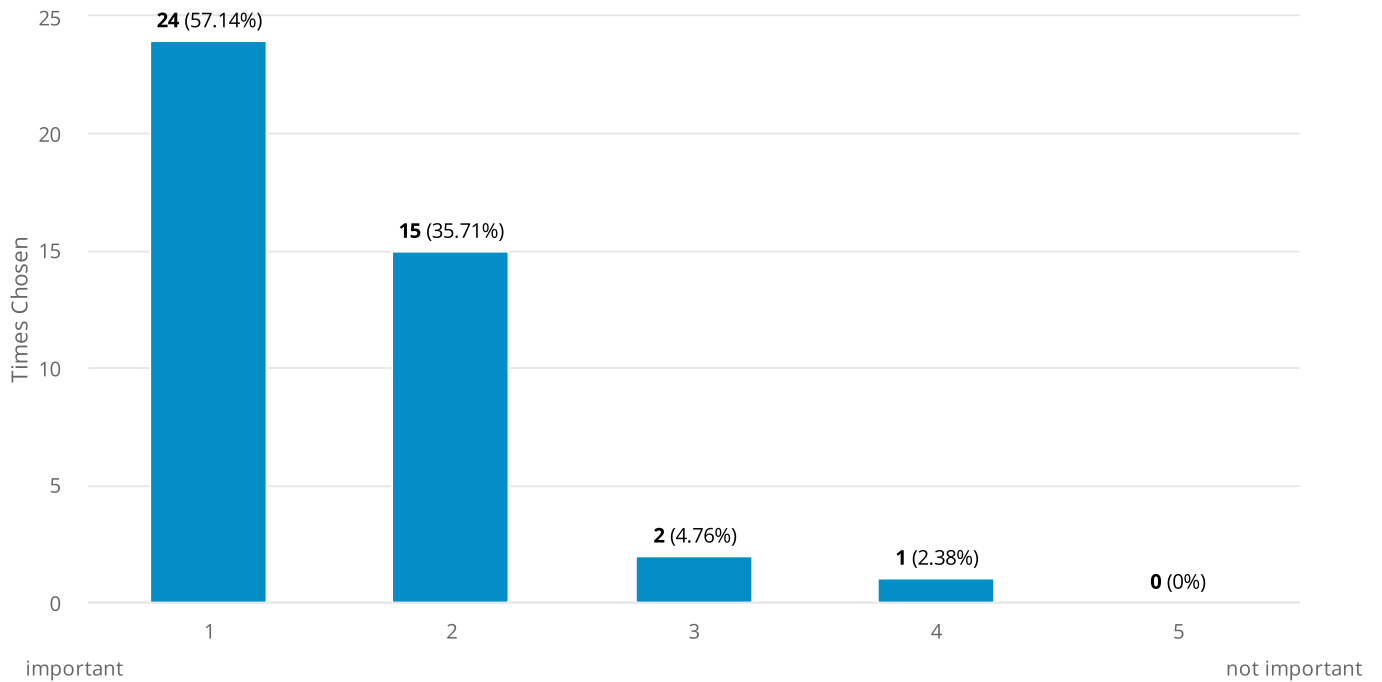
Number of responses: 42
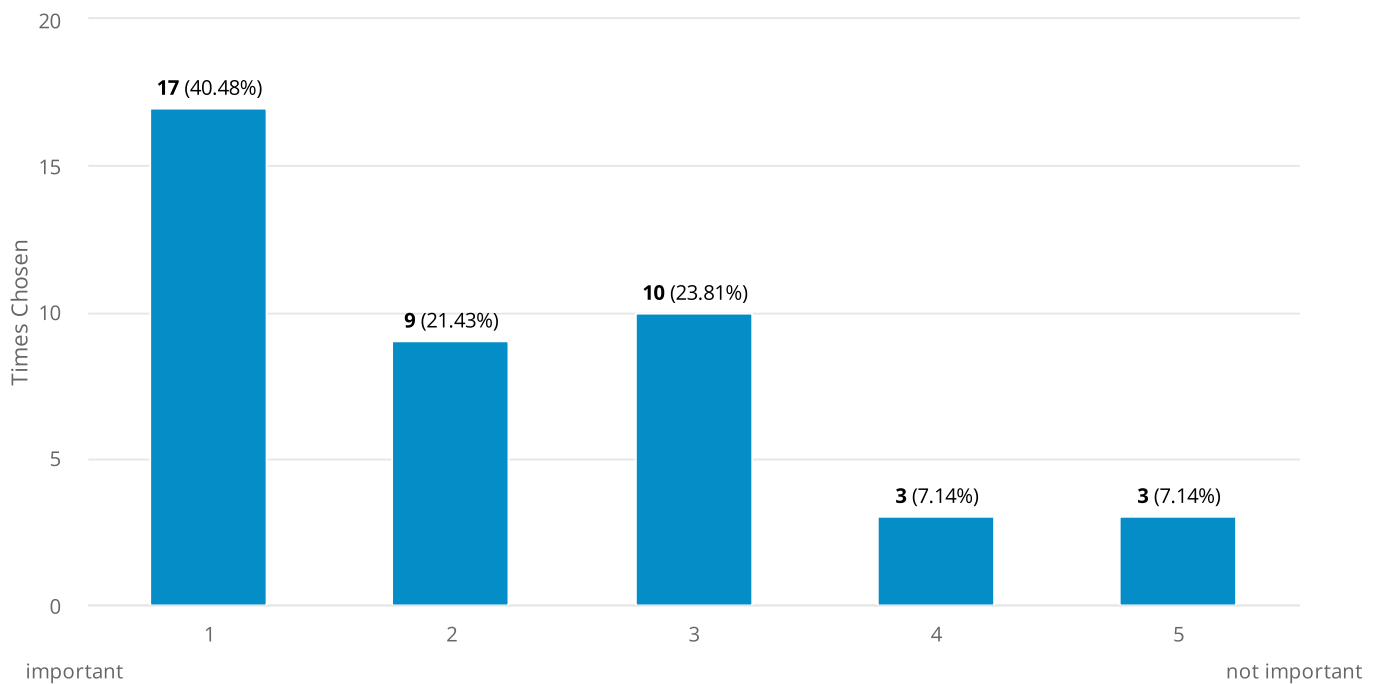
Is a commitment to inclusion in leadership positions essential and a necessity for the progress towards a better and more accessible work environment for everybody?
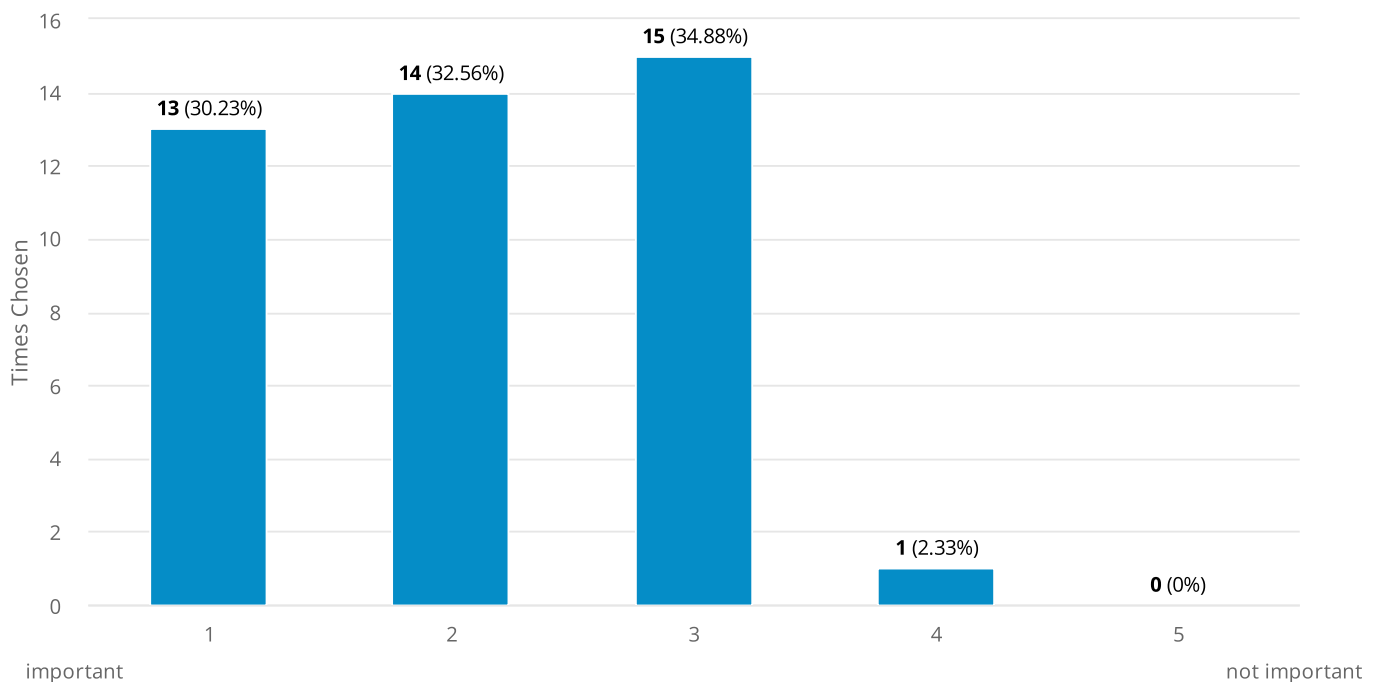
Number of responses: 42
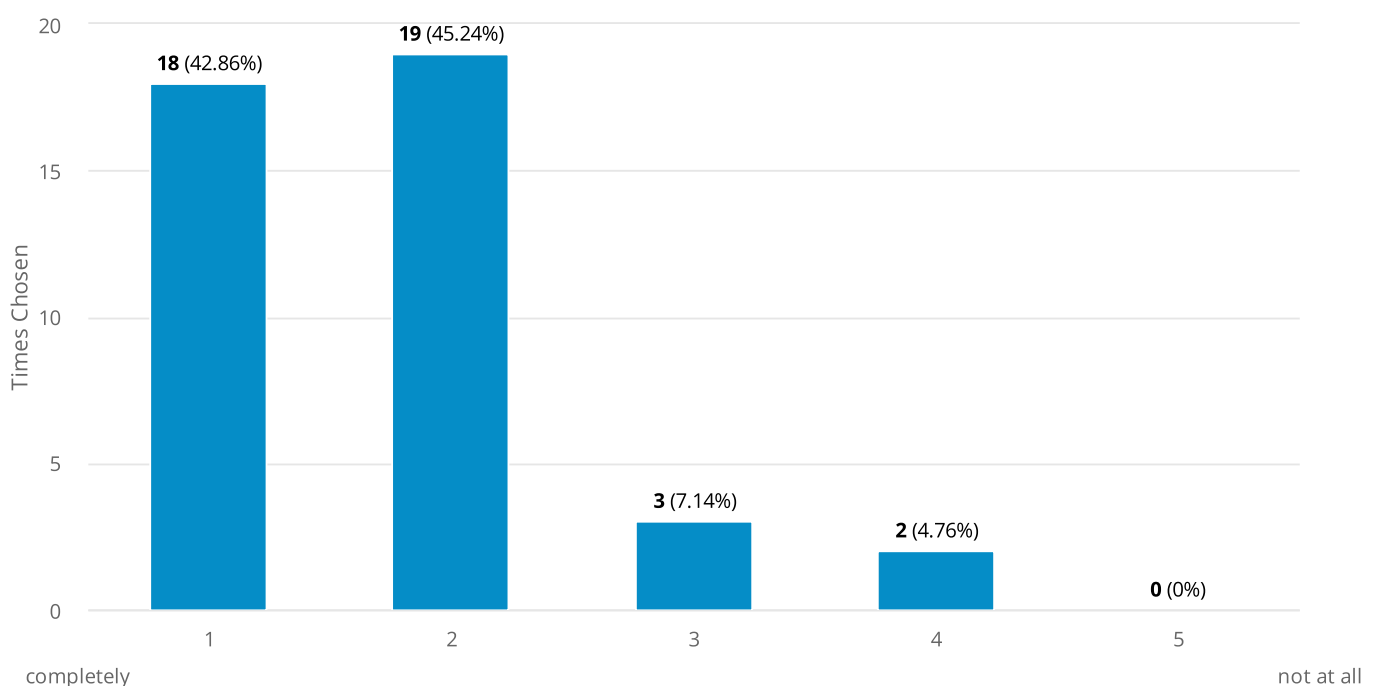
How do you value the importance to have a contact person or point dedicated to diversity and inclusion in your institution/company?

Number of responses: 42

How much do you value the conducting of workshops to improve innovations regarding the work environment?

Number of responses: 43

What arrangements and designs in instrument hardware and software lead to misunderstandings or confusion?

Number of responses: 13

Text answers:

gleich aussehende Knöpfe bzw kein unterschied, ob man etwas gedrückt hat oder nicht (kein Licht geht an, kein Geräusch ertönt und der Knopf geht auf Ausgangsposition zurück -> unsicher ob gedrückt oder nicht oder ob zu wenig stark, möglichkeit zweimal zu drücken etc)

Zu kleine Symbole, zu ähnliche Symbole, zu komplexes Softwaredesign

Different terminology (often proprietary) between vendors, toggle buttons where off and on are not clear.

kein einheitliches System oder Beschriftung vorhanden

Being unaware of the barriers that are faced by users "in the field". Not sure that manufacturers have ever put any thought into how the worker-instrument interface can be improved and made safe?

None come to mind at present. Good training for the user should mitigate/negate any design flaws.

* Unklare Fehlermeldungen.
*Fehlercodes die zu allgemein beschrieben werden.

too much low level error messages may cause that more important ones are overseen

Verschiedene Disziplinen sprechen verschiedene Sprachen.

bad users manuals and closed algorithms in data processing

when software is outdated and has to be run on virtual machines, for example.

Kommt auf den Hersteller an

Software Bugs, fehlende Schnittstellen Kommunikation

Is everything properly declared, labelled and, if necessary, explained at an instrument for easy recognition (e.g. buttons, switches, connections, ...)?

Number of responses: 41
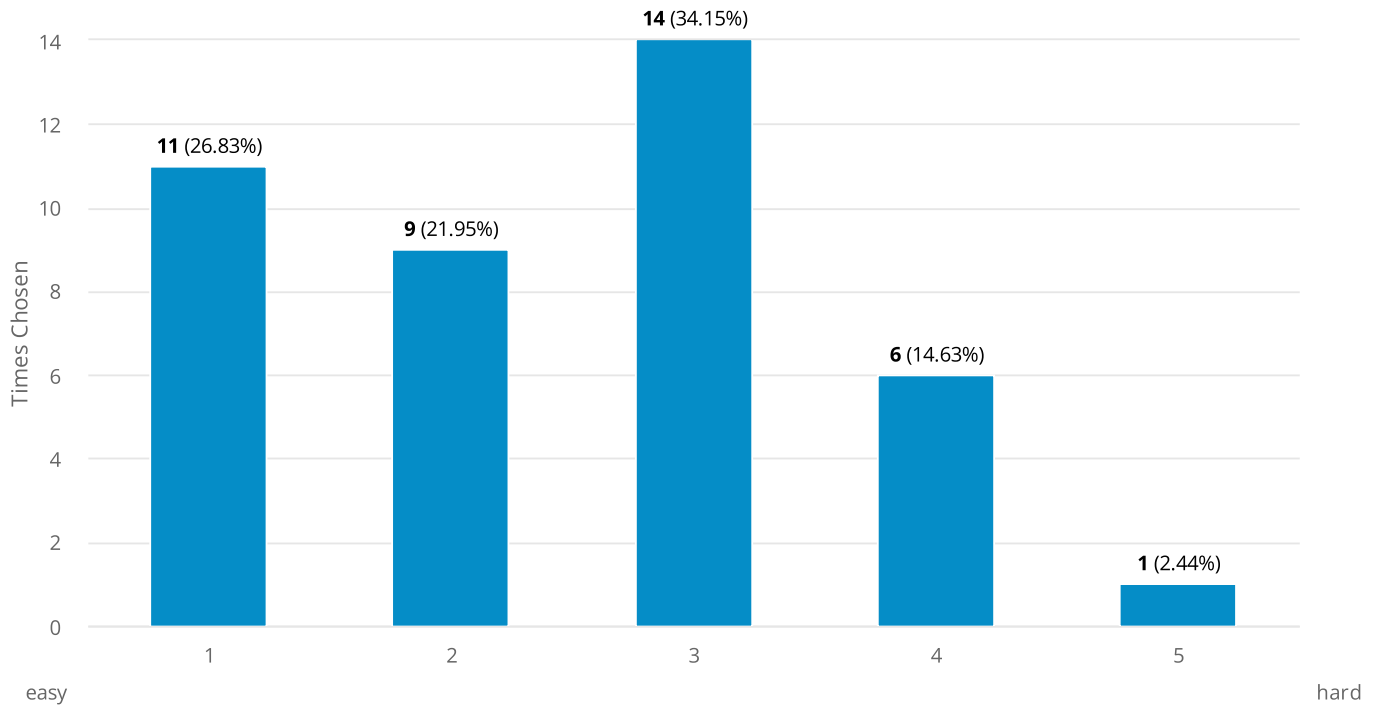
If not, give examples.

Number of responses: 10

Text answers:

Der Ein/Aus Schalter ist manchmal auf der Geräte Rückseite und deshalb schwer zu erreichen.

We often have to develop our own "cheat sheets" since this information is often not clear in manuals from vendors.

meist gar keine Erklärung

Unmarked buttons or buttons whose functions are not described in detail in the user manual.

*Häufig uu allgemein gehalten (häufig nehmen Hersteller die gleichen Beschreibungen für viele Subtypen).

that really depends on the particular instrument....

Es gibt Geräte, die ohne Doku geliefert wurden bzw. diese nicht nachvollziehbar ist (schlecht geschrieben).

clearing data/

Hängt sehr vom Hersteller ab. Analytik Jena hat beispielsweise unterschiedliche Große Fittings für die Gasversorgungen von Nebulizer und Sheath-Argon (ICP-MS), sodass keine Möglichkeit besteht, die Anschlüsse zu vertauschen. Grundsätzlich ist es sinnvoll, durch solche Maßnahmen an der Hardware zu verhindern, dass Fehler gemacht werden, wenn es nur eine Möglichkeit gibt.

not everybody needs to have the complete knowledge about an instrument, it is more important to have a go to person at the institution

Is the regular language used (in any form) for an instrument easily understandable for all personnel and users?

Number of responses: 41
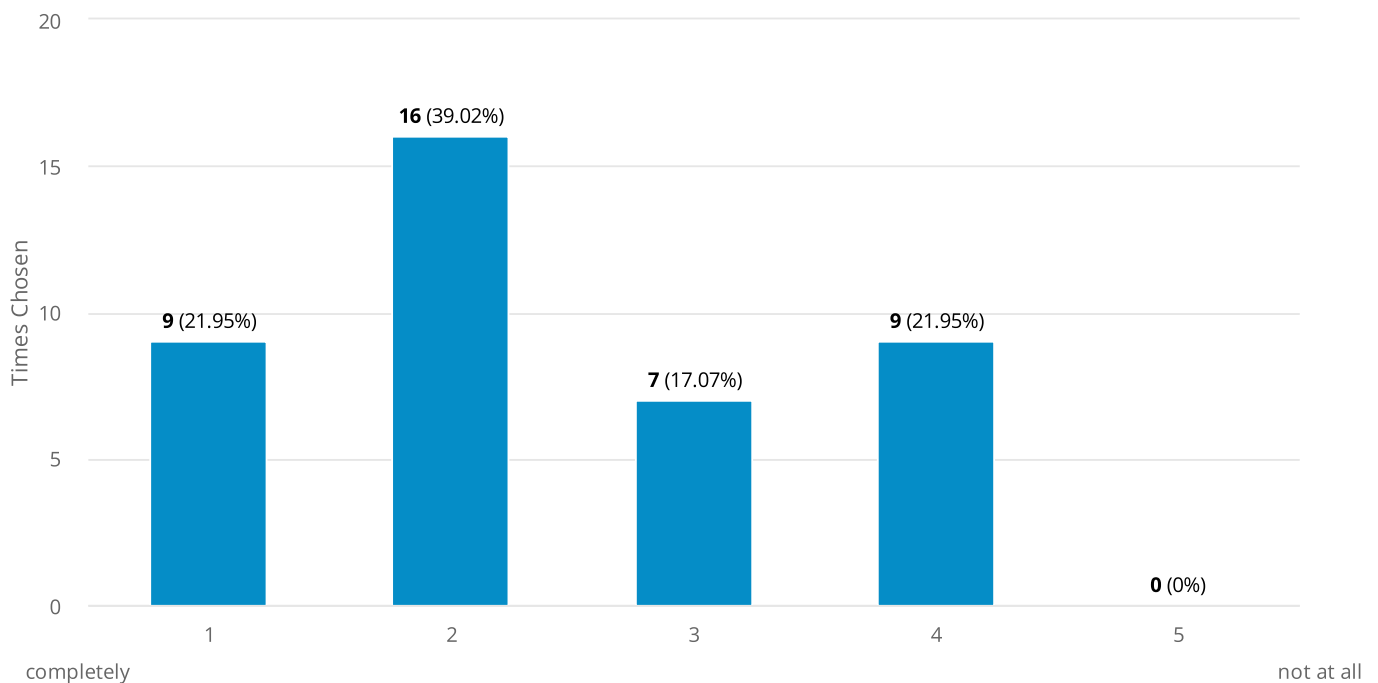
If not, give examples.

Number of responses: 11

Text answers:

Unsere Geräte sind alle auf Englisch, da wir Angestellte aus vielen Ländern haben, jedoch kann nicht jeder gleich gut englisch.

Some instruments and guides at the university are in German, making it difficult for non-German speakers.

Manuals sind of unstrukturiert und Arbeitsschritte nicht vollständig dokumentiert

Most people need to have proper training to use specific analytical instruments. Most of the instrumentation software is brand specific and different softwares use different definitions for the same thing, so it becomes specific to that instrument and not to the technique.

Some companies put more effort into user graphical design and accessibility in manuals/descriptions than others. Some produce nice videos to walk through parts of the instrument you can't see to facilitate understanding.

meistens nur eine Sprache und manchmal sehr "wissenschaftlich"

Manuals are often written from the perspective of the individual that built/designed the instrument, not a typical user in the field. Some language not understood universally, some operating details discussed without any context or background knowledge shared with the reader.

Often more technical than it needs to be (jargon)

This all depends on the training that users receive. A well trained user in a correctly working lab environment should have no problem understanding what the language used means.

Fehlermeldungen der allermeisten Autosampler und ICP-MS sind vom Durchschnittsanwender nicht zu verstehen. Mann muss wissen, was sie bedeuten und ob man sie ignorieren kann. Das ist aber ein grundsätzliches Problem seitens der Software, wo scheinbar nicht genug Entwicklungszeit in das Handling der Error Messages gesteckt wird.

mostly it is ....

Are explanations from the instrument providers about technical details clear and intuitive to understand?

Number of responses: 41
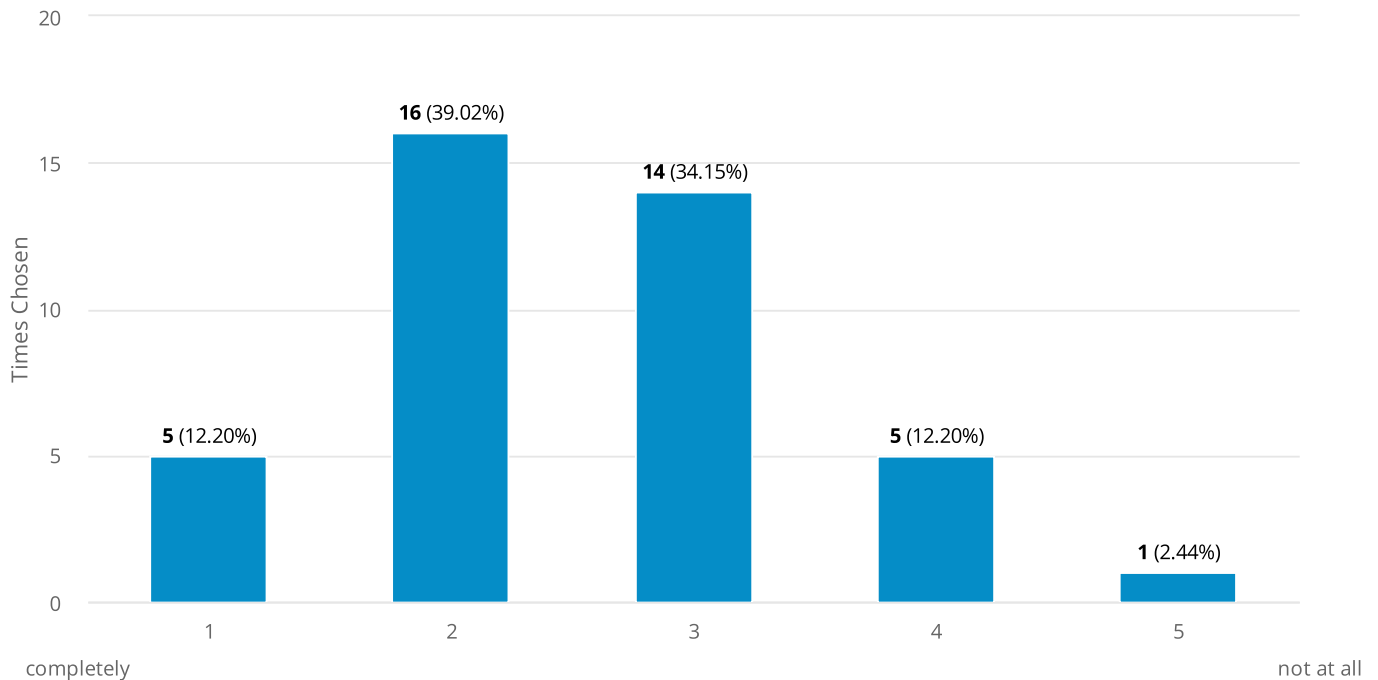
If not, give examples.

Number of responses: 13

Text answers:

im interaktiven Manual wäre ein kleines (i) hilfreich für Begriffe, die spezifisch sind und wichtig richtig verstanden zu sein

Depends on the instrument provider.

This ranges from vendor to vendor. For example explaining steps for cleaning/maintenance is often only done orally and is not written out, explanations of operation of computer boards on instruments is often very poor and only in the hands of service engineers. Rarely accessible without a very strong computer science background.

komplizierte Anleitungen oder Erklärungen die für die Geräteanbieter*innen klar sind, aber für Nutzer*innen nicht

Manuals are often written from the perspective of the individual that built/designed the instrument, not a typical user in the field. Some language not understood universally, some operating details discussed without any context or background knowledge shared with the reader.

Often surprisingly poor. Help files, for example, are typically terrible. They'll tell you that the 'plasma on' button turns the plasma on. Help files should be much more process-oriented. E.g. the user wants to achieve task X, the help file should describe how to do the task rather than what the buttons do.

This all depends on the training that users receive. A well trained user in a correctly working lab environment should have no problem understanding how to use an instrument. Requires that the trainer is experienced and knowledgeable and can interpret manufacturers words correctly. Manufacturers may need to use experienced users to translate manuals etc. into different languages.

error codes from instruments are often hard to connect to a specific failure. Same for OS.

hängt von der Firma ab, MAnuals der Firma Gerstel sind Positivbeispiele! Grafiken klar gestaltet, Text gut verständlich.

sometimes when software is updated, errors which have changed are not passed on - Stilla Naica usb software caused a pressure problem rendering the instrument unusable

Die meisten neueren Geräte sind anhand der Handbücher verständlich. Um allerdings clevere Workflows oder Methodenentwicklung im Sinne von Forschung zu starten, braucht es einen Kollegen/eine Kolllegin, der eine Geräteeinweisung gibt.

data processing algorithms are not always explained for non-targeted analysis by HRMS.

yes, after a while one gets the experience and can fill blanks by him/herself

Are specific terms used by the instrument providers well defined, well explained, and easy to understand?

Number of responses: 40
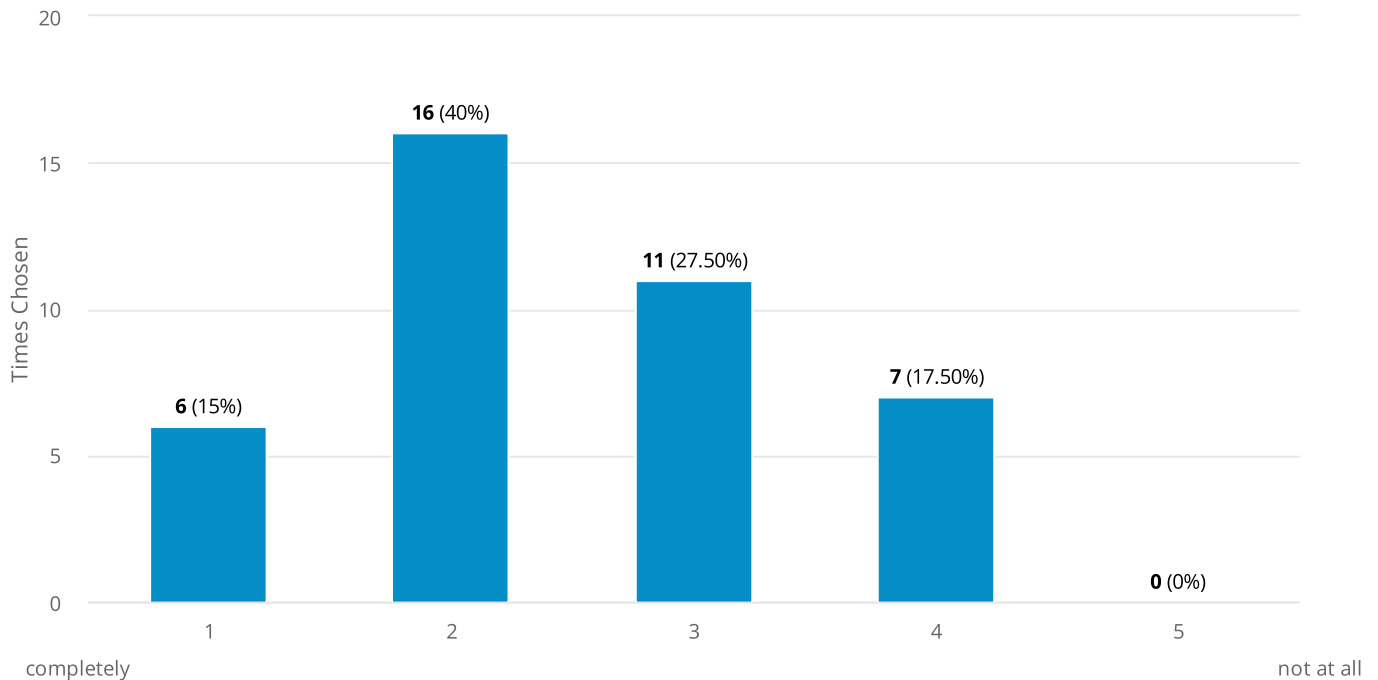
If not, give examples.

Number of responses: 7

Text answers:

> Oft nur einmal im Manual erklärt und dort teilweise auch verwirrend, da sie sich auf nichts beziehen. Beispiel wären hilfreich

> Depends on the instrument provider. Some providers are good at being clear with their definitions, others are more ambiguous.

> Cross-training between instruments can take additional weeks to months simply due to proprietary wording (batches vs. experiments), using different units such as counts vs. counts/sec, when someone knows instrument operation and principles but can't easily transition to new instruments for these reasons.

> meist gar nicht definiert

> *Die einzelnen Parameter im spICP-MS Modul von Agilent sind viel zu grob und kurz erklärt (z.B. Weighed Bin size, Peak integration mode, ...).

> If you really want one, here it is: Script error 0x8000a018 detected at line 89.
> Desctription: Object required, 'force cold restart'

mostly yes

Which terms, used by the instrument providers, are often misunderstood or open to interpretation by users?

Number of responses: 6

Text answers:

I can't think of any but them I'm a highly experienced user. Again, all should be clear if the correct training is undertaken.

*Integration time vs. dwell time

warranty

Names of custom technologies / patents. Every company names different the same fucntions

Sometimes will create a brand specific name for an already existing thing. e.g Cq values in real time PCR being called Ct or others depending on manufacturer

Reproduzierbarkeit

Did our questions, in your opinion, miss an important aspect of non-physical limitations and possible improvements?

Number of responses: 4

Text answers:

no

Questions on training; the importance of it and how much is received by users.

Bei einer Behinderung benötigt man öfters für die Dinge des Alltags und auch im Labor mehr Zeit als nicht behinderte Kollegen. Im Labor könnte es spezielle Geräte für Leute mit Behinderung geben, welche leichter zum Ablesen sind da diese größer und mit einer größeren Beschriftung sein könnten

Ja, psychische Einschränkungen. Depression oder Angststörungen sind Teil des Alltags vieler Menschen. Diese Probleme sind nicht nur durch Verbesserung von Infrastruktur oder Technik zu lösen.