# *Improving the visualization of the Career Compass tool*

Graduation project Creative Technology

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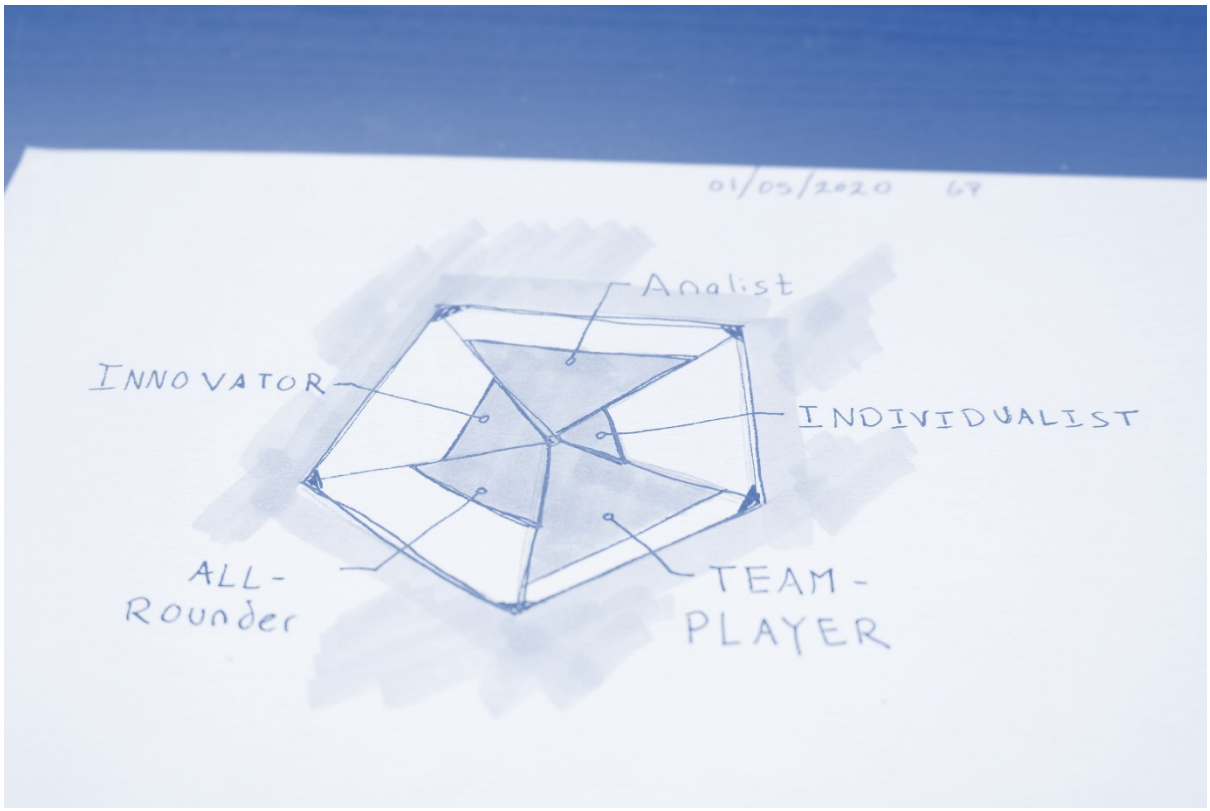


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## Abstract

Many students start out with a technical program but drop out. To aid the development of the professional identity of students and to help raise these new technical professionals, the Career Compass has been designed. In this research, the topic of visualizing the data and the manipulation of the data to increase clarity is covered. For both steps, participants were asked for their opinion and to input user data in order to gain insight on these aspects. Multiple designs were constructed for both the visualization and data manipulation, supported by user interviews.

The conclusion for this research is that the design of the tool can be improved through design principles, which can aid the transfer of the information towards the user.

# Acknowledgements

De scriptie die voor u ligt is gemaakt met de support van mijn vrienden en familie, en in het bijzonder Geanne die me elke dag weer motiveerde om lekker aan de slag te gaan. Ook wil ik mijn dank uitspreken naar de huisgenoten van het prachtige HBB, waar het altijd goed toeven was – ook als ik tijdens Corona de hele dag met jullie thuis mocht zijn. Een speciale dank gaat uit naar Maaike Endedijk, bij wie ik deze opdracht mocht doen. Ook mijn dank voor Job Zwiers, die me prikkelende vragen stelde en me verder hielp.

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# Chapter 1 – Introduction

Our world revolves around technology and science, and many aspects of our life depend on it. Almost every subject of our life is connected to science, technology, engineering and mathematics, otherwise referred to as STEM (Ryan, 2018). In the coming years, the amount of STEM-careers should be increased (National Science Board, 2007) (Smithsonian Science Education Center, n.d.), as the current amount of STEM students and professionals is insufficient.

To address the gap where students do not successfully enter STEM-careers and drop out before graduation, earlier on an initiative was taken in the form of the project 'Bridge the gap'. In the literature, this gap is also referred to as 'the leaking pipeline' (Torraco & Hamilton, 2013). Through that project, a Career Compass was designed, a tool to aid students in their professional development as a STEM-professional. We aim to improve upon this tool by examining the visualization of the tool results that are presented to the students. The impact of the visualization as exists of right now in the tool has not been examined with their users, and leaves room for improvement. Another aim is to assess the different possibilities to visualize and support the data presented to the students, to increase self-assessed motivation of the student and to possibly address the lack of role-models through a visualization supporting this Career-Compass.

Important factors in this project are that there is a bridge to be gapped between students who are studying within STEM-education and actual STEM-professionals. Many students find themselves disconnected from the STEM-field and lack a connection to the subjects within their education (Holmegaard, Madsen, & Ulriksen, 2014). Another issue is that there are misconceptions around STEM-education and careers, one of them being that STEM features a non-inclusive work field (Doerschuk, Bahrim, & Daniel, 2016), leaving hardly any room for non-prototypical STEM-professionals.

The aim of the 'bridge the gap' project is not to adjust the educational system itself, but rather to address the students and relieve them of possible misconceptions that they do not belong in the STEM-sector. To this end, a tool had been developed that, through a large number of questions, give feedback on five different sectors in the life of a student (Hattum-Janssen & Endedijk, 2017). From a study connected to this tool it could be concluded that the so called "nerd-profile" was highly connected to STEM-careers (Endedijk, Veelen, & Möwes, 2017), and that a more non-prototypical student is less likely to aim for a technical career in the STEM-sector. It is therefore of importance to address and relieve students of misconceptions – prototypical and non-prototypical alike. To further address the motivation of these students and investigate on how their image of their professional identity (PI) can be address through the visualization of the results of the career tool, it is of interest to research the following question:

*How can the visualization of the Career Compass tool be improved?*

With the following sub questions:

*-Which type of graph is most suitable for displaying results on personalities?*
*-How can data visualization be manipulated to increase clarity but maintain sincerity?*

We take a look at the design of the Career Compass according to a number of design principles, after which we investigate the self-assessed Career Clarity / Identity clarity of students and we compare by means of interviewing the differences between the existing version and our new version of the design of the Career Compass.

Lastly, conclusions were made through the use of the first assessment of the graphics and the second research of the data manipulation, after which a final design was made to presented to the client.

# Chapter 2 – State of the Art

To improve upon the existing visualization that is present in the Career Compass tool (CC), first two items must be reviewed to give inspiration and guidelines for the design. First, the motivation of students for STEM education must be reviewed to assure the correct and complete guidance that the feedback tool must offer to address the motivation, and secondly the characteristics of a good and complete feedback tool which offers proper information in a correct visual style must be taken into account to form an improved design for the CC. This is done through first looking at literature about these two elements and then taking a look at existing tools similar to the career compass to review their design.

## *2.1 Review of Literature*

**What does literature say about the visualizations of feedback tools for the career compass or similar tools in general? What should a feedback tool do to make it a good feedback tool?**

According to de Vos (de Vos, 2017), who conducted research on the Career Compass itself, it is of great importance that the design of texts as presented to the student should be according to the signaling principle, segmenting principle and also the personalization principle of Mayer (Mayer, 2009) who underlines the important aspects in the use of multimedia principles. Mayer states that it is the instructor's job to not only present material but to also aid the learner's cognitive processing of the presented material. In this material he also touches upon the following statement: "People learn better from words and pictures than from words alone" (p.1). Mayer covers twelve multimedia principles, used for design as shown in the figure below.

These twelve principles were reviewed within the research of de Vos towards designing the Career Compass, and from the twelve principles six were selected as the selected forms of multimedia for the compass would not include narration (figure 1). The principles for multimedia, spatial contiguity, temporal contiguity, signaling, segmenting and personalization were considered into the design for the Career Compass tool. Her conclusion was that the students' professional identity should make use of *texts and images* to stimulate maximal understanding of the feedback, which is a shared conclusion with Mayer who claims that image and text have an advantage over just using text to stimulate deeper learning.

What can be considered feedback? According to Hattie and Timperley (Hattie & Timperley, 2007) feedback can be defined as "information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" (p. 102). Feedback can be either corrective to prompt change or be affirmative to not prompt change (Gilbuena, Sherrett, Gummer, Champagne, & Koretsky, 2015). Corrective feedback can also have two possible functions: to facilitate or to direct (Black & Wiliam, 1998). Directive feedback informs the recipient of what must be corrected, whilst facilitative feedback will guide the recipient towards his or her own revisions.

**Mayer's Principles for Effective Multimedia Design**[3]

| Multimedia Design Principle | Description |
|---|---|
| 1. Coherence | No irrelevant or extraneous words, pictures, sounds. |
| 2. Signaling | Provide cues such as highlighting, circles, arrows, etc. to signal essential words or organization of concepts. |
| 3. Temporal Contiguity | Present corresponding narration and animation simultaneously not successively. |
| 4. Redundancy | Avoid redundancies (images + narration + text). Go for (images + narration or images + text) to reduce extraneous processing. |
| 5. Spatial Contiguity | Place corresponding words and graphics, as well as feedback and responses, close together (i.e., not on opposite sides of the screen). |
| 6. Segmenting | Present learning materials in learner-paced segments that are broken down into smaller chunks. |
| 7. Pre-training | Provide explanations of key concepts in a lesson for beginners. |
| 8. Modality | Consider types of words and images that pair well (e.g., text and graph vs. on-screen text and video). Students learn better with narration and graphics than with on-screen text and animation. |
| 9. Multimedia | Words and pictures are more effective than words alone. |
| 10. Image Principle | The speaker's image on-screen does not enhance learning. |
| 11. Voice Principle | Superimposed voice presentation enhances learning. |
| 12. Personalization | Use a conversational/personal tone (first person: "We are going to…" vs. "Today's lesson is…"). |

Figure 1: 12 Multimedia Principles according to Mayer [source: https://journal.opted.org/article/interactive-multimedia-learning-vs-traditional-learning-in-optometry-a-randomized-trial-b-scan-example/]

One factor that influences STEM students' career decisions is professional identity (PI). "A stable and well developed PI has been shown to keep students on the career path towards the STEM sector" (Möwes, 2016)(p. 1). Gati, Krausz & Osipow (Gati, Krausz, & Osipow, 1996) define three difficulties that could occur during the process of forming a career choice: the lack of readiness, the lack of information and inconsistent information.

The motivation for students to join STEM education can be caused by prior experience and interests within science and math (Wang, 2013). Wang also suggests that motivation can be caused by math and science education in high school and that a certain social background and parental education are influencers on the motivation. Another source suggests that childhood experience only is beneficial for some students, but not for all (Tolstrup-Holmegaard, Møller-Madsen, & Ulriksen, 2012). Other sources suggest that mentorship, support from peers and an overall sense of community contribute to the motivation, which is especially of importance to minorities (Edwin, Prescod, & Bryan, 2019). Next to this, there are also personal contexts like positive emotion and personal development that lead to motivation for joining STEM education and careers, but also societal contexts like helping others, interacting with others and impacting the world (Lee, Capraro, & Viruru, 2018).

## *2.2 Review of Existing tools*

To improve the design of this tool, we look at the existing tool (Career Compass, n.d.) and other available tools to review their design options. A look is taken at the Career Compass as it exists as of right now, and another tool with similar feedback characteristics. A critical note must be placed as the Career Compass does not focus on *choosing* a career but is there to assist the user into *developing his or her own professional identity*. It is then difficult to compare this tool with a study choice test, but for the sake of visualizing personal data and guidance, it could be worthwhile to review these other types of tools.

### *2.2.1 – The Career Compass Tool*

Through the Career Compass tool, students get an insight in their own professional identity. After having filled in a number of questions, a result from the test emerges which gives the student feedback on his or her score. The five different types are presented, and these are related relative to where they fit towards 'you', the student (figure 2). The distance towards the center displays how well the profile corresponds with your responses.

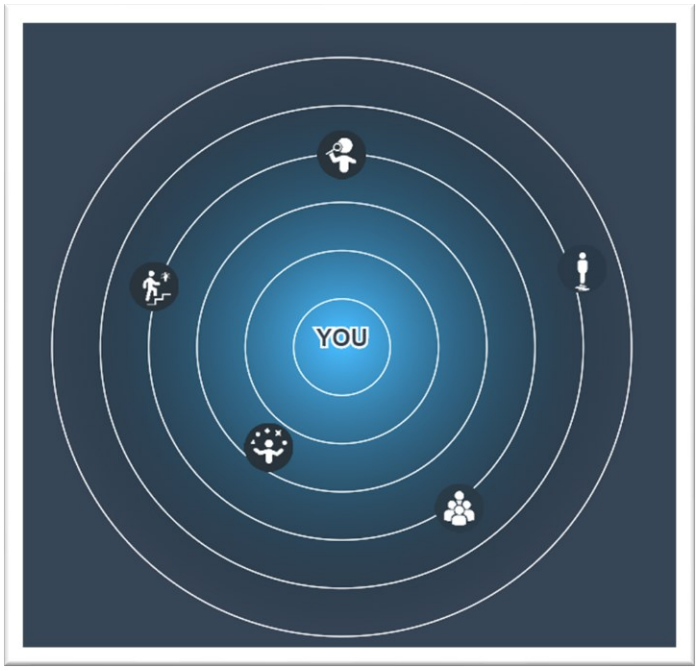



Figure 2: Ring-diagram to show the proximity of characters to 'you' – the student who filled in the test.

When scrolling down from figure 2, the student is able to see what defines the type of character that seems to fit that user the best. This is done through a text which specifies the characteristics of the profile that is best for the user, whilst the other profiles are also present upon clicking the specific icon.

Next to this visualization, also a reflection is given on the personality of the student next to some other characteristics. The blue graph (figure 3) represents how you score on the different sub-elements within the category, and the yellow line represents the average of students who have filled

in the tool. The tool concludes with a page in which the follow-up steps are given for a student on how he or she can further develop the professional identity and in what ways this can be achieved.

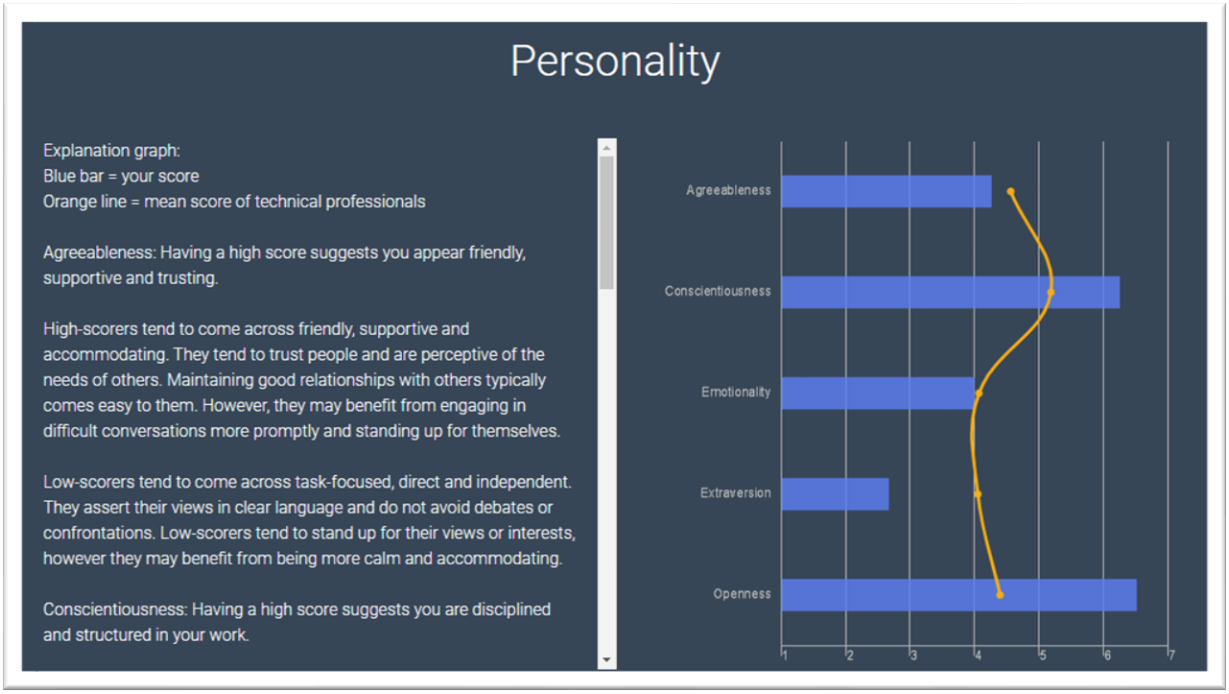



Figure 3: An explanation of the tool to further dive into the material, and to compare own results with the mean (yellow line).

Within this research, the focus will lie on the design of figure 2 (the initial figure with which students are presented at the beginning of the tool) and not with the elements as seen in figure 3. Next, we take a look at how other personality tests go about their design.

### *2.2.2 – Intermediair beroepskeuzetest*

First, we take a look at a tool which is similar in outcome and questions. This is the Intermediar Beroepskeuzetest, which will give the user feedback about his/her personality type. In this light, it is similar enough to review and see what design is used.

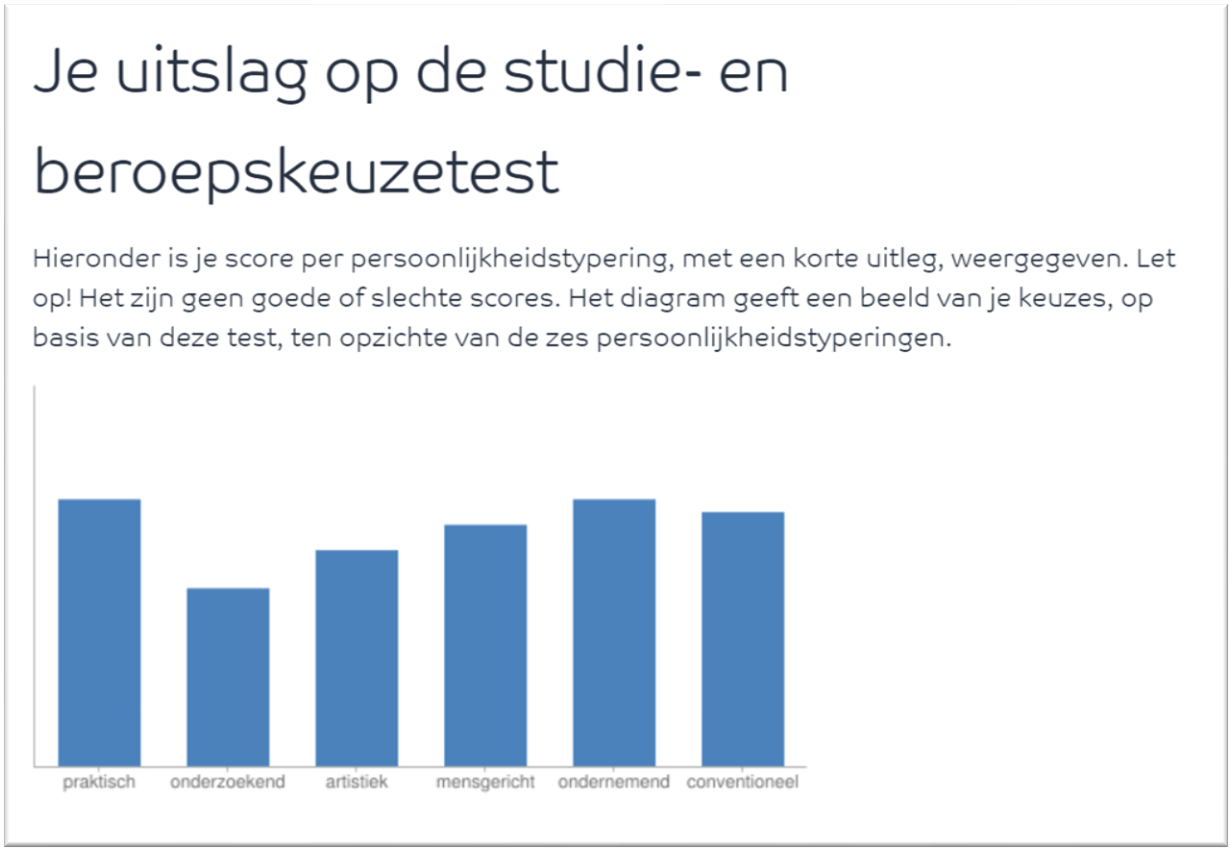



Figure 4: Results from the career tool.

The Intermediair Beroepskeuzetest (Int. Beroepskeuzetest, n.d.) makes you fill in 60 questions based on your preferences. The result from these 60 questions, which are all based on a 4 point likert-scale, gives a graph of which of the 6 personality types you resemble the most, as seen in figure 4.

After the graph, all of the different types are mentioned and explained, after which couples are made of two personality types. These combinations can be used as a reference after having seen the personal results. For example, the items 'praktisch' (practical) and 'ondernemend' (entrepreneurial) can be combined to form an advice as in figure 5, where examples of careers and studies are mentioned which are applicable for the specific set of two characteristics. Next to the bar graphs, this website does not feature any more visualizations which stand out to the user. The bar graphs also give a relative score, meaning that it is readable which characteristic is the strongest but not by how much or if this is a generally high score overall.

| Combinatie | Beroepstypering / Voorbeeldberoepen / Studies |
|---|---|
| Mensgericht & conventioneel | Mensen helpen, verzorgen in combinatie met organiseren, op orde brengen of regelen van gegevens, activiteiten of omgeving. |
| *Voorbeeldberoepen* | Bedrijfsleider, Maatschappelijk Werker, Manager, Project manager, Personeelsadviseur, Sociaal Pedagogisch Hulpverlener, Rechtshulpverlener, Helpdeskmedewerker, Leraar Basisonderwijs |
| *Mogelijke studies* | Lerarenopleiding Basisonderwijs, Pedagogiek, Verpleegkunde, Maatschappelijk Werk en Dienstverlening |

Figure 5: Combination of personality traits.

From these combinations, one could see the type of career one could end up in, examples of careers and studies that go along with those interests. An upside of this tool is that it is easy to use and fill in, and the answers are concise with a clear direction of what to do with the information. A downside is that the tool is not automated to a point where the important information is filtered out for your outcome and that the visualization is very limited.

This tool features a bar graph to show the different personality traits and gives a textual explanation to show following steps and possible careers.

### *2.2.3 – Examples of visualizations of personality tests*

Another type of personality test is the DISC-test (figure 6) (DISC, n.d.). In this test, the user also fills in a questionnaire which corresponds with specific personality traits towards someone can be oriented. The test can give you scores for every personality; and whichever score is highest gives you the best-fitting profile.

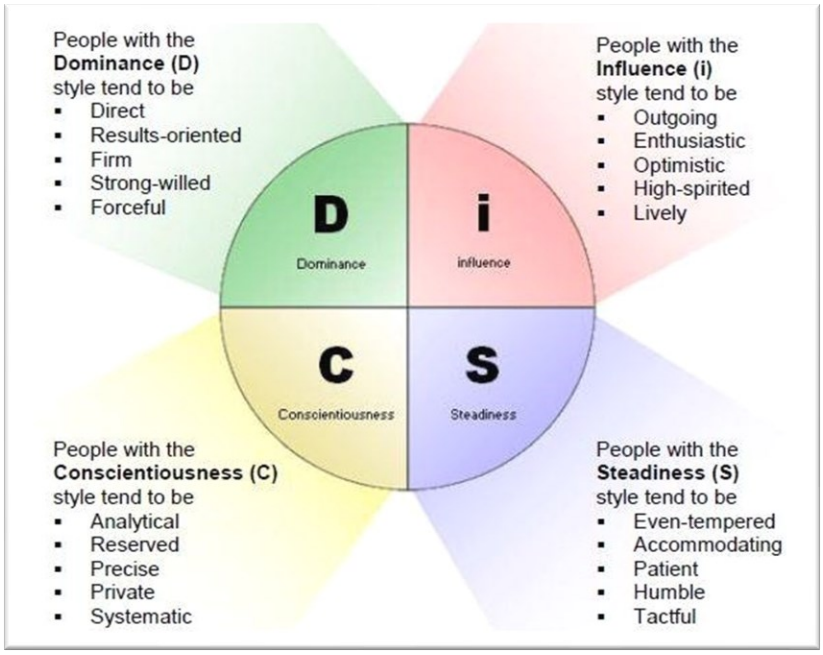



Figure 6: DISC personality test

The Myers-Briggs Type Indicator (MBTI) test (figure 7) is another test which can show certain values and personality traits to the user through the use of a series of questions (MBTI test, n.d.). This is displayed in certain 'scales' whereas for example 'extravert' and 'introvert' are opposing scales on which a user can be in the middle of. This can represent certain balance or skewness in the data that the user has presented to the system, making the user aware of the different traits (and also which ones oppose each other).

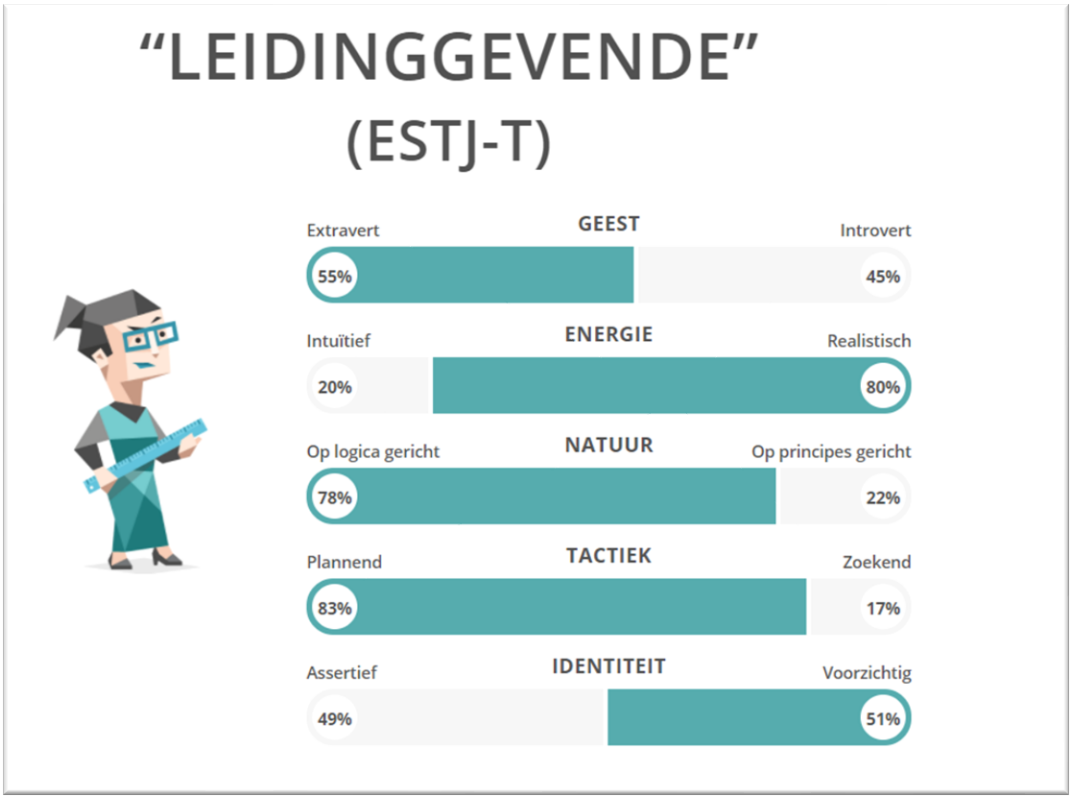



Figure 7: Outcome of the MBTI test

The last example is the 'E scan' from a Dutch company that is supposed to give the user a 'photograph of you as an entrepreneur' (figure 8) (Inmoerdijk E-scan, n.d.). This test is focused on business and does not necessarily learn the user much about himself next to his professional attitude but could aid the user in discovering his/her professional identity.

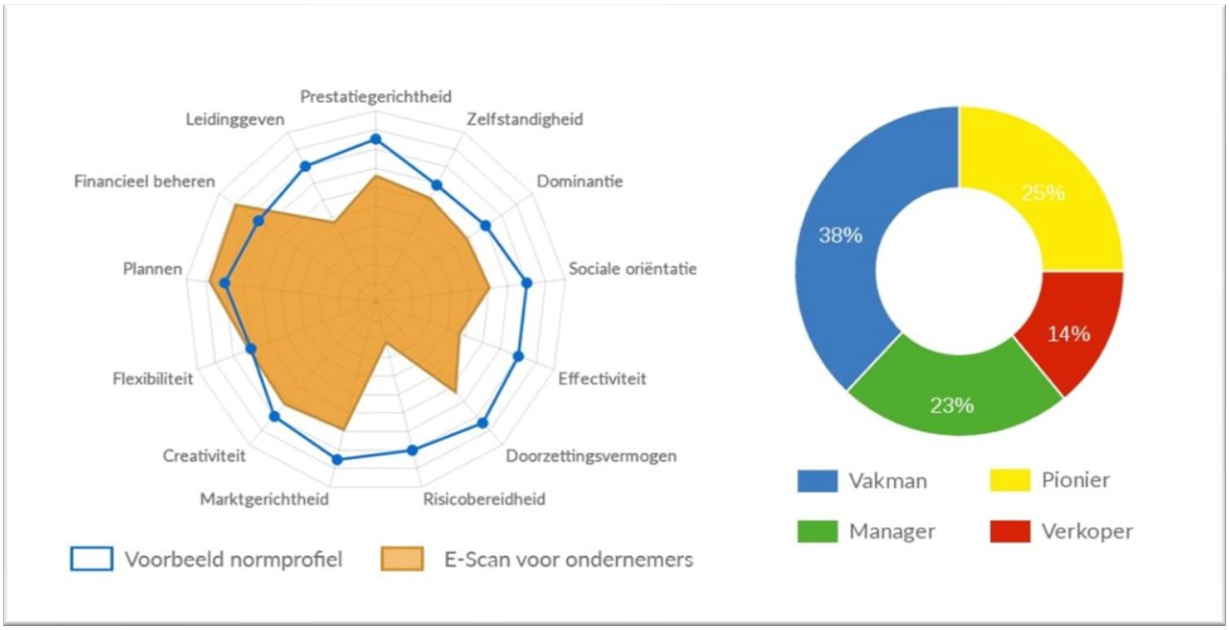



Figure 8: Personality trait test outcome

This tool makes use of a spider chart and a pie chart to differentiate the different personality traits and strengths. Also, a difference is made between a normal profile (blue points on the left graph) and the results from the E-Scan for entrepreneurs (orange figure on the left graph). The pie chart on the right determines which style of businessperson fits to your profile the best and is supported by the percentages.

## *2.3 – Research on the Career Compass and its design*

Already, a solid amount of research towards the design and visualization of the Career Compass has been done, to find out which methods could be used. From research conducted by Smidt, a number of visualizations was tested with participants and their reactions were captured (Smidt, 2020). From this research, it became apparent that two types of visualization stood out for the participants of the study. The first visualization style was the radar chart (figure 9). Later, in her final design and how the current visualization of the Career Compass looks like, the radar chart was 'reversed', placing 'you' in the middle (being the student) and having the items closest to the center being the most fitting to the student (figure 2).

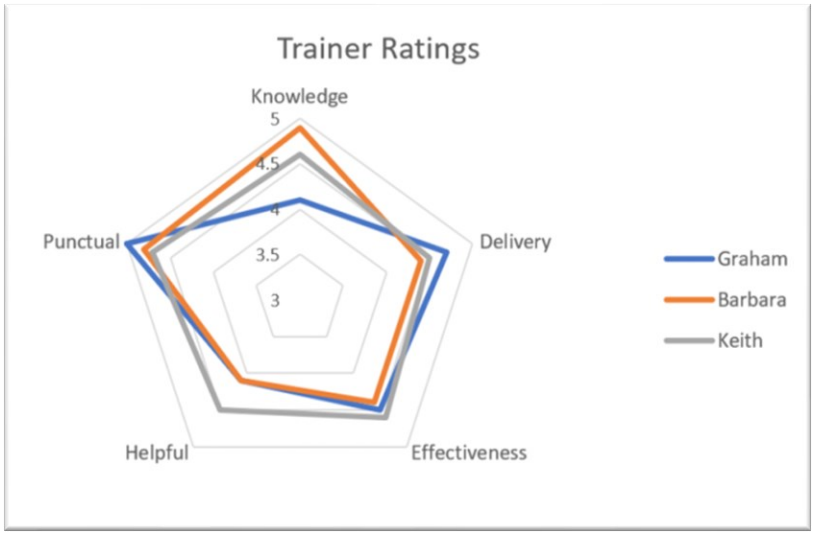



Figure 9: Example of a radar chart

Another element that was researched by Smidt was the bar chart. This bar chart also proved to be of interest towards her participants. Within her version of the design and how the design looks like now, the bar chart is used for the explanation of the different sub-dimensions which are present in the tool (figure 3). It has not been made clear, however, why the bar-graph cannot be used for the main five personalities.

## *2.4 – Conclusion for further research*

From literature, not a great deal can be concluded for this specific situation in which advice is given and insight is shared into personal characteristics. However, research suggests both that students can be motivated through prior experiences with math and science, and that – if made personal – these insights can help the student developing his or her professional identity. There is no consensus on how all students can be approached through a single method, so it cannot be concluded that one approach towards students is the best, but through mentorship and role-models many can be motivated to join STEM education and careers.

What was also discovered is that within visualization the methods of Mayer can be of great help within the design. Next to his publication, no peer-reviewed methods for visualizing personal data have been published which are of importance to this research. The methods of Mayer will be considered, next to the design examples which were reviewed in section 2.2.

One element that seems to occur in most personality tests is that all information is shown within the visualization, and the graphics points towards the specific elements that stand out for the user. One could debate on the relevance of all other characteristics, when they do not specifically apply to the user as this opposes one of the principles from Mayer, but this could be investigated further to draw conclusions.

# Chapter 3 – Initial ideation

To start out with the idea phase and to more align the expectations with the ideas, an initial ideation is done. In this initial ideation, certain ideas towards the improvement of the visualization and the tool are considered, and at the end a conclusion is drawn towards which idea should be best for the continuation of this project.

The initial ideation features the three following ideas (figure 10):

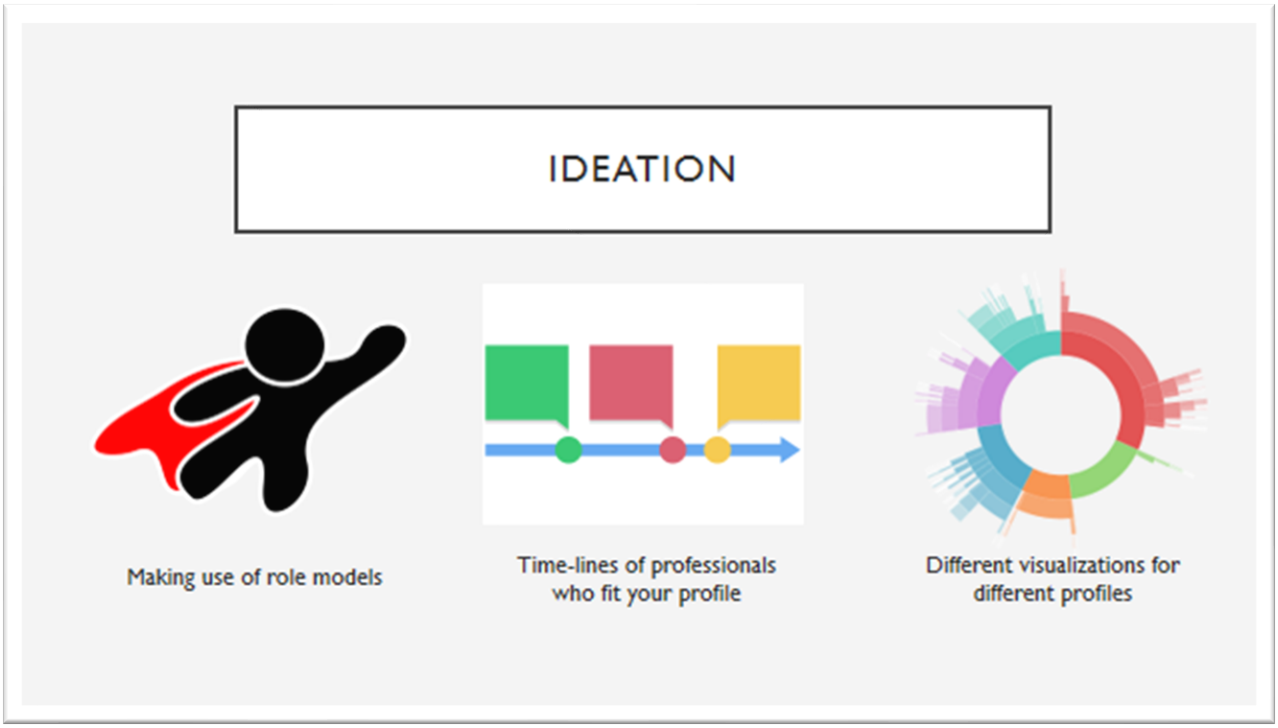



Figure 10: Initial ideation for the improvement of the Career Compass

One of the first ideas was to expose student to role models. These role models could be incorporated within the tool or could be portrayed after the students would contact the tool and receive his or her score. By identifying with one of these role models, a student could possibly boost his/her confidence.

Second, the idea of using timelines of professionals who fit the students' profile was created. In such a timeline, the route which the professional took towards his or her growth in professional identity would be visualized to give the students a guide towards how they could develop such a path for themselves. The idea is that the students will not necessarily make the same decision but learn which choices one could make in order for them to develop themselves in their professional identity and give them a sense of direction.

Lastly, to further build upon the Career Compass as it exists now, different visualization for different profiles could be generated in order to improve the overall impact. Right now, every student with every profile receives the exact same visualization style. In order to adhere to the initial idea of students who have different profiles – namely that they work in different manners and take information in different ways – it could be interesting to investigate whether or not different visualizations work better for different profile groups.

These three different ideas were presented to the client and coordinator, on which they replied that these ideas would need much work and would be non-fitting to ongoing research in the short span of a bachelor graduation project. In the end, it was chosen to continue with the latter idea of adapting the visualization. This could be one step too far to begin with, as not much research is done on the initial design of the CC itself, which might first need investigating. After this, it could be interesting to look into the different visualizations for different profile groups, but this will not be touched in this research.

# Chapter 4 – Requirement capture / Initial specification

For the initial specification, it is important to understand the goals of this Career Compass. The goal of the compass is described in the following terms, which the user sees when he or she enters the tool:

> *The Career Compass provides insight into who you are as a professional. This is important as it will help you in making career choices that are right for you.*
>
> *The Career Compass exists of four dimensions: your personality, interests, values, and competencies. Thereby it provides insight into your characteristics as a person, your interests in daily life, the things you find important in life and which competencies you believe you have. Click on the 'Dimensions' button to find out your score on each of the four dimensions.*

This covers the basic aspect as how it should come across towards the user. For the functionalities and other elements, we performed a MoSCoW analysis (figure 11).

| **Must** | **Should** |
|---|---|
| Provide user with professional identity feedback.<br>Make use of a graphic to display scores of different profiles | Show which profiles fit the user and do not fit the user<br>Be coherent to the 13 profiles of Mayer |
| **Could** | **Would Not** |
| Contain animated graphics to increase clarity of the profiles<br>Be adaptive – contain a different method to display graphics for every different profile outcome of the tool as some graphic styles might appeal more to certain profiles. | Be a complete working prototype |

Figure 11: MoSCoW analysis for the initial specification

Then for the initial specification, we can conclude that the tool must provide insight in who the user is as a professional through the use of graphics to display scores of different profiles. These should show which profiles fit the user and do not fit the user and should be corresponding to literature.

# Chapter 5 - Designing and improving upon the current design

The earlier mentioned design principles of Mayer have been taken as our leading example, as they are one of the much-researched items that are very much relevant in modern-day multimedia design. His principles are based around 'learning', which he defines as 'change in knowledge due to an experience'. In the case of the Career Compass tool, a certain way of transfer is hoped to be achieved that does not only imply rote learning (learning through repetition) but rather meaningful learning where knowledge can be applied after it has been learned. He talks about multimedia design, which covers the design of images in combination with text. Mayer suggests that there is a great benefit in using images in combination with text rather than just using text.

When we took a critical look at the design of the existing Career Compass, a critical assessment with help of the twelve principles of Mayer was made. Many elements that exist in the tool right now could possibly be improved through the use of these design principles. One element that seems to be neglected is the principle of narration. According to Mayer, narration has great impact within deeper learning and understanding of multimedia and could be used to great advantage. Within the prior research by de Vos and Smidt, reasons for avoiding narration were that research on narration varied in outcomes (Tabbers & Rob L Martens, 2004), but the implications for use are evident and can therefore be applied within the prior testing of the design of the updated Compass.

Two principles that Mayer stresses are:

1. The coherence principle – people learn more deeply when extraneous material is excluded rather than included. This implies that information which does not add to the material that should be learned should rather be removed as it will only lead to an increase in the cognitive load, which does not benefit transfer.
2. Spatial contiguity principle – people learn more deeply through putting information near pictures rather than further away. Mayer suggests that the continuous movement of the eyes looking for the right information will reduce transfer, and that information should be moved as close to the image as possible.

## *5.1 Career Clarity*

Another important element within the design of this tool is Career Clarity**.** Career clarity is an important element within the development of the Professional Identity and can be described as: "Defining yourself, your potential careers and how those two concepts fit together" (Aeseducation, n.d.). Jane Jackson Careers describe it in a series of questions which can be answered after getting a clear description of 'career clarity' (figure 12) (Jane Jackson Careers, n.d.).

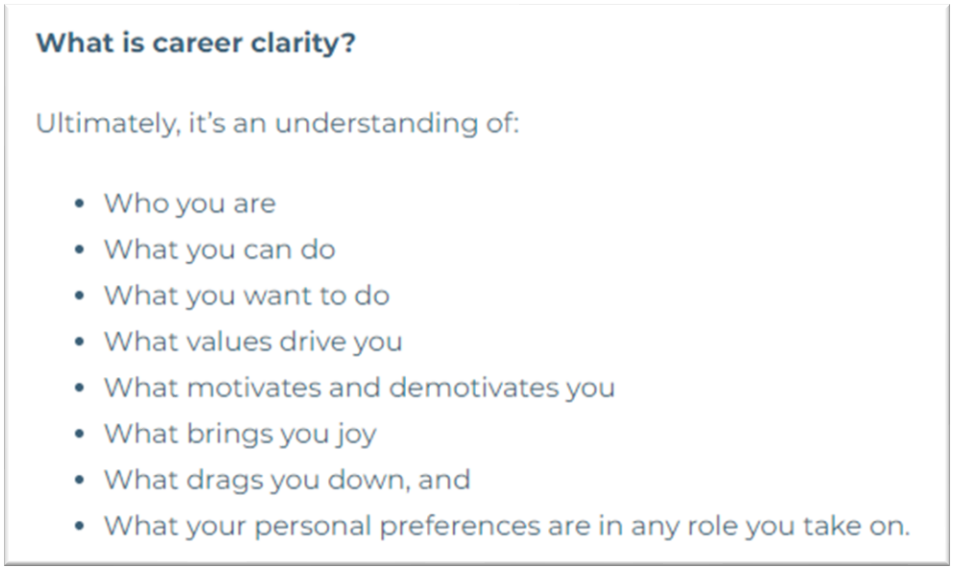



Figure 12: List of questions which can be answered through Career Clarity

## *5.2 Ideation*

To start out with the creation of design, first sketches were made on paper to illustrate various methods of design. According to every principle of Mayer, in combination with already researched methods by Smidt (Smidt, 2020), new designs were made which could fit better to the principles of Mayer, as some elements seemed to be insufficiently implemented.

It could be of use to try and see if narration could benefit the transfer of this graphic and this tool. This could mean little more than bringing selected graphics to the front and taking the user through that specific element, telling him/her why this fits the user/why it does not. One practical implication that could be mentioned is that for every user, recording and sending the information to the user is a task which would require great computing power, but this problem could be overcome by designing and pre-recording standard texts, as they are standardized right now in their textual form. Mayer does suggest that when using a voice for narration, a human voice trumps a computer-generated voice when it comes to information transfer and learning.

One form of design that could be in the middle of taking the user through the tool step by step and narrating the information, a look can be taken at the design that Spotify creates yearly for their users. Every year, Spotify releases 'Spotify Wrapped' which presents the user with personalized data (Nanduri, n.d.)(figure 13,14).


Figure 13: Spotify Wrapped visualization


Figure 14: Spotify Wrapped visualization

This design makes use of a number of principles by Mayer, including signaling (providing cues such as highlighting, circling and making use of colors), segmenting (presenting different types of information on different pages with a different style to let the user determine the pace) and spatial contiguity (proving the image and textual information close to each-other).

From these design requirements and through inspiration of existing apps, an initial design session was created. Within this session, five participants were individually interviewed about three different designs of the Career Compass feedback which can be found in the following sections.

## *5.3 Technical details*

The design of the Career Compass will be made in the standard web format with an aspect ratio of 16:9. This is done because the standard design of the Compass has also been made in such a format and the use of an application for mobile phones has not been suggested yet by either research or client. It could be of use to investigate whether or not the transfer of the Compass is affected

through the use of a webpage sized tool or a smartphone sized tool, but this will not be addressed further in this research.

## *5.4 Designing prototypes*

For the design of the first visualizations, the tool Adobe XD was used. Other sketching tools were first used to make primary designs and for ideation purposes.

### *Design 1:*

The first design consists of a slightly adapted version of the already existing design, but now the radar chart is no longer inverted but consists of a normal size radar chart. Next to the elements of the chart, the profile-types are always visible, not just when clicked upon. Visual cues direct the user to the profile which suits them the most and this is also the first visualization – next to the chart information with personalized text is shown to the user.

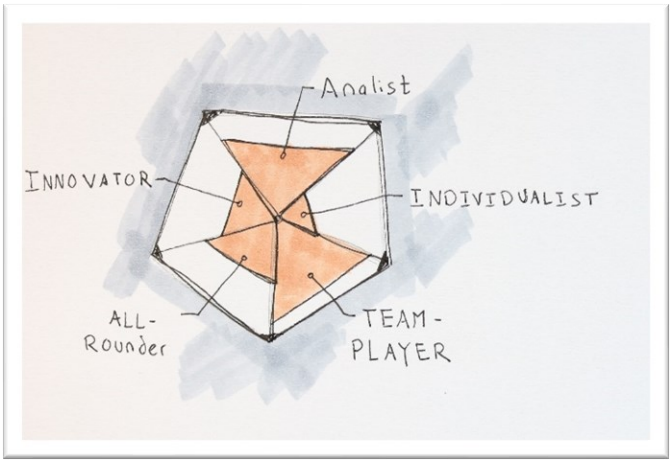



Figure 15: A pentagram shape to represent the different profiles and their sizes in sketch form

From the sketches (figure 15), the following two designs were made. Next to the graphical element, the text was put on the same page on the right side of the visualization.

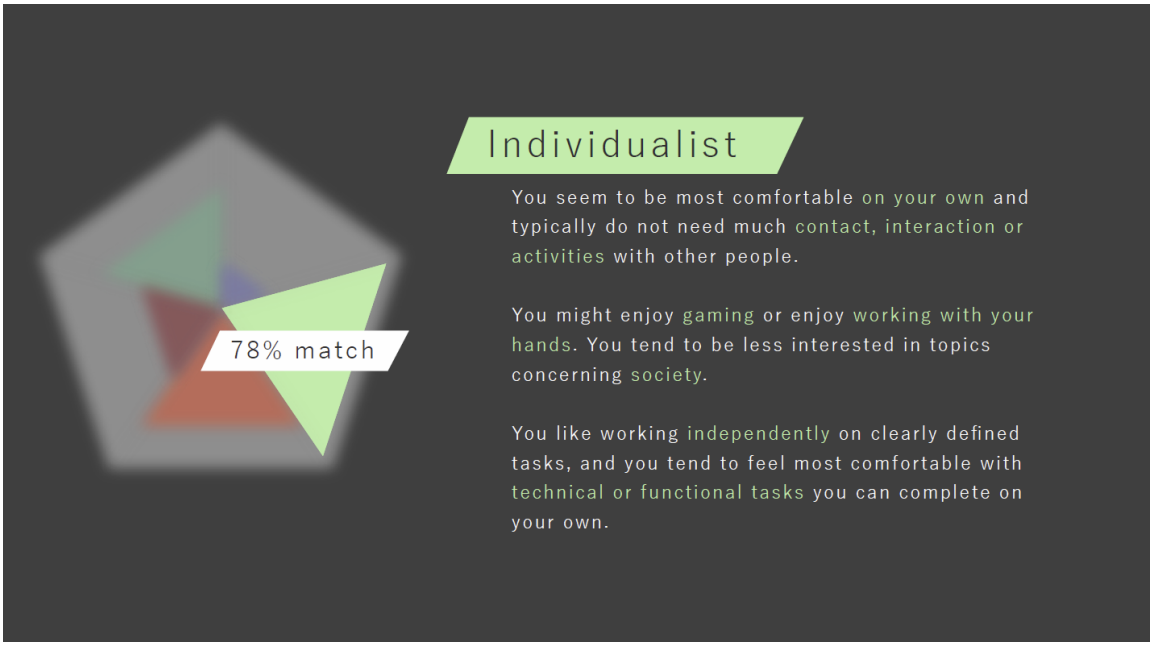



Figure 16: Visualization A1


Figure 17: Visualization A2 – different color pattern

This design was mainly made to keep the spiderweb – circle diagram but to change the characteristics of the original graph. Within this graph, a larger surface means the profile fits better to you. The figures shown above (figure 16, figure 17) show the final screen that is seen in adobe XD. Before this, all five triangles start out in the middle of the figure with different colors but with equal surface area. After clicking, the figure opens up and makes every triangle a different size according to the score of the user. The differences in color were to depict the contrast between the different profiles and to see what style users would prefer.

### *Design 2:*

This design is the original design of the Career Compass tool and is unaltered. This is to compare the original design to the new designs and see what elements in the original design are good and which ones could be improved upon (section 2.2.1 – Career Compass tool). This design is also referred to as design B.

### *Design 3:*

In this design a novel item of narration is added. The choice was made to test this feature, as this could unveil new opportunities for the Career Compass. Next to the text on screen, a voice guides you through the information and shows you the same data, but now the information is also read to the user to possibly enhance learning. Next to narration, a style which closely resembles the style of design 2 (original design) is used, but with additional features such as added tags to the profile icons with the names of the profile and text written on the right side with underlined words (figure 18). This design is also referred to as design C.


Figure 18: Design C

## *5.5 Designing an interview*

Next, a series of questions were prepared to ask to the participants. These questions are based on the prior design criteria for the Career Compass, prior questions asked in the research by de Vos (Vos, 2017) and questions based on the twelve design principles of Mayer (Mayer, 2009). These include questions about color, animation, text, and general points of improvement. Prior to the research, participants were asked to sign a consent form, which can be found in Appendix D.

The main goal of this interview was to discover which elements of the design principles that were introduced in the new visualization were appealing to the user and which should be improved.

At first, the participant would be explained what the nature of the research was and what the question-section of the CC looked like. This is to make sure the participant understands where the

data for the graphics come from. Next, the participant was explained that there are five profiles students could relate to, next to the fact that no-one truly corresponds fully with one profile, and everyone fits to a certain extent to a profile.

Next, participants would be shown the first design. The participant would receive ten seconds to get a first impression of the design and after these ten seconds they would be asked for their initial response. This is to get a first impression of the student and see which elements directly cause confusion or clarity, and what attracts the user to the design. Next, the participant is asked a number of questions on the design. This process is repeated for all three designs.

Lastly, the user was asked to assemble his or her favorite design based on what could be seen in the previous three designs and perhaps some elements that he or she would like to see.

This research was conducted digitally, through the use of videoconferencing and with signed consent of the user. The questions asked for this interview can be found in Appendix A.

## *5.6 Results interviews regarding first research*

Based on five interviews, the following points of improvement could be introduced. These five interviews were held with four male and one female participant, all between the ages of 19 to 22. All were students from either the University of Twente or Saxion school for applied Sciences in Enschede. Their responses were written down and the relevant answers were selected in the following sections.

### *Color and styling*

A number of participants mentioned that the actual colors of white and blue could be described as ‘boring’ and ‘dull’. Not all participants mentioned that this was distracting or not attractive enough. Participant 4 also mentioned that the actual scheme of colors can be described as ‘business-like’ and fits the style, although it was also mentioned that colors could benefit the user. The colors used in visualization A1 (figure 16, pg. 26) were perceived as attractive and guiding the eye of the reader. One participant also mentioned that the use of colors could attribute towards more guidance of the user and to make it easier to distinguish icons by guiding the eyes towards the most important elements.

### *Text*

Two participants found that the text in the original visualization (B, pg. 27) had a lot of text and that the text in B was put too wide on the screen, so it became hard to read. Three participants said that the use of keywords was favorable to some degree whilst one other mentioned sometimes the keywords are a bit overused. In visualization C the keywords were underlined instead of colorized, which some preferred whilst another found it less clear. There was also a slight preference towards text on the right side of the visualization rather than on the bottom.

## *Figure used to display profile proximity*

For the first graphic (A1 & A2) four participants found it immediately clear what the best profile for the user was. Most users preferred the color scheme of graphic A1, where the colors seemed brighter and having more contrast. The second visualization (B, pg. 27) was seen as 'hard to compare', old-fashioned and some participants found it difficult to notice straight away that the icon closest to you fits you best, but others mentioned this was very nicely designed. Other remarks for B was that blue with grey can sometimes be unclear and that it was not clear the icons were clickable. For the third visualization (C, pg. 27) people mentioned they found the graphic clear, and easy to follow whilst others found it unclear. Through the animation, the icon which fits you best floats out of the graph above the personal text. This led to confusion for three participants. Others thought the animation was guiding them and found that this visualization was still too 'blue'.

## *Narration in visualization C*

The last visualization (C) was given an auditory narration that played whilst the animation of the visualization was playing. A few participants found this not useful at first glance but did find the text in the visualization easier to follow. Participant 1 mentioned: '… but because I heard it and was reading it, I enjoyed it and could follow easier.' Participant 3 mentioned: 'I think I would prefer it if you would just be able to read it yourself. Upon clicking on the different icons, I can image that the voice would continuously start reading another piece of text again and that would not be very helpful'. A few people mentioned that this style could maybe be more preferable for people who have trouble reading or who have dyslexia (1,3,5). Other participants mentioned that hearing the text and reading it at the same time gave them more clarity about the text (1, 4).

## *Other remarks*

Other remarks were that some participants would actually prefer seeing a percentage of their match in combination with the graphic instead of just seeing the graphic (1, 5). Participant 2 mentioned that he would prefer circles (B and C) over triangles (A). Other participants mentioned that they would prefer a light graphic over a dark background (2) whilst others rather have it the other way around (4), so no real conclusions can be drawn about that.

## *5.7 Conclusions for the first research*

To improve upon the design and to gather all information of the users that we received so far, the results will be summarized per category.

### *Color and styling*

The colors in the final design should be contrasting and make the visualization clear. Participants mentioned that having enough contrast between the background and the different backgrounds can benefit the icons and overall clarity. It should not become an entire color-palette, but it should also contain a professional and business-like look.

### *Text*

Text-wise, the information is preferably on the side of the graphic and is supported by keywords which are either colorized or underlined. The text should also not be too wide to enhance readability.

### *Figure used to display profile proximity*

Many users claimed that the design with triangles is clear, but also the proximity-model with the circular icons (design B) conveys the message well. The distance is sometimes hard to compare in design B.

### *Narration*

Narration in the style as used in visualization C should be left out and could help people with reading disabilities but are not in favor of the participants from this research.

### *Other remarks*

The percentage that could be displayed next to the icons could potentially be helpful to participants. Participants have no clear preference for light background with dark content or dark background with light content.

# Chapter 6 – Second Specification

After this first research and consulting the client, it became apparent that another problem within the actual tool deserves attention. One issue that is currently faced is that the numeric profile scores, as calculated by the tool, had a wide range of possible values. It is oftentimes not easy to distinguish the profiles that fit the participant very well and the profiles that do not really fit at all, due to the small distances between the user and the profile. Normalizing the data does not lead to more clarity in this case but can often lead to more clustered data where all data points are very close towards one another. This results in a visualization which has the potential to show clearly which profile fits best.

It is then of importance to find out which type of data manipulation can produce the best graphical outcome to show the participant which profile fits best in a correct manner and which is representing of the actual numbers. To again assess what elements should be included in the second part of this design, we execute another MoSCoW analysis on this new design (figure 19).

| **Must** | **Should** |
|---|---|
| Provide user with professional identity feedback.<br>Make use of a graphic to display scores of different profiles. | Make clear which profile is fitting for the user<br>Give a clear but honest representation of the scores of the user<br>Avoid giving the user a false impression of his/her profile |
| **Could** | **Would Not** |
| Alter the numbers so that it becomes clearer to the user | |

Figure 19: MoSCoW analysis of the second design

We then tried to design a graphical representation of the scores to provide the user with feedback on his/her professional identity. This should make it clear which profile is fitting for the user and give an honest representation of the scores of the user whilst avoiding giving the user a false impression of his/her profile. This new representation could alter the numbers so that it becomes clear to the user what his/her profile is.

# Chapter 7 – Designing the manipulation of the data

## *7.1 Design phase of manipulating the data from the Career Compass*

From the original data, it can be seen that many people lie far from each other in terms of 'closeness to a profile'. In this case, a low score can be seen as a strong relation towards a profile. A difficulty can be that for someone, the lowest score can be 6,01, whilst the largest score can be 62,02 where both persons have the same profile that fits them the best. In order to overcome this issue, a number of ideas where assessed.

Before we can assess these ideas, it must be mentioned that there are four possible routes to take in order to design a fitting dataset with accordingly clear visualization. First, the data could be shown as-is. This means that data might be clustered around the 20.0 score in the middle of the circle, as the profile of the participant is factually not very strongly biased towards one profile. Secondly, the data could be manipulated up until the point where the factual information is not very important but where the visualization should just make clear in what order the profiles are in closeness towards the participant, and where there is one clear 'best profile' to present to the user. Thirdly, a middle ground could be found in between these first two options, where there is an accurate mix between factual information and clear visualization which both informs the participant and also gives a clear image of what profile fits best to the user. A last option which will not be touched upon in this research is the alteration of the scoring model of the test itself, as it is questionable how some students already receive such high scores and other students such low scores and this test could perhaps benefit from more research to stabilize the scores of participants.

## *7.2 Designing manipulations*

We considered five possible transformations of the datasets:

1. Rescaling percentages

In a regular situation, scores can be translated into percentages where the lowest score is placed on the '0' on the x-axis, and the highest score is placed on the '100' on the x-axis and all other scores are calculated in between. This is done through the following formula.

$$Rel_{Score} = \frac{DISTprofile - MIN(DIST)}{\Delta DIST} * 100$$

We call this the relative score (Relscore). In this instance, DIST profile stands for the distance given by the original formula towards the specific formula, MIN(DIST) stands for the minimal distance from the five profiles and delta DIST stands for the distance between the minimal and maximal distance from a profile of one person.

This formula will always cause the best fitting profile to be at score '0' and the least fitting profile at '100'. This can either be an advantage so that it becomes very clear which profiles fits best and

which profile is furthest away from the user but could give a false image of the data as now the score which was initially far away from the user now lands at zero. Someone with all low scores and someone with all high scores could receive the same visualization of data, which could be misleading.

2. Using a sigmoid transformation

When using a sigmoid transformation (figure 20), datapoints can be altered so that points that lie below the center value (0,5) receive an even lower score, and so that points that lie above the center value receive a higher score. This transformation will create larger gaps between the scores of users and will enlarge differences between profile scores.

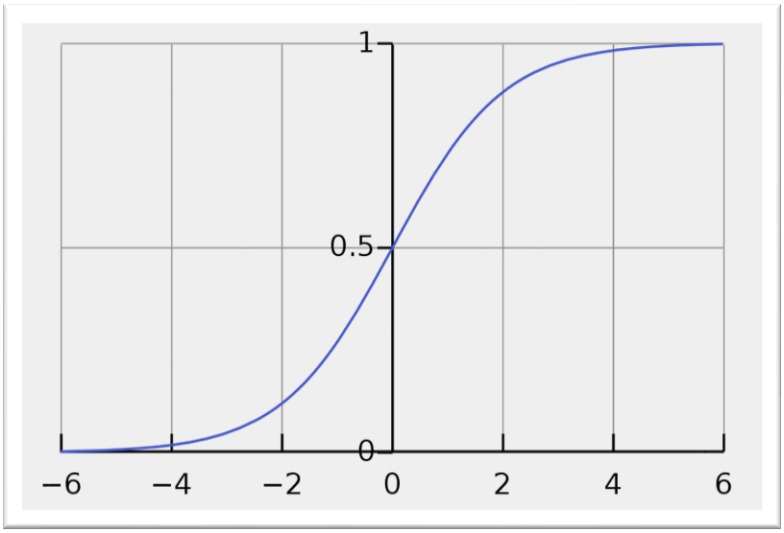



Figure 20: Sigmoid transformation

To achieve scores that follow the curve of the sigmoid function, we use the following formula:

$$Score = \frac{1}{1 + EXP(-m * \left(\frac{Rel_{Score}}{100}\right) - 0.5)} * 100$$

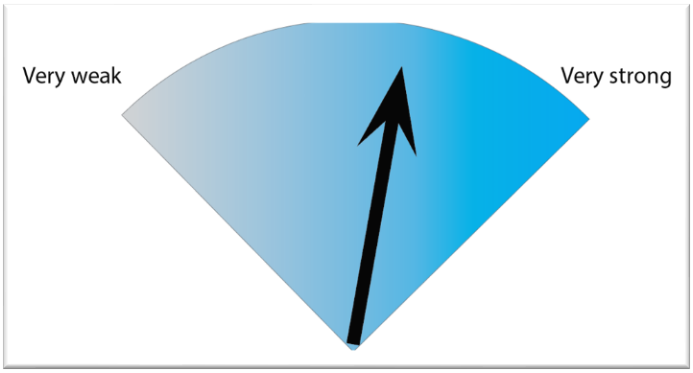
where m is a multiplier used to strengthen or weaken the slope of the sigmoid function, and where Relscore is the relative score of a profile as calculated. An advantage of this function is that it will 'pull the data apart', which makes the differences between the different profiles larger. This can be a disadvantage, however, if the data has already a great distance between the points. Another disadvantage is that this formula makes use of the relative score which can give a skewed view of the persons' profile. This is done as the value of Rel_score must be a value between 0 and 100.

3. Rescaling percentages with 'strength indicator'.

Like in the first option, a decision could be made to redistribute the datapoints on a line between 0 to 100, where the lowest scoring profile will be moved to 0, the highest scoring profile moved to 100 and the other points laid in between. This style does not convey whether or not there is a large

distance between the original datapoints or a small distance. For this reason, a ‘strength indicator’ (figure 21) could be introduced where participants with a low distance for their best-fitting profile receive the indication that their profile is a ‘strong match’, and where a high distance is measured for the best-fitting profile a ‘weak match’ signal is given off to not mislead participants.

This strength indicator should be paired with the distance between profiles for one student, as someone with a high ‘best-profile’ score and relatively low distance between profiles has a weaker profile than someone with a high ‘best-profile’ score and a relatively high distance between profiles.




1,97/2 (high strength)

Figure 21: Example of strength indicator, on the right a textual representation from another possible outcome.

The formula used to calculate the strength of the profile is calculated as follows:

$$Strength = \frac{1}{MinDIST} * \ \Delta DIST$$

Where MinDIST is the minimal distance of all profiles, so the profile, which is closest to zero, and where $\Delta DIST$ is the distance between the profile of the highest and lowest score. As a low score for the minimal distance is preferred and a large distance between profiles to make the winner stand out more, the strength is the multiplication of these two factors.

An important remark must be made next to this element that ‘strength’ could be a term that should be left out of the design all-together. Giving the user the impression that they have ‘low strength’ or even ‘weakness’ in their profiles is not likely to contribute towards the professional growth and must then be avoided. Instead, the term ‘overlap’ could be used, as this also gives an accurate representation to the user of what the data is portraying.

The distribution for the profile strengths can be seen in the figure below which is taken from the dataset on 915 participants who filled in the original Career Compass, supplied by the client.

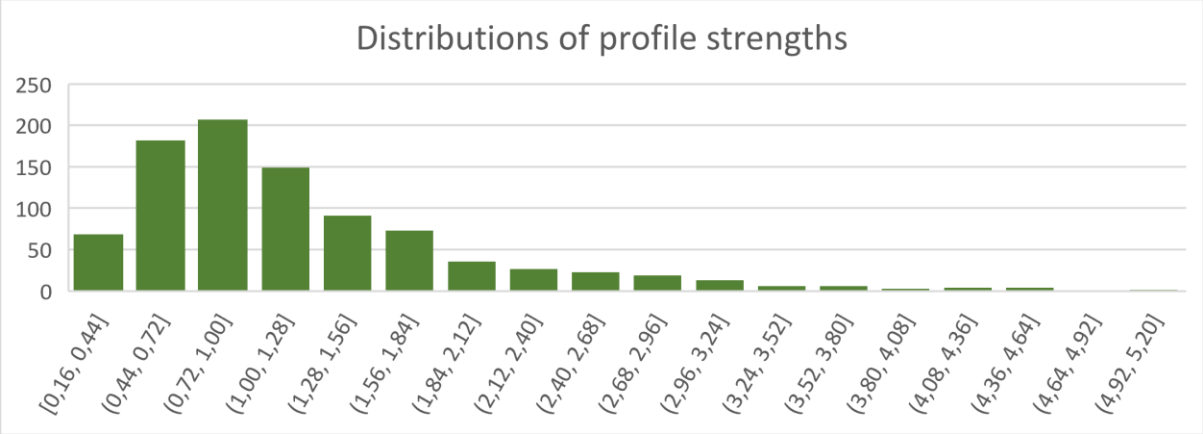



Figure 22: Distributions of profile strength in a large dataset (n=915)

Based on the distribution (figure 22), it can be clearly seen that the average strength lies between 0,72 and 1,00, hence they can be seen as an 'average strength'. The range of the strength indicator is set for 0,00 to 2,75, as this is the regular interquartile range, as seen below (figure 23).

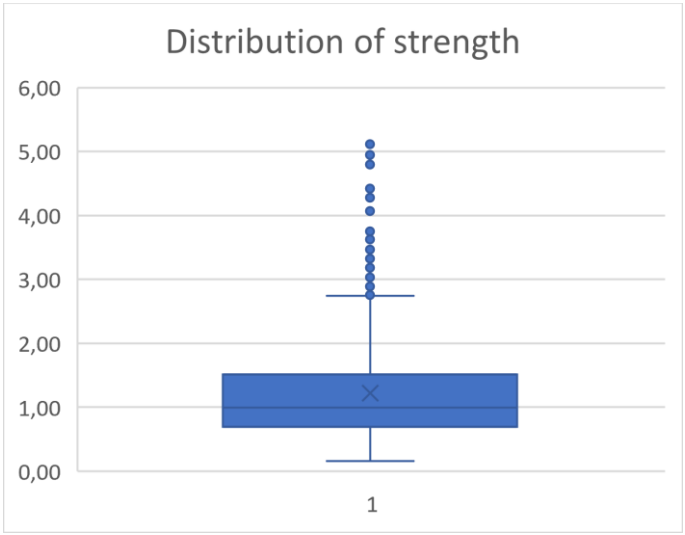



Figure 23: distribution of datapoints for the strength indicator (n=915).

4. Using a fixed percentage

One of the options can be to fix the percentage ratio to make it clear for all users by placing the profiles evenly on a scale from 0 to 100. This will neglect the intensive process of calculating the precise scores for every individual but could potentially give a clear image of which profile fits best to the user. This also does not consider the distance between certain profiles and can therefore be labeled as a weak contestant. This can be compared to the earlier version of the career compass where a simple bar graph was used or a 'podium' with a clear winner at the highest position, but this version was disliked by participants in an earlier research (Vos, 2017).

5. Combining the sigmoid graph where the strength indicator influences the multiplier within the sigmoid function

Another possibility to address the clustered data is to enhance the graph in a more positive direction when there is also a different strength indicator present. This could mean that upon a lower profile strength, the sigmoid function receives a higher strength operator to pull apart the data further to increase differences. A drawback of this method is both an ethical case: is it wise to pull apart data from 'weaker' profiles more? In that case, it could be possible that someone with a high strength and low strength profile receive the exact same graph which could be problematic if these users were to compare their graphs. With the use of combining the sigmoid graph and the 'strength indicator', some differences in data can be accounted for. The formula for this style graph can be defined as follows:

$$Score = \frac{1}{1 + EXP((-m * strength) * \left(\frac{Rel_{Score}}{100}\right) - 0.5)} * 100$$

Where in this case, the strength is according to the formula from method 3. This method, as opposed to method 4, will adapt the scores per user on what strength their profile seems to have. When the relative score is 0 in the regular sigmoid graph, the sigmoid function gives the same value for every person. With this altered formula, the score is altered based on the calculated strength and makes differences smaller when a person seems to have a profile with limited overlap between profiles and enlarges the differences when the person seems to have a good amount of overlap.

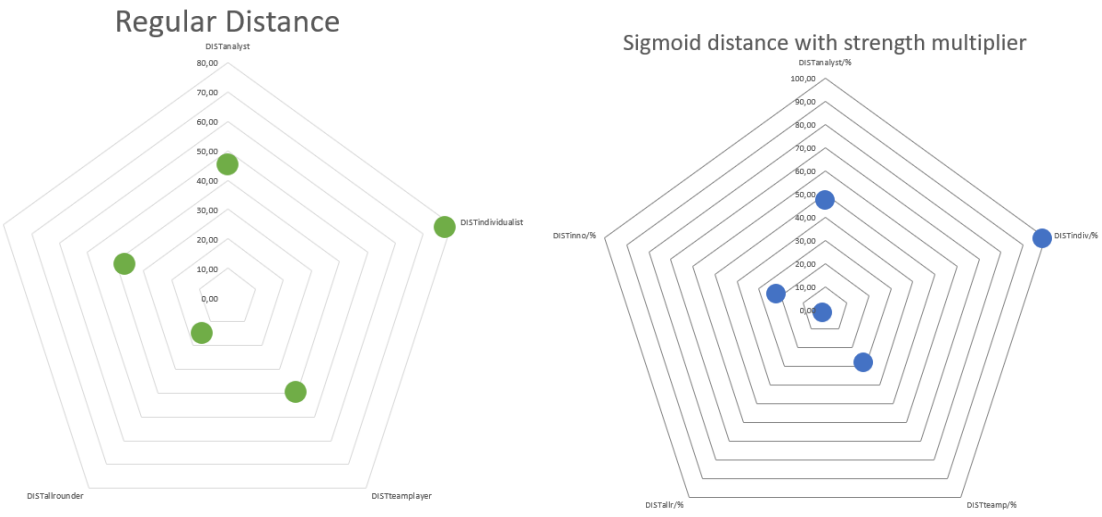



Figure 24: Regular distance (left) as opposed to sigmoid distance with strength multiplier (right)

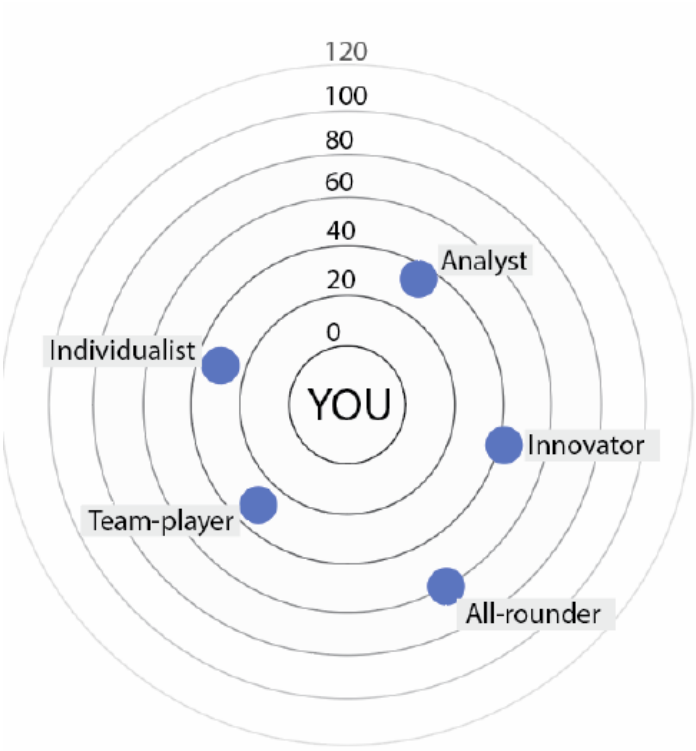
In the figure above (figure 24), a comparison is made between the regular distance and the altered distance. Both graphs make use of the same datapoints and the multiplier for the sigmoid distance is 2.

From this, it is easy to see that these graphs look much alike. The results are slightly enlarged, and the strongest profile is drawn more towards zero.

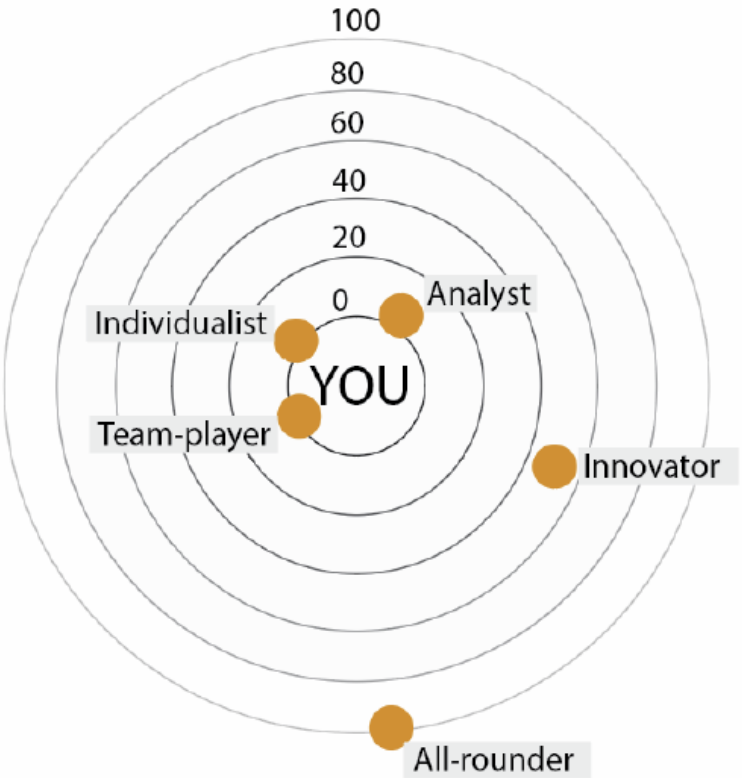
## *7.3 Designing a test-method to assess clarity of graphical models of altered calculations*

In the previous paragraph, a number of different methods have been introduced that transform the data in one way or another. All of these methods were implemented in an excel file, where 10 samples of data were chosen to implement these calculations with. From these 10 samples, a selection of profiles was made that is representative for the dataset and the different outliers that might be present. From this selection, four different profiles were chosen: a profile with outlier low strength score, low strength score, average strength, and high strength. No outlier for high strength was chosen as the outlier for high strength is actually represented by the high strength score and the difference between these two seems to be negligible.

To conduct a survey on this material, first a method to review the different designs has to be thought out. The option we chose was to give the user three different visualizations of the style 'regular distance' with a fixed axis, 'relative distance' and 'sigmoid distance'. These three visualizations were combined with the four chosen profiles and put into a survey in Qualtrics (Appendix C) where users were presented with a number of questions. One of the four bundles of graphs can be found below in figure 25.




Option 1




Option 2

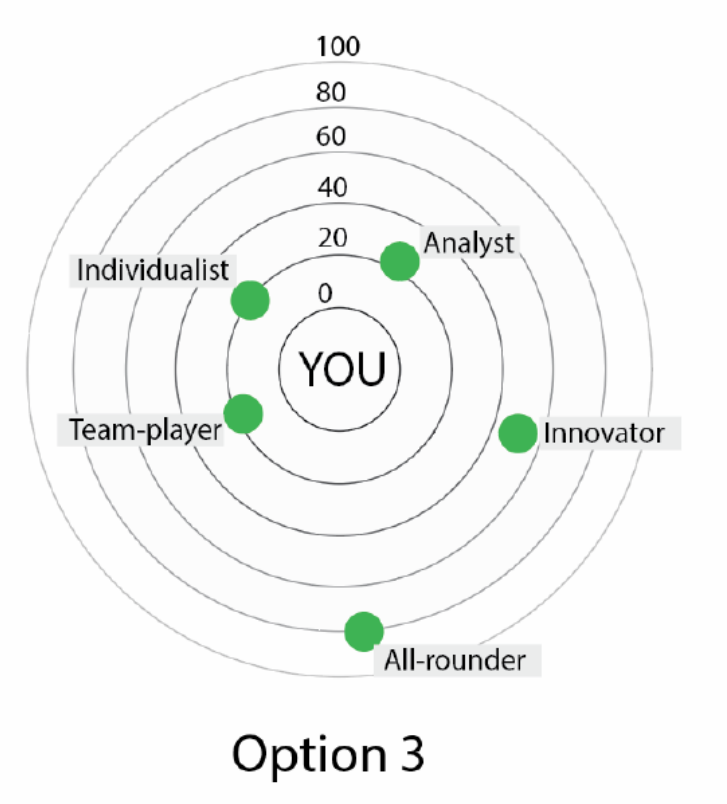



Figure 25: Three styles of graphs for one entry of data-points of a profile

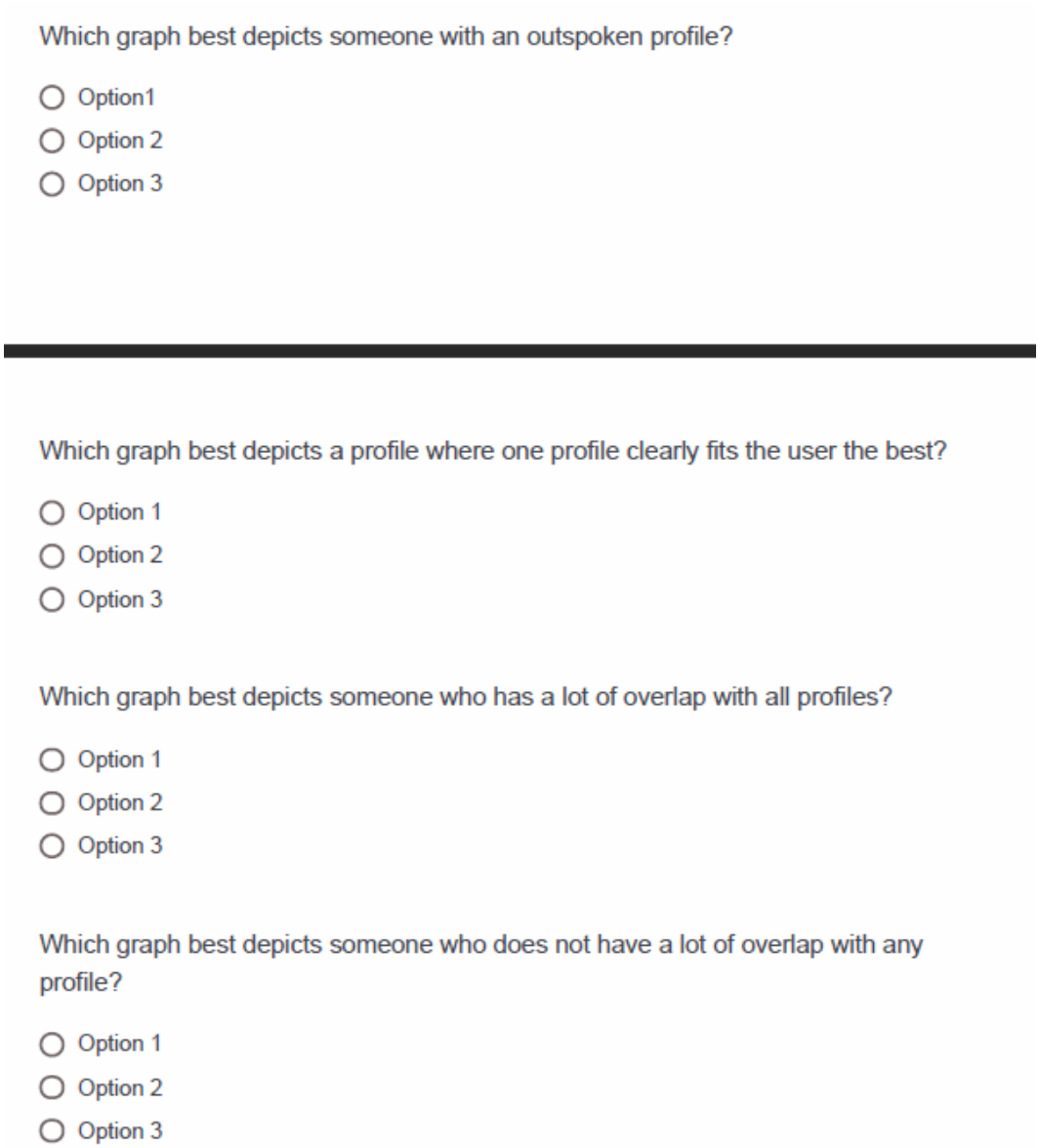


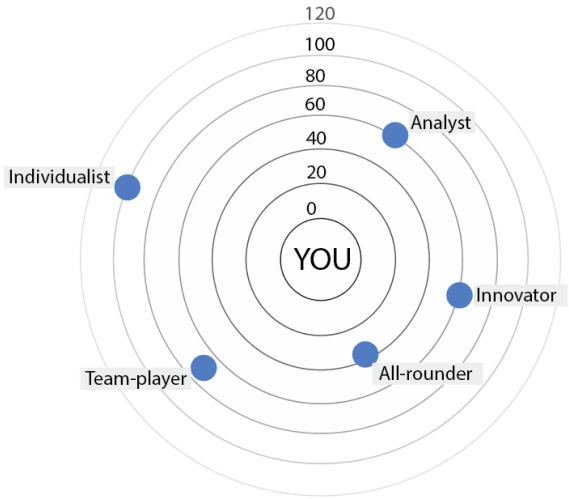

Figure 26: Four questions that were asked for every set of graphs.

After these questions (figure 26), one question was asked about the scaling of the circles in the background and a few questions regarding the ethical aspects of these alterations were asked. A possible issue could be that participants might agree that the altered visualizations look better but give a less accurate image – hence getting into ethical doubtful terrain. A remark can be placed if participants actually had understood the meaning of this question, so conclusions cannot be drawn easily. Finally, some questions were asked about an equal-distance graph were given to reassure that the opinion from students about this style is still negative as stated by earlier research. Lastly, some demographic information was requested (Appendix C).

## *7.4 Results of survey*

For this survey, there were 23 useable responses, with both males and females and range of age between 21 to 24 years. Most responses were recorded with students from the University of Twente. The results for this survey were recorded in tables per category. First, we will take a look at the first category of a low strength score:

### *Using the regular distance*

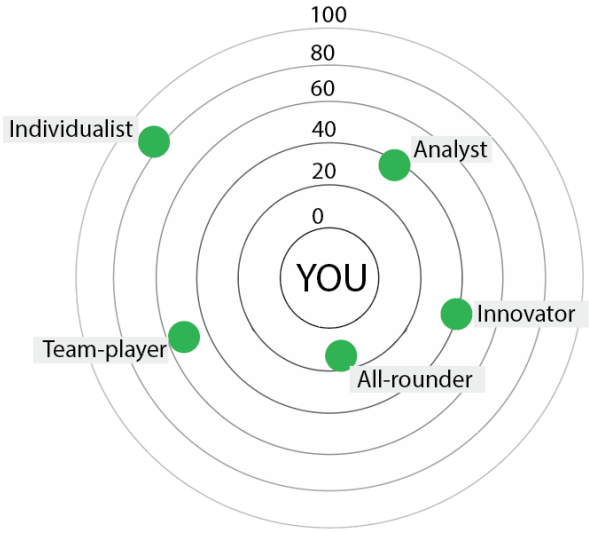



Option 1

| | |
|---|---|
| **Best depicts someone with an outspoken profile** | 8.7% |
| **Best depicts a profile where one profile clearly fits the user best** | 4.3% |
| **Best depicts someone who has a lot of overlap with all profiles** | 39.1% |
| ***Best depicts someone who does not have a lot of overlap with any profile*** | *82.6%* |


Option 2

| | |
|---|---|
| **Best depicts someone with an outspoken profile** | 78.3% |
| ***Best depicts a profile where one profile clearly fits the user best*** | *87.0%* |
| **Best depicts someone who has a lot of overlap with all profiles** | 13.0% |
| **Best depicts someone who does not have a lot of overlap with any profile** | 8.7%% |




Option 3

| | |
|---|---|
| **Best depicts someone with an outspoken profile** | 13.0% |
| **Best depicts a profile where one profile clearly fits the user best** | 8.7% |
| ***Best depicts someone who has a lot of overlap with all profiles*** | *47.8%* |
| **Best depicts someone who does not have a lot of overlap with any profile** | 8.7% |

For all the following categories (low strength, average strength, and high strength) the same results were gathered. The following table (table 1) depicts the scores based on all results and features the highest percentages along with which figure was rated the highest (also see Appendix C for all the figures).

Table 1: Scores of the online survey

| | Outlier low | Low | Average | High |
|---|---|---|---|---|
| Best depicts someone with an outspoken profile | Figure 2 – 78% | Figure 2 – 73% | Figure 2 – 87% | Figure 2 – 78% |
| Best depicts a profile where one profile clearly fits the user best | Figure 2 – 87% | Figure 2 – 65% | Figure 2 – 91% | Figure 2 – 82% |
| Best depicts someone who has a lot of overlap with all profiles | Figure 3 – 47% | Figure 1 – 69% | Figure 1 – 65% | Figure 1 – 73% |
| Best depicts someone who does not have a lot of overlap with any profile | Figure 1 – 82% | Figure 1 – 61% | Figure 1 – 47% | Figure 3 – 70% |

From these results, it can be seen that figure 2 scores the highest for both depicting someone with an outspoken profile for all data types and also best depicts a profile where one profile clearly fits the user the best, as figure two aims to stretch the data and make sure that differences are enlarged. For question 3 (best depicts someone who has a lot of overlap with all profiles) the answers seem to not give clear results – especially for the low outlier. The last questions (best depicts someone who does not have a lot of overlap with any profile) which should point towards a 'low overlap/low strength' score favors figure 1 to some degree where the original score was used and also chooses figure 3 one time.

For the next element, participants had to choose between two different styles of the circular graph. These graphs are shown in figure 27 below.

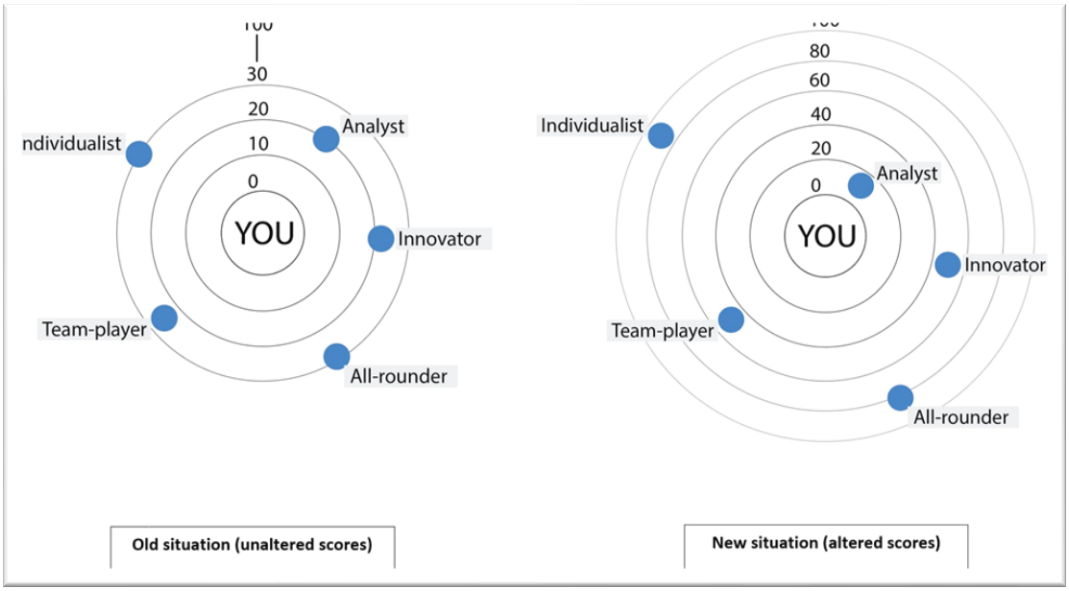



Figure 27: Old and new situation of circular graph

From 23 participants, 3 opted for the old situation and 20 for the new situation. Participants who chose for the new situation mentioned elements such as larger clarity of data, differences more easily noticeable and easier to compare. Participants who preferred the old situation mentioned that they found changing the graph dishonest and not easily comparable with other students when performing the same test. The way in which these questions were stated did include words like 'manipulation' and 'altering', which could have brought up negative emotions with the users, so conclusions on this cannot be drawn on this data alone.

Participants were now asked to state their opinions on the following two statements, as seen in figure 28 below.

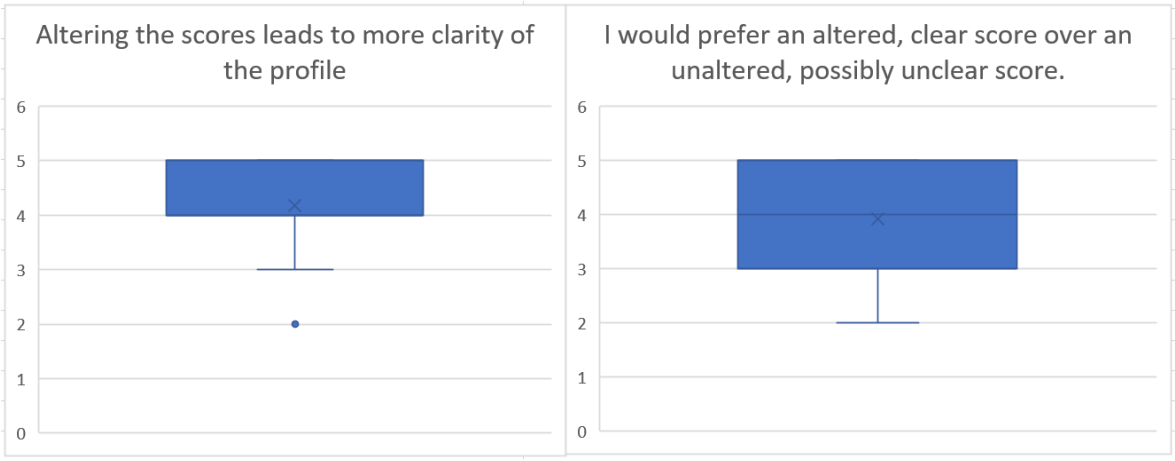



Figure 28: Two opinions, responses represented in a boxplot with answers ranging from 1 (totally disagree) to 5 (totally agree)

From these two graphs we can clearly see that for the statement ‘altering the scores leads to more clarity of the profile’ ranges mostly from neutral to totally agree with a large portion answering agree or totally agree. For the statement ‘I would prefer an altered, clear score over an unaltered, possibly unclear score’ the answers had a wider range, mostly between neutral towards totally agree. The mean still lies at around 4 (agree) so the general outcome could be seen as neutral towards agree.

Next, participants were asked to give their preference for either a graph with an equal distance for every profile (20% - 40% - 60% - 80% - 100% distance set in advance, just in the correct order) or a regular distance graph. These figures can be seen below (figure 29).

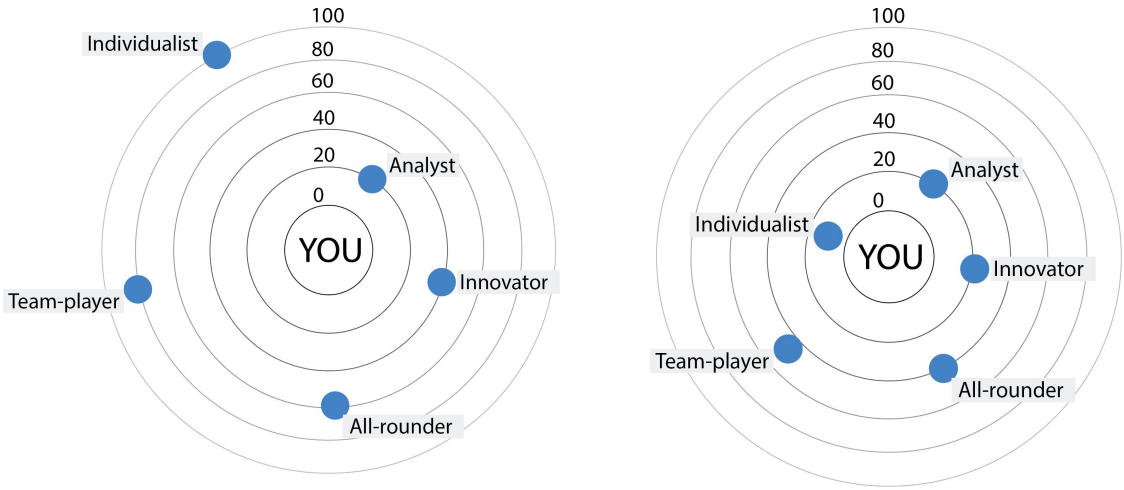



Figure 29: Equal-distance graph (left) versus regular distance (right)

From 23 participants, 15 opted for the regular distance whilst 8 participants chose the equal-distance graph. Participants who chose for the regular distance graph mentioned that displaying the regular score is fairer, and to change the data to make it more clear is not ethical and could give the user a wrong image of their score. Participants who chose for the equal-distance graph mentioned that it makes the result from the test clearer and that profiles are easily identifiable. Another participant who chose option 2 (equal distance) mentioned the following:

“Equal distance graph better represents which profiles are closer to me and helps understanding my professional profile better. Although, an accurate representation would give a more realistic view on whether the differences are large enough to take into consideration.”

This is an important factor to keep into consideration, as the equal-distance graph has no option to display the distances between the profiles.

Lastly, participants were shows three statements regarding showing people equal distances. The three statements and the responses are shown in figure 30 below.

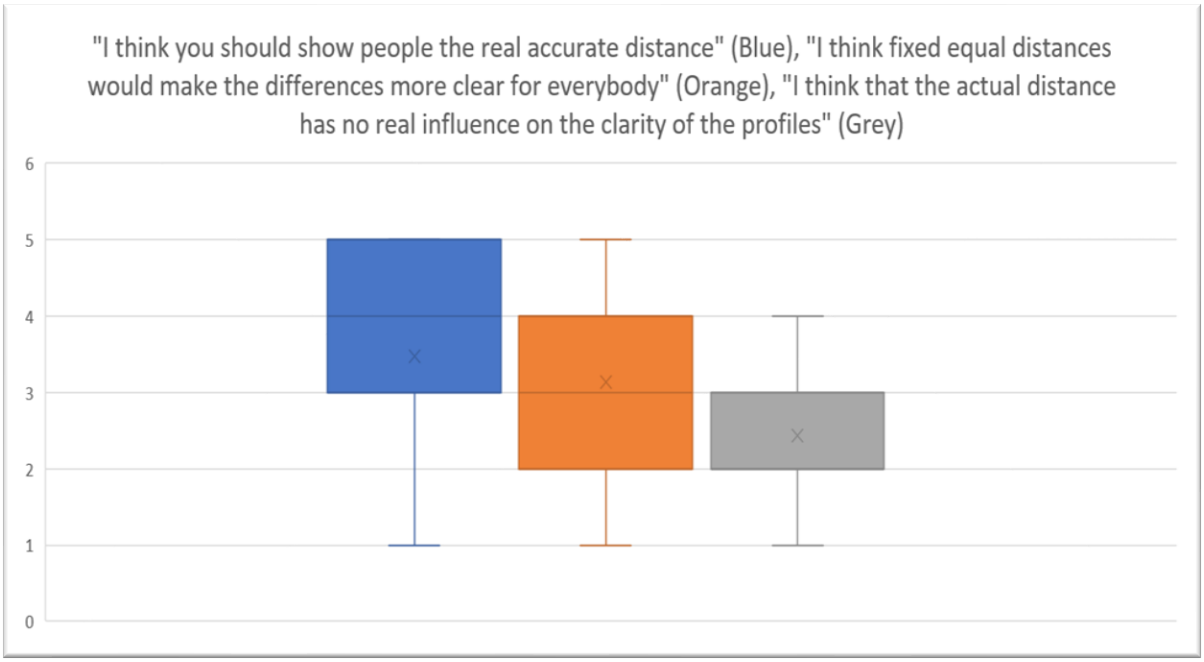



Figure 30: Three different boxplots for opinion statements on showing people actual distances ranging from 1 (totally disagree) to 5 (totally agree).

It can be seen that for the statement 'I think you should show people the real accurate distance', the outcome is generally positive, but the mean lies between neutral and agree. Mostly, the participant agrees with the idea that one should show people the real accurate distance. For the statement 'I think fixed equal distances would make the differences clearer for everybody', the responses didn't show an obvious skew towards agreement of disagreement. This could be due to the fact that the words guide the user as it would never be okay to 'not show the real accurate distance'. Instead, another way of formulating these questions could have been tried where the words would be changed in order to see if this would change the opinion of participants. For the last statement 'I think that the actual distance has no real influence on the clarity of the profiles', the general opinion lies between disagree and neutral, with a mean also in between of these two opinions. Generally, it can be said that the opinion is neutral towards disagreement.

## *7.5 Conclusions*

What we can conclude with this is that figure 2 (table 1, pg. 43) clearly shows best fitting and outspoken profiles with exactly the same data. Where we to lean towards the fitting and outspoken outcome of the tool, we could implement two. To show diversity, it is likely best to use figure 1 as this will correctly picture a profile that has a lot of overlap with all profiles. The option which provides a mix between these two options could possibly by the sigmoid graph, but this should be tested further to see if it actually provides a healthy balance between telling the truth and helping the students.

A note must be placed for the latter two questions which featured the term 'overlap'. Some participants said to be confused by this term, so there exists a possibility that the answers on the last two questions are not very reliable.

In terms of altering scores, participants are not always in agreement about whether or not altering scores is positive for the user. There seems to be a positive attitude towards altering scores as this could give more clarity, but some participants think this could make the graphs unreliable and could give a false impression of what kind of profile the user actually has. This does not go as far to make all scores have an equal distance, where 15 participants would still opt to show the regular distance as opposed to an equal-distance graph where the results are changed thus far that important information could be lost.

When it comes to using equal distance graphs and the influence on the clarity of the profiles, the reactions of the participants also widely vary. Through the use of box-plots we can get an image of the data as being put out by the participants, which leads to believe that there is no real consensus on whether participants would like to see clear, altered data or unclear, unaltered data and that every individual has his or her own preference. Perhaps more research could be conducted towards with how best-fitting profiles relate to a persons' preference towards a certain visualization style.

# Chapter 8 – Final design

Based on the first and second research that were executed, a final design can be made which can be presented to the client and could potentially lead to new and better designs for the Career Compass.

Elements that were taken from the first research were based on the twelve design principles of Mayer and the interviews. From these sources, it became apparent that the tool could make use of the circle diagram style and should also feature clear tags for the profiles and have a short piece of text, guided by either underlined or colored keywords.

From the second research, we could learn to strongly express a profile, the relative distance could be implemented, whilst the original score should give the correct representation of the distances to begin with. As a middle ground, the distance with sigmoid transformation is chosen as the primary method to manipulate the data entries to portray both a correct and more accented profile to gain maximum clarity.

Both of these elements led to the following design, which were again constructed in Adobe XD:


Figure 31: Adobe XD preview of final design

Within this design (figure 31), the use of a circle diagram has been decided, with the icons changing in opacity as well as distance from the middle to accent the profile overlap. Also, the icons are used with the tags right along them. In the lower left-hand corner, an option for 'audio guidance' is given, which could give the user the option to turn on this guidance to possibly enhance the experience or to aid users who are visually impaired. The text is placed on the right-hand side and features short sentences with underlined keywords which display the most important terms. For the background, a slightly more playful graphic is chosen in stead of plain grey to hopefully give a sense of design and modern features.

# Chapter 9 - Discussion, recommendations, limitations and conclusion

**Discussion**

One element in this research which has been a major point of the attention from the beginning is the ethical element of the outcome of this tool. Through the use of such a tool which carries responsibility and credibility with the connection towards the University of Twente and other partners, one could have great impact. Especially if this tool is meant to help the students shape their career, the tool could impact the choices students make when starting a certain study or when graduating or choosing their career path. Through the use of data manipulation and choice of words, students could also be guided into a certain direction. The use of this guidance could go towards the direction of nudging; where someone is gently reminded of what they lack in order to get the user to execute a certain task or to acquire a specific product or service. Especially when one of the motivators of this project is that there is a lack of STEM professionals, it would be in favor of the designers of this tool that the outcome is gently oriented towards STEM professions in order to close the gap that is present. As the design of the questionnaire and the measurement methods that calculate the scores has not been made publicly available, questions could arise to which goal is behind this tool and how the certain scores do or do not guide you towards STEM education.

Perhaps it is also not wrong to make people interested in STEM and the gentle push could be sufficient to make student aware of their own career abilities, but it should be noted that the team that is behind the design of the Career Compass should be well aware of their possible impact. It is also important that the Career Compass is never guided by investors who have another aim than to make sure the user is guided in developing his/her professional identity. If a company would invest in the University or in the tool in order to guide users towards the company, it would be ethically questionable, and these types of situations must be avoided.

One element that was mentioned in the initial ideation of this tool was to adapt certain visualizations to the outcome of profiles by making the visualization automatically adjust to the score of the user. This element has not been researched within this thesis but could very well be researched later as to see whether or not this could have impact on the transfer of information to the user and if this has a positive impact on the professional identity of the user.

What also deserves attention is the fact that the purpose of this tool should not be to make sure people are sorted into a category and that this can be told to them as a fact, but this could be an indication of where the strengths and weaknesses lie for the user. This is why it is of importance to make sure that the relationship towards other profiles is shown and that the simple structure of ‘ranking the different profiles from 1 to 5’ lacks in quality to fulfill this task.

Another element which deserves discussion is the element of ‘measuring someone’s profile strength’ as the term ‘strength’ possibly does not apply to an environment where the aim of the tool is to help student develop. Using, then, the term high strength and low strength could possibly damage the confidence of the participant and should be avoided in the actual design.

**Recommendations**

During the first research on the different visualizations, there was a number of participants who mentioned certain improvement that could be made for this tool. One of these recommendations was to encompass a font for people with dyslexia. These fonts make reading for people with dyslexia easier and could benefit these users greatly. This font transforms the letters to different levels of thickness, which is potentially beneficial for a reader who has dyslexia.


Figure 32: Dyslexia typeface[1]

In this typeface (figure 32), letters are made easy to distinguish and certain letter structures change.

One recommendation could be that the color type of this tool could be adjusted with the results of the tool and could also be changed all-together is this is favorable to the user. One user noted that the use of colors right now (grey and blue) are quite business-like which adds to the overall theme of being professional and developing a professional career, but this could also be different for certain users who would like the tool to be more colorful or playful. This could potentially be done through the use of a small amount of questions that is displayed after the results of the tool are shown to the user to gain feedback on the tool and what users think of certain color-schemes.

Right now, the total amount of users that gave their feedback on temporary designs is 5. This number is quite low and could use more research and more participants. Especially for testing if the data manipulations have the preferred results, it could be of great importance to let the users fill out the real test and have them look at their own results with a chosen data manipulation. Right now, there are only user tests done through profiles that are not their own profiles. Adding to this, not much research has been done on the effect of personality tests upon confidence on users and what techniques are best for designing personality tests. To get a better view on this specific Career Compass and its impact, it could be helpful to implement a short survey after the results of the

[1] https://www.dyslexiefont.com/en/typeface/

Compass to get user input and perhaps invite a number of users to join a panel on which they can express what the tool did for them.

As stated earlier, we can derive from the research on multiple profiles that the professional profiles of users vary widely. From this, there could potentially be a gain within the adaptation of the visualization in this Compass, where different personalities receive different visualizations that fit their need. One queue for this is that some participants within the first research that was done mentioned that they preferred the circle diagram and found it clear, whereas others found it hard to read and were more interested in the text that was next to the figure, leading to believe that everyone has their own methods of transferring knowledge. This could potentially be researched by giving the user a random visualization out of three visualizations and let the system run for a while. After this, the user should get a number of questions which would give feedback to the system about how useful the tool was. Then, a possible correlation could be found between which profiles find which visualization the most useful.

Another element which could gain from more testing is the audio input. In the first research, one visualization with spoken text was added to the graphic. Within this test, a voice literally read the words that were next to the figure, adding only one sentence before it and one sentence after the text was read. Whilst research could lead to think that this would increase transfer, many participants mentioned that this was not necessarily helpful, and they would want to turn it off if possible. Perhaps a different style of auditory assistance could prove itself useful within the visualization of this project, as this is a widely researched element which has proven to aid learning and transfer.

**Limitations**

During the time of writing this thesis, the COVID-19 virus had impact as no interviews or user-testing could be done physically. Both the primary and secondary research were done online, and video calling was used to converse with the participants.

**Conclusion**

In this research, we have taken a look at the design of the Career Compass according to a number of design principles and we have researched the impact of different data manipulation styles towards the clarity of the design and it's effectiveness. What we have found is that the visualization of the Career Compass can be improved through the use and implementation of the twelve design guidelines of Mayer, and that it is of importance to come up with designs and test them frequently with users as they eventually are the ones that should benefit from the visual representation of their own data. With the ethical elements in mind, it should also be noted that the goal of this tool should be well formulated and the process of users watching the data visualization and getting into action should be monitored if possible.

We conclude that the use of a circle graph with distance towards the middle is a proper method to visually represent the data that comes out of the test if the graph is properly designed. The use of a triangle graph/spider graph could also be used, as there was no clear preference for either, but the circle diagram resembles closest what the aim of the original Career Compass is. What we can also conclude is that the data manipulation through normalization and a sigmoid transformation is likely suitable for use as this forms a balance between deforming or amplifying the data to be clear and seeing what the actual distance is between profiles. More research should be conducted towards the use of this manipulation of the data, as no real experiments with this type of graph have been done next to showing a number of participants certain graphs and asking for their opinion.

Lastly, we can conclude that there is room not only for improvement but also for new ideas regarding the visualization. Next to this type of graph and the provided text, it could be of great interest to see if there are more graphical ways of representing who someone is and could be as a professional.

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# Appendix A: Interview questions first research

Vragen voor design van Career Compass

-Bij elke ronde:

1. Mensen krijgen 10 seconden de tijd om daarna te vertellen wat ze als eerste opvalt aan dit design. Snappen ze het ongeveer of niet?
2. Daarna krijgen mensen zoveel tijd als ze zelf willen om de informatie te bekijken. Ze mogen zelf aangeven wanneer ze klaar zijn voor vragen.

-Vragen bij elk design:

-Wat valt je het op aan dit design?

-Kun je mij vertellen welk profiel het beste bij deze persoon past? Waarom?

-Wat vind je van de afbeeldingen die worden gebruikt? Voegen die wat toe of leiden ze je af?

-Wat vind je van het gebruik van kleuren in deze visualisatie?

-Wat vind je van de animaties die worden gebruikt?

-Wat vind je van de signaalwoorden die worden gebruikt? Helpt dit je of niet?

-Wat vind je van de tekst in dit ontwerp?

-Zou je iets aan dit design willen veranderen zodat het voor jou duidelijker zou worden?

-Vragen na afloop van de drie gepresenteerde designs:

-Stel je voor dat jij de tool invult en ook feedback hierop krijgt. Hoe zou jij dit dan het liefst willen zien? Welke elementen van de voorbeelden zou jij graag terug willen zien?

-Heb je nog andere opmerkingen of vragen?

# Appendix B: sheet with visualizations for the participant in study 1.

*Document begeleidend voor het eerste onderzoek – Hermen Pastoor*

*Foto 1:*


*Foto 2:*

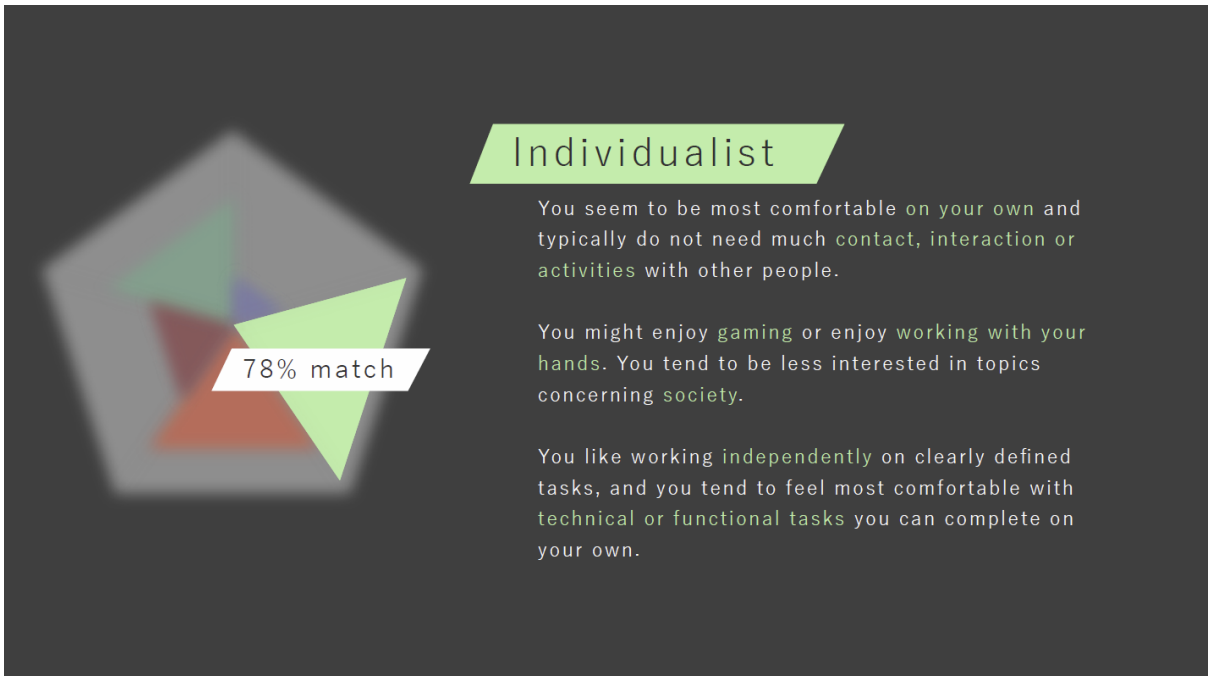
[redacted]

[redacted]

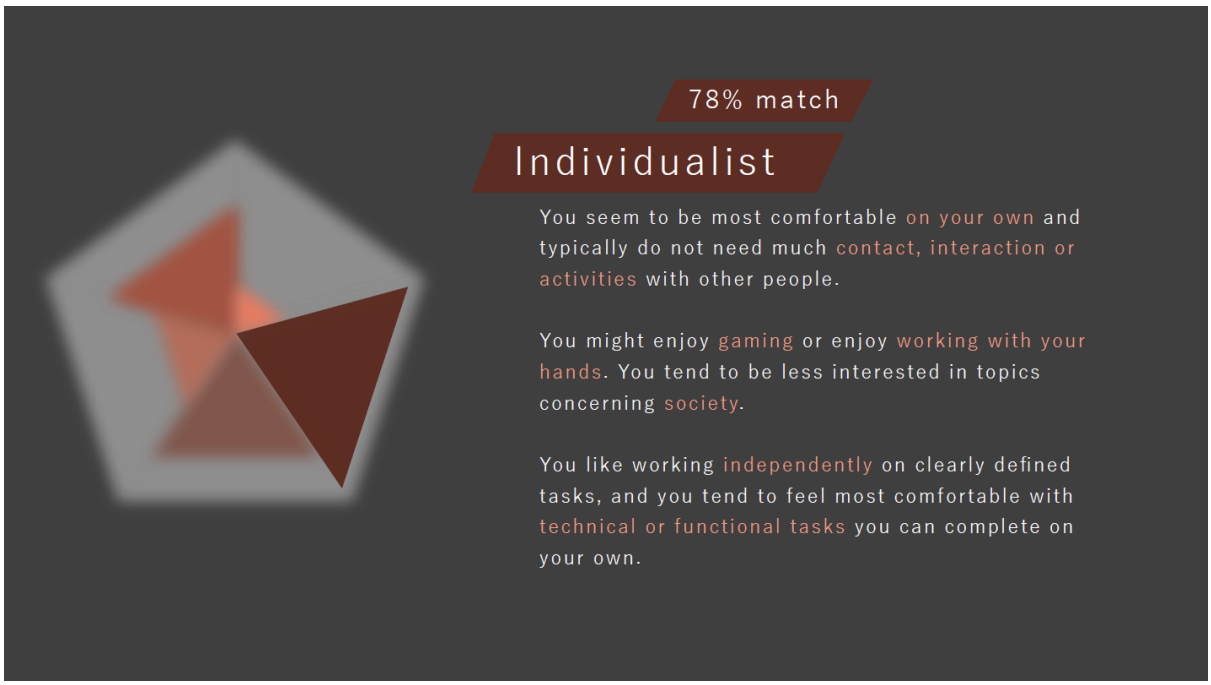
Sectie A

**-Filmpje A**

**-Visualisatie A1**



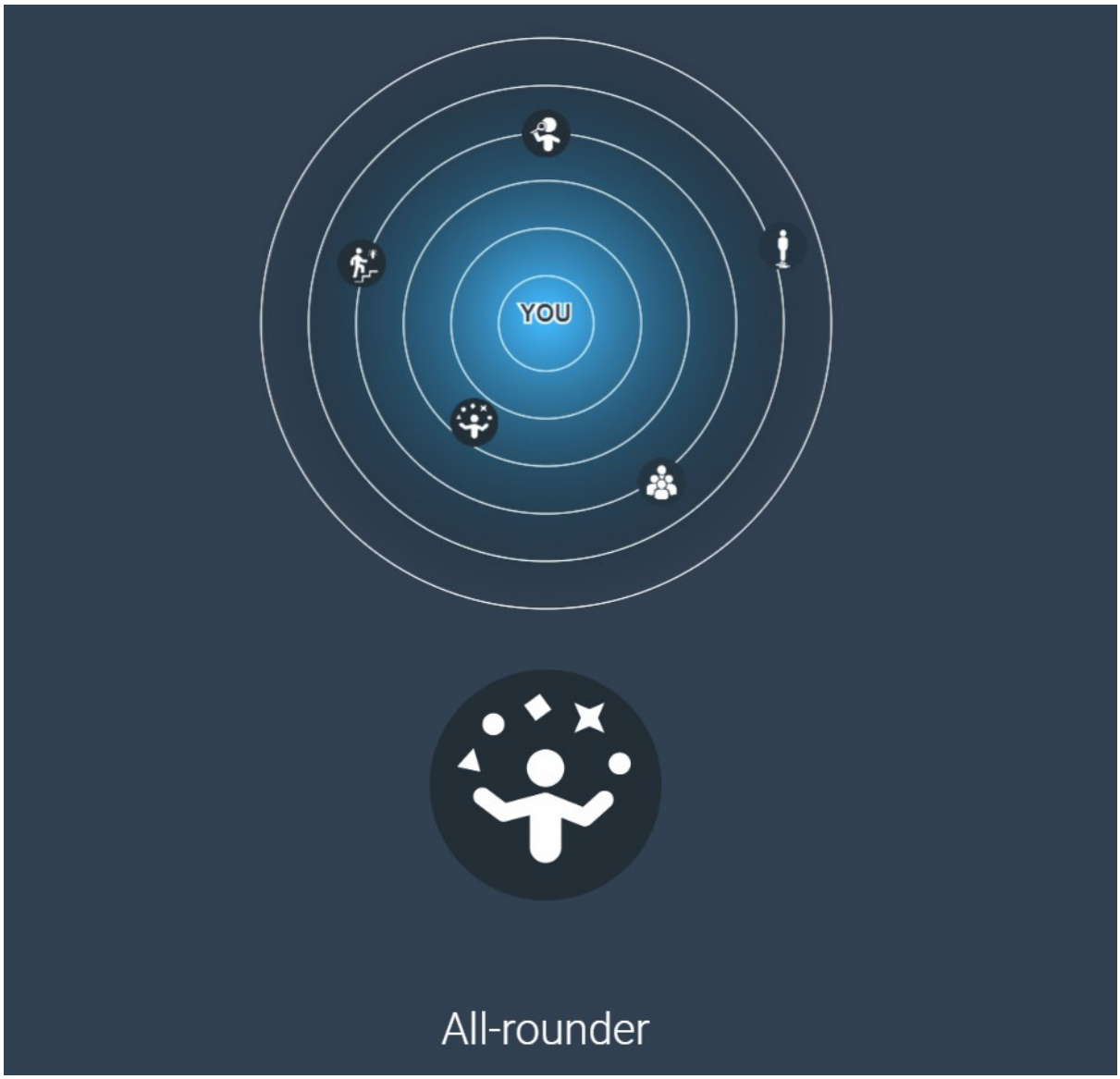

**-Visualisatie A2**



Sectie B

**-Link:** https://cc-feedback.tech4people-apps.bms.utwente.nl/akpqA/user/Z6lKt

**-Visualisatie B**



Sectie C

**-Filmpje C (geluid aan!)**

**-Visualisatie C1**


**-Visualisatie C2**

## Appendix C: Qualtrics Survey for second specification

Default Question Block

Dear participant,

This research is about the Career Compass, and is used to provide suggestions for improving this tool. This tool was designed in the collaboration with other universities next to the University of Twente, and is used to give students insight in their 'professional identity'.

By continuing, you agree with the usage of your responses for my graduation assignment. Participating in this research is voluntary. At any point you are allowed to remove your consent and to leave this survey. You are free to stop at any point. You can request results of this research and they will be made clear to you.

When you have questions, you can email me (g.h.pastoor@student.utwente.nl) or my bachelor coordinator Job Zwiers (j.zwiers@utwente.nl). If you would like independent advice on partaking in this research or submit a complaint, then you can reach out to the ethical committee (ethics-comm-ewi@utwente.nl). This committee consists out of independent research members of the university and is available for questions and complaints in regards to this research.

Please tick your answer:

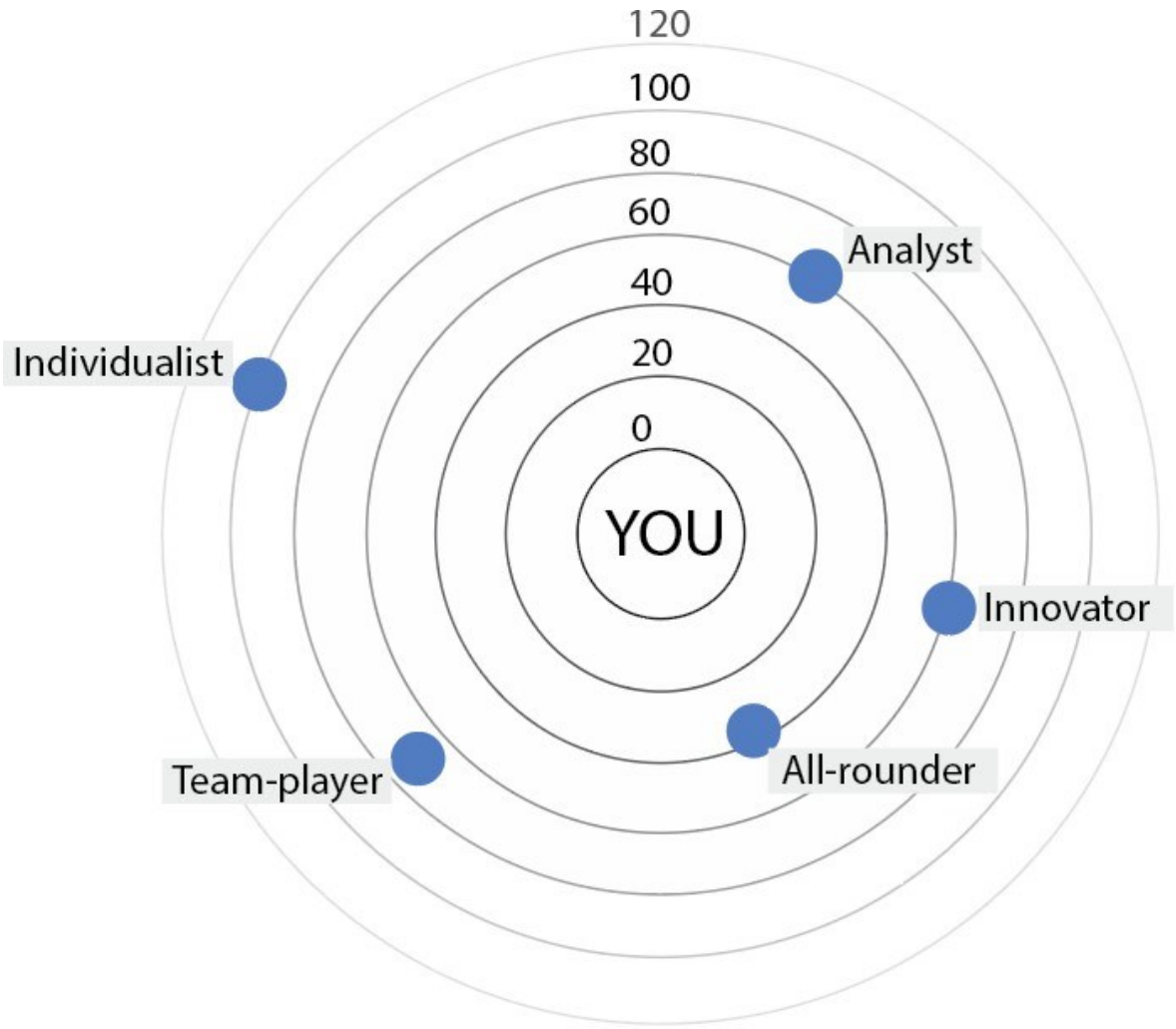
- ○ I agree with the terms and conditions
- ○ I do not agree with the terms and conditions

Block 1 - uitschieter laag

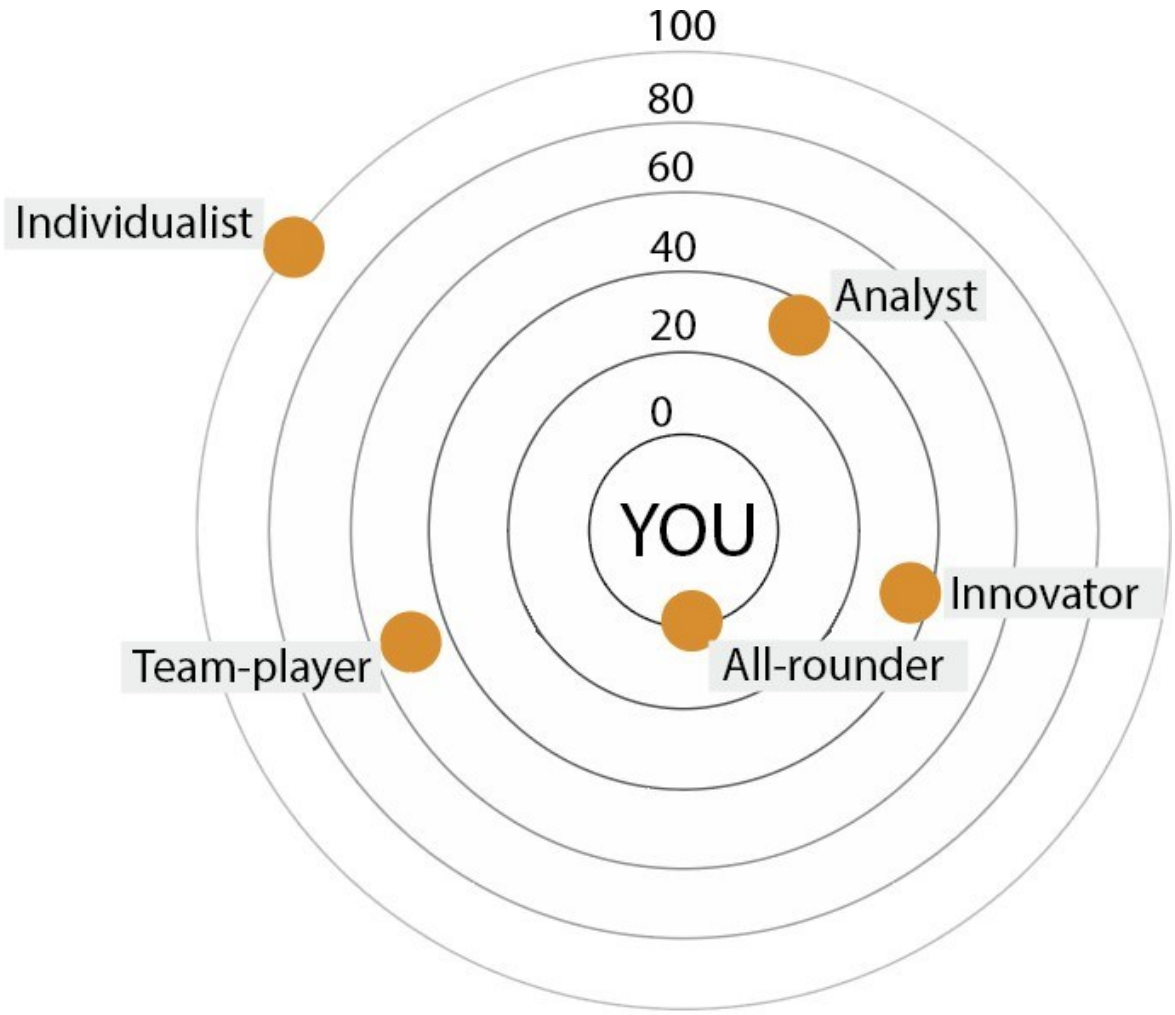
The following questions will be covering an element of the visualization of the Career Compass feedback tool (https://www.techyourfuture.nl/a-351/mind-the-gap-de-doorstroom-van-b%C3%A8tastudenten-naar-de-technische-arbeidsmarkt). The Career Compass is an online test in which students get provided with insight into who they are as a professional. This is important as it will help them make career choices that are right for them. The tool consist of four dimensions: personality, interests, values and competencies.

Based on the score that the student receives, a scoring pattern is created to gain insight in which profile the student fits best and how far away the student is from the other profiles. There are 5 profiles in total: analyst, innovator, all-rounder, team-player and individualist. Each profile represents a profile of a technical professional.

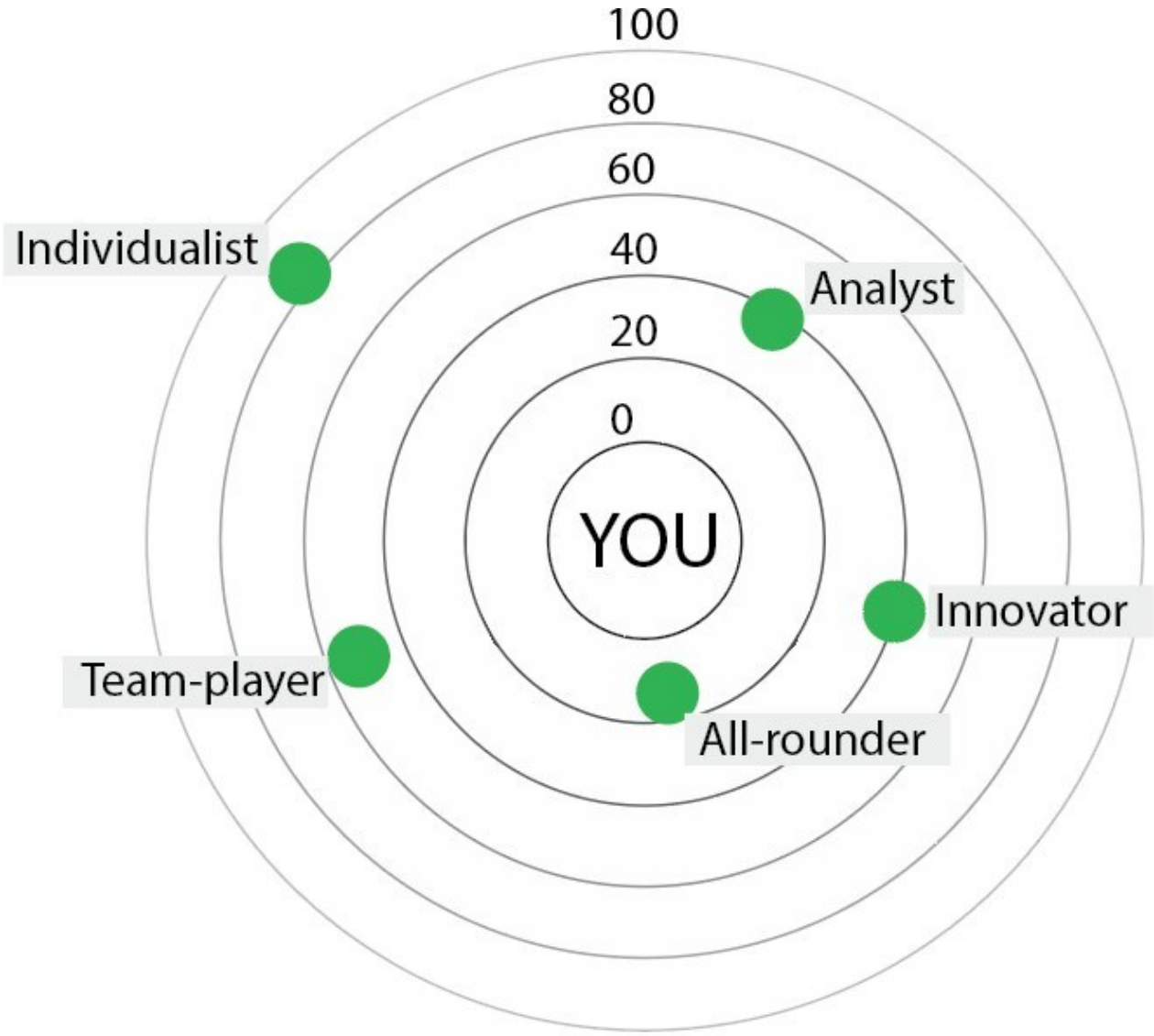
The following questions will be about the graphical representation of these five profiles on a radar-chart style, where elements close to the center (marked as 'you') fit best, and where elements far away from the center do not fit that well.


120
100
80
60
40
20
0
YOU
Analyst
Innovator
All-rounder
Team-player
Individualist

Option 1


100
80
60
40
20
0
YOU
Individualist
Analyst
Innovator
Team-player
All-rounder

Option 2




Option 3

Please pick one of the images above for every question below:

Which graph best depicts someone with an outspoken profile?

- ○ Option 1
- ○ Option 2
- ○ Option 3

Which graph best depicts a profile where one profile clearly fits the user the best?

- ○ Option 1
- ○ Option 2
- ○ Option 3

Which graph best depicts someone who has a lot of overlap with all profiles?

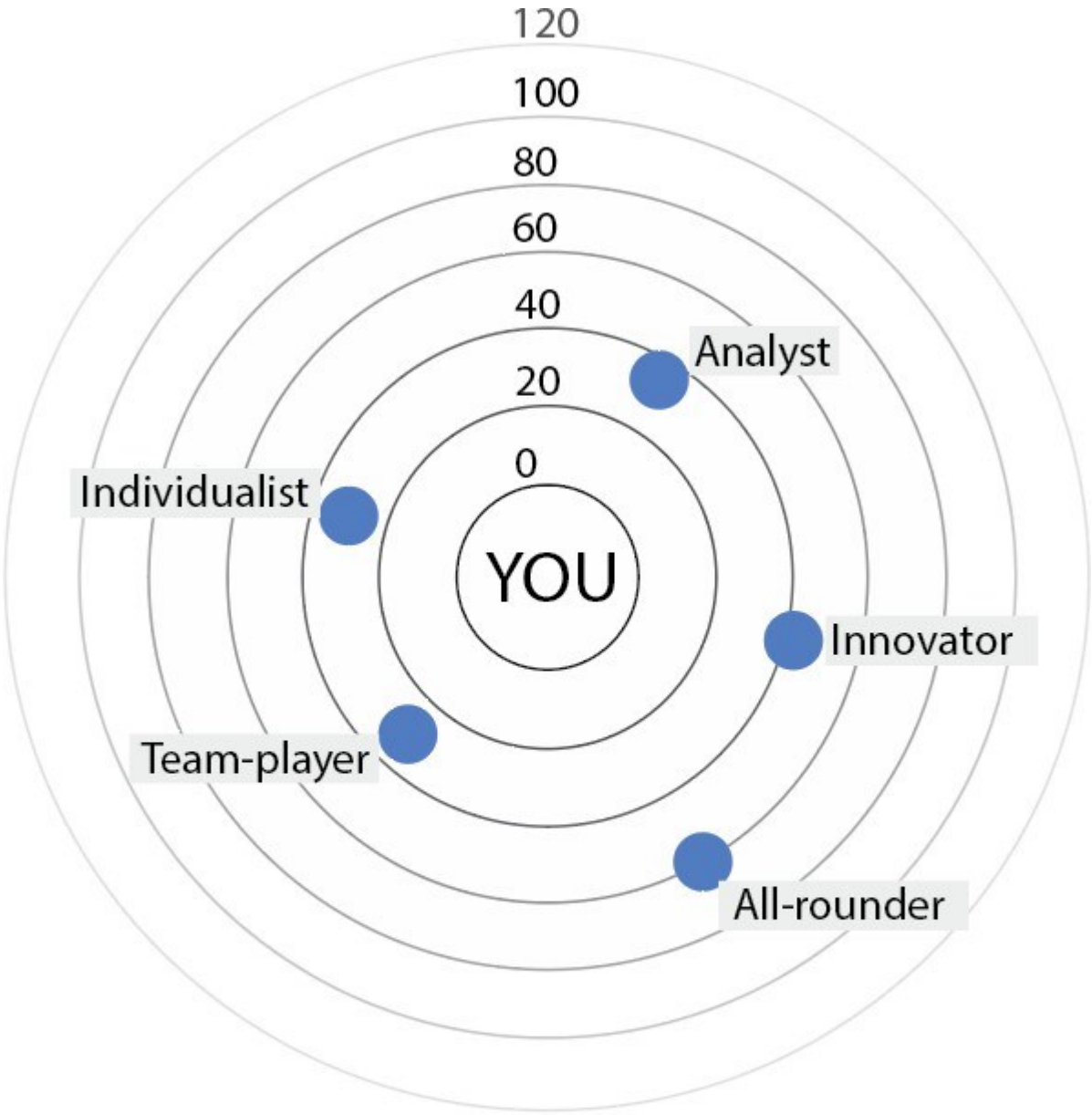
- ○ Option 1
- ○ Option 2
- ○ Option 3

Which graph best depicts someone who does not have a lot of overlap with any profile?

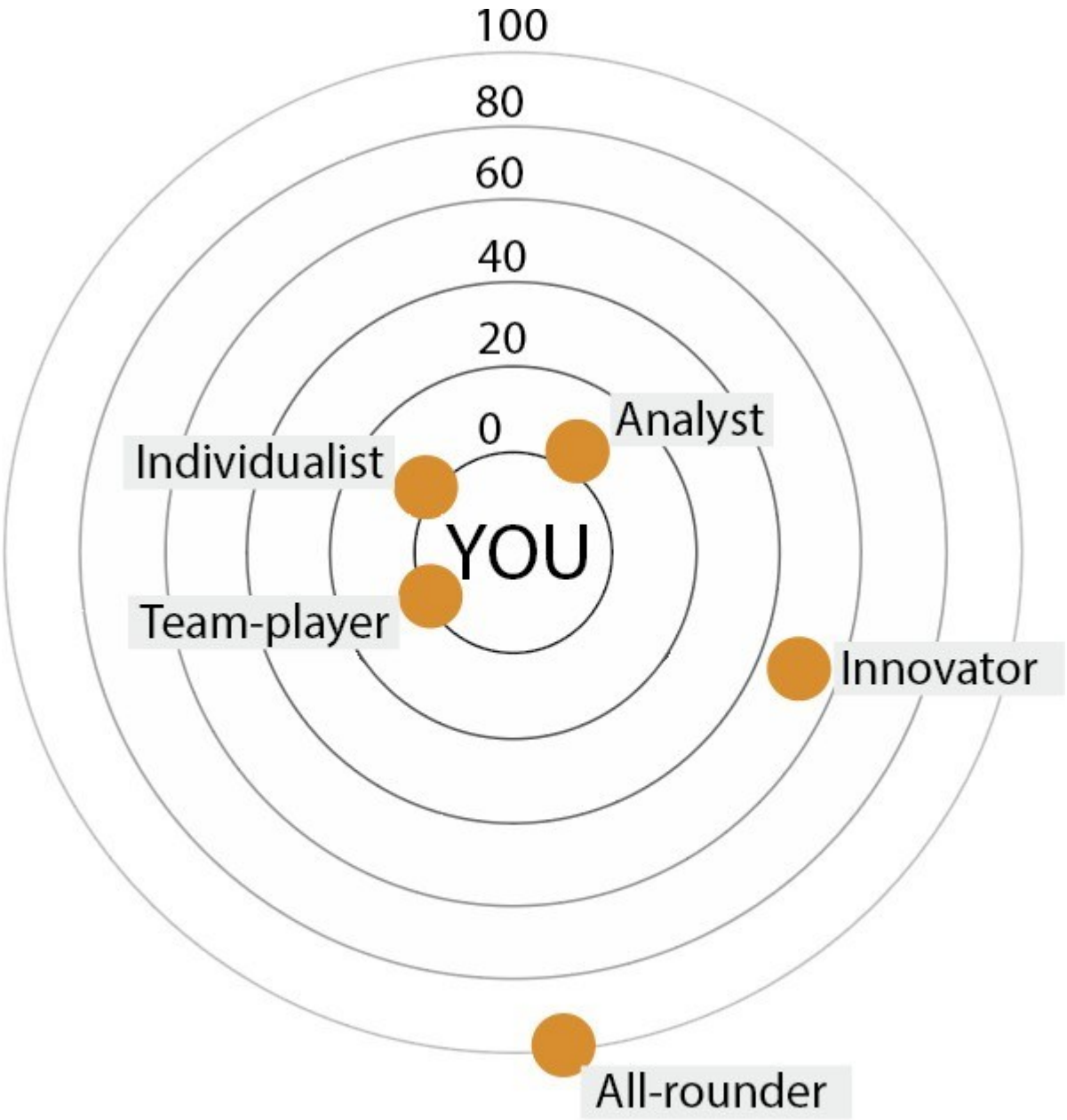
- ○ Option 1
- ○ Option 2
- ○ Option 3

## Block 4 - zwak profiel

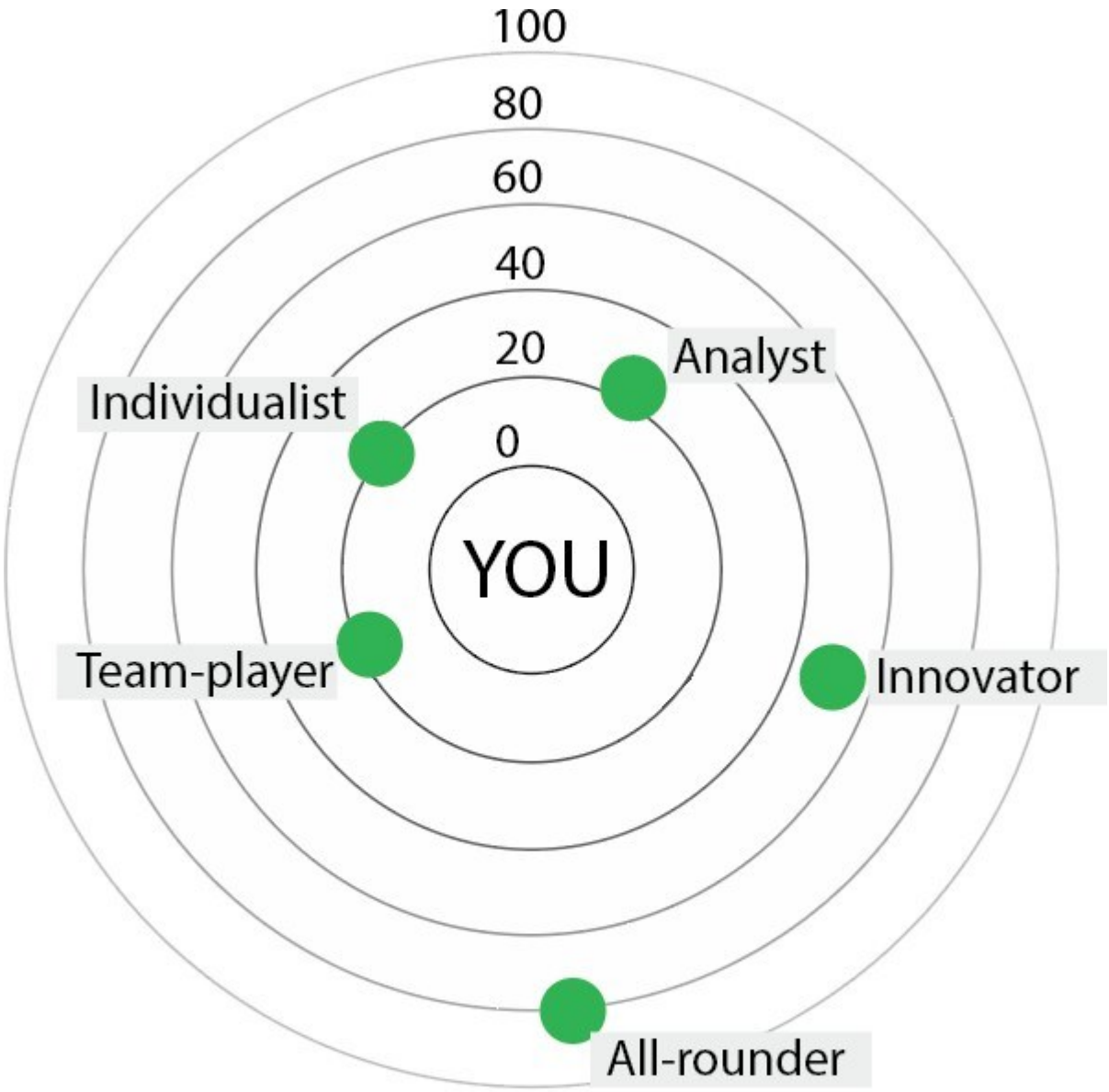
This question contains another set of graphs, with different results. Please answer the questions posed underneath the graphs. [2/4]


120
100
80
60
40
20
0
YOU
Analyst
Innovator
All-rounder
Team-player
Individualist

Option 1


100
80
60
40
20
0
Analyst
Individualist
YOU
Team-player
Innovator
All-rounder

Option 2




Option 3

Please pick one of the images above for every question below:

Which graph best depicts someone with an outspoken profile?

- ○ Option1
- ○ Option 2
- ○ Option 3

Which graph best depicts a profile where one profile clearly fits the user the best?

- ○ Option 1
- ○ Option 2
- ○ Option 3

Which graph best depicts someone who has a lot of overlap with all profiles?

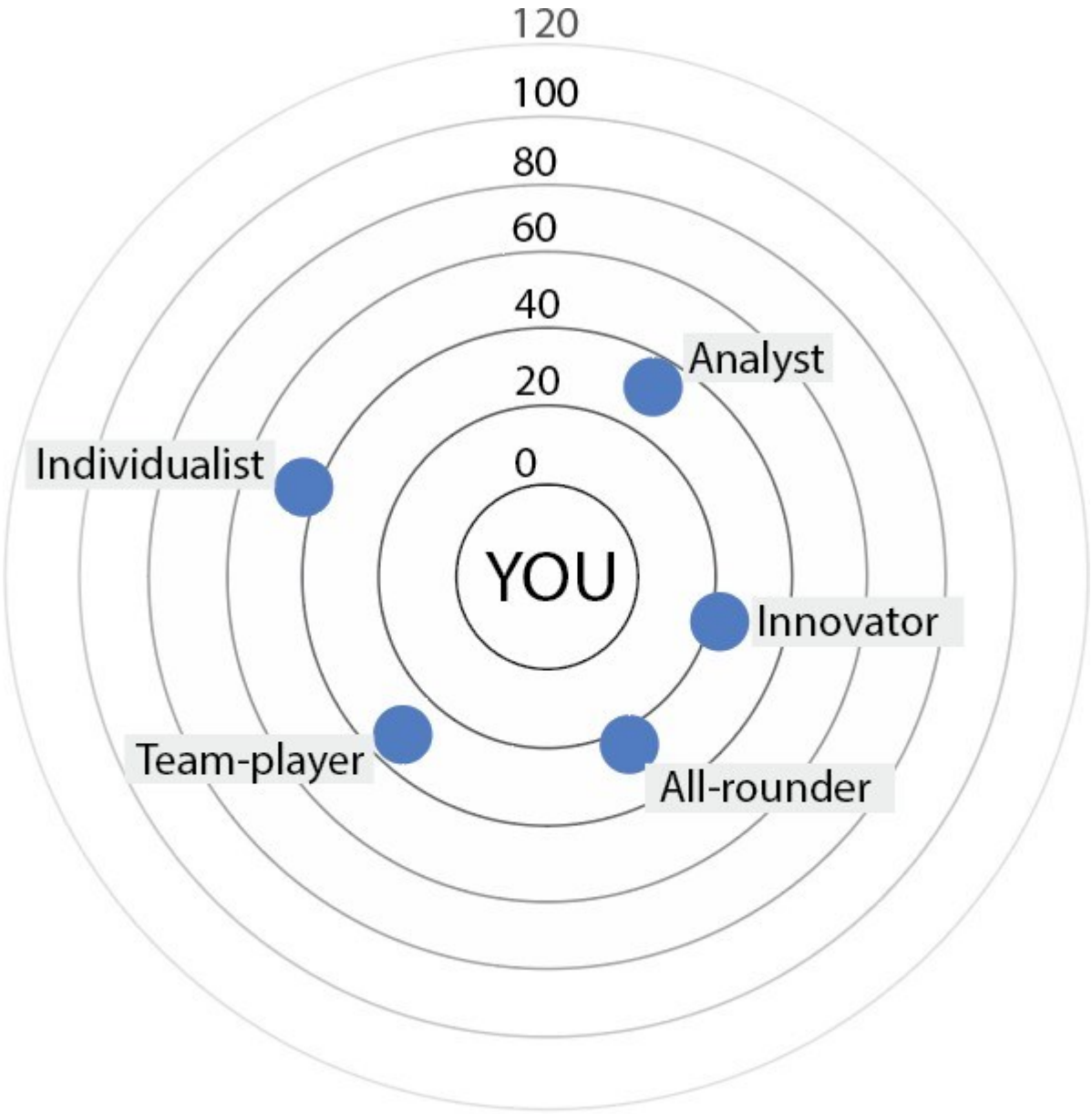
- ○ Option 1
- ○ Option 2
- ○ Option 3

Which graph best depicts someone who does not have a lot of overlap with any profile?

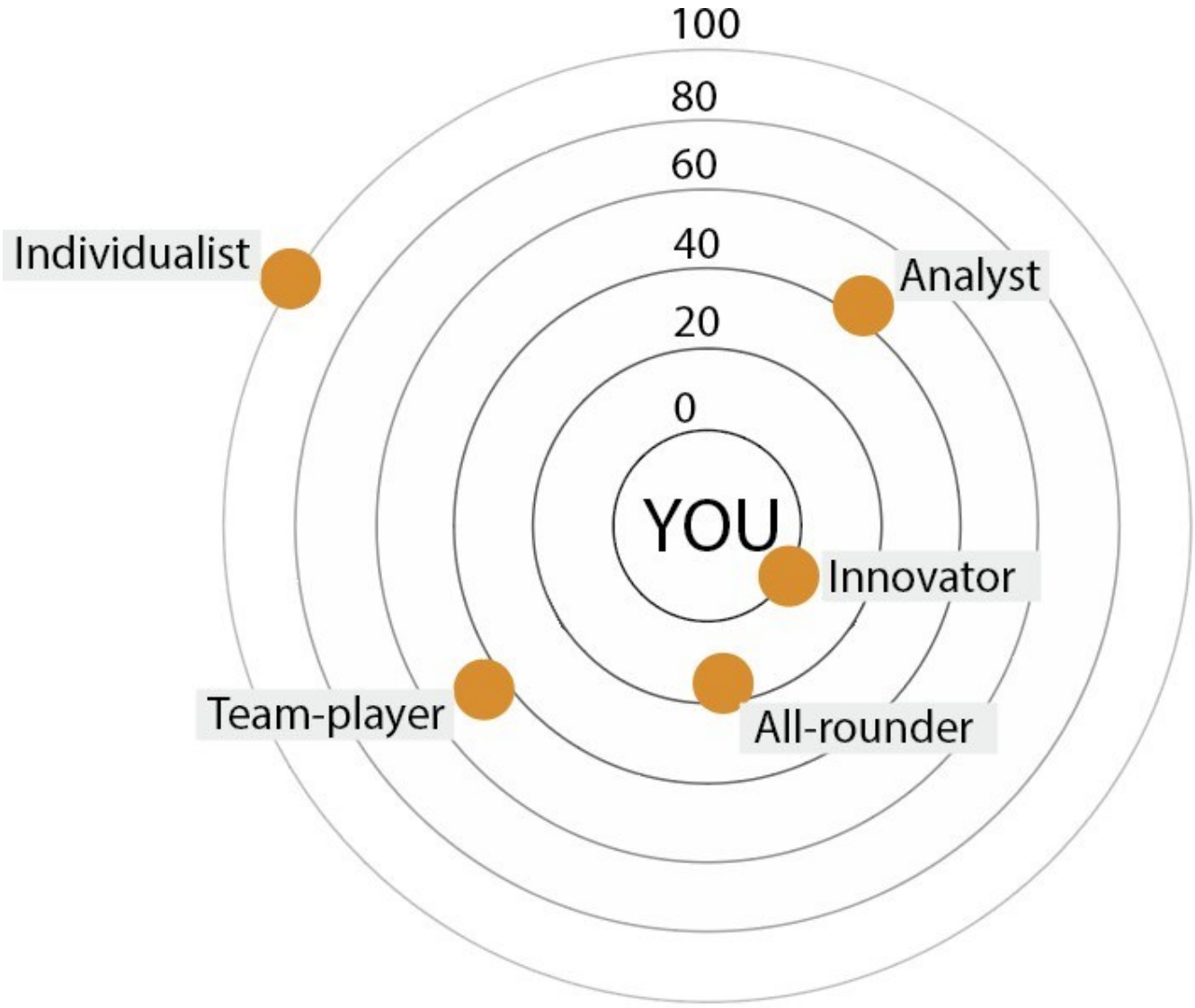
- ○ Option 1
- ○ Option 2
- ○ Option 3

## Block 5 - gemiddeld profiel

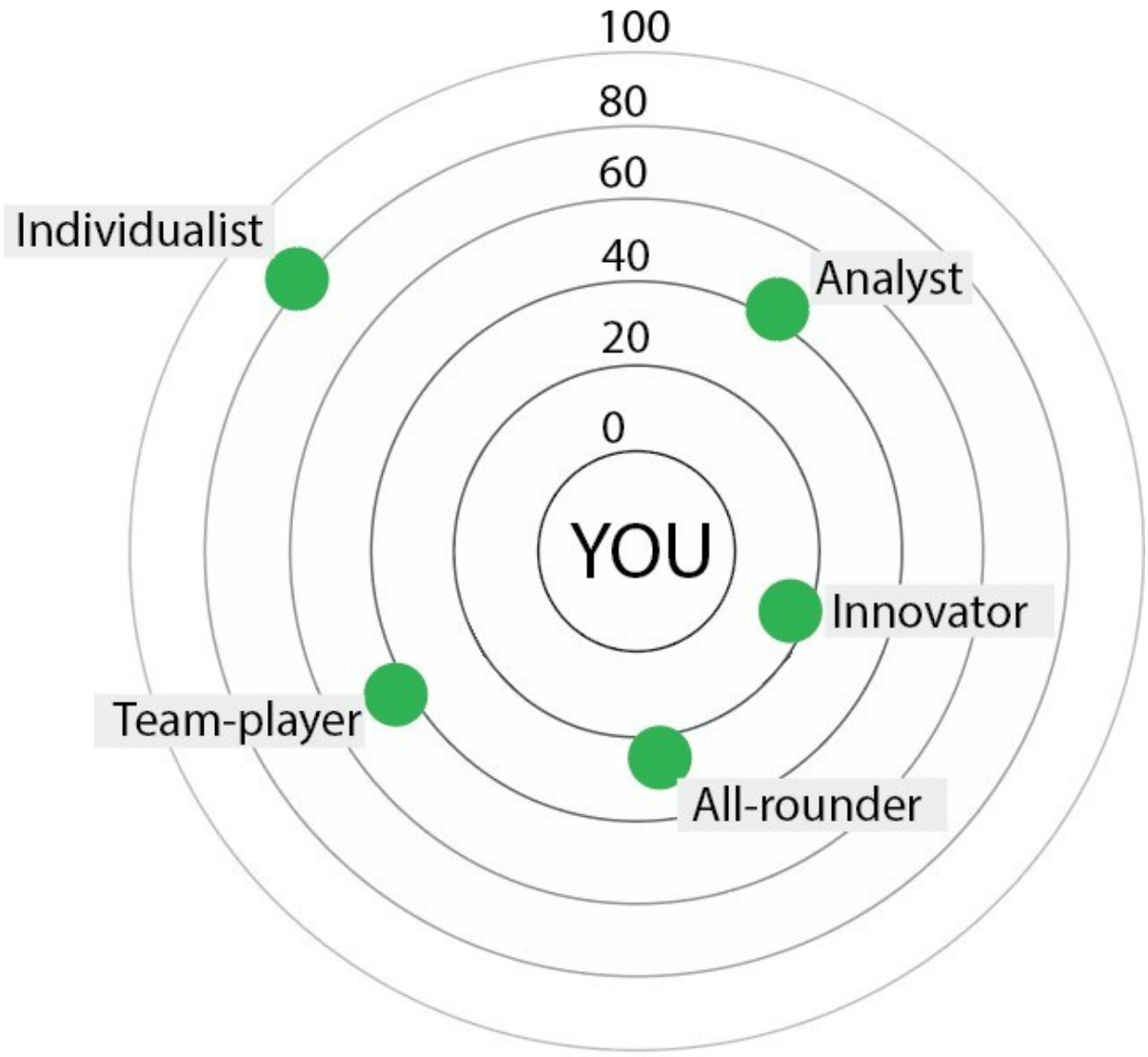
This question contains another set of graphs, with different results. Please answer the questions posed underneath the graphs. [3/4]


120
100
80
60
40
20
0
YOU
Analyst
Innovator
All-rounder
Team-player
Individualist

Option 1


100
80
60
40
20
0
Individualist
Analyst
YOU
Innovator
Team-player
All-rounder

Option 2




Option 3

Please pick one of the images above for every question below:

Which graph best depicts someone with an outspoken profile?

- ○ Option1
- ○ Option 2
- ○ Option 3

Which graph best depicts a profile where one profile clearly fits the user the best?

- ○ Option 1
- ○ Option 2
- ○ Option 3

Which graph best depicts someone who has a lot of overlap with all profiles?

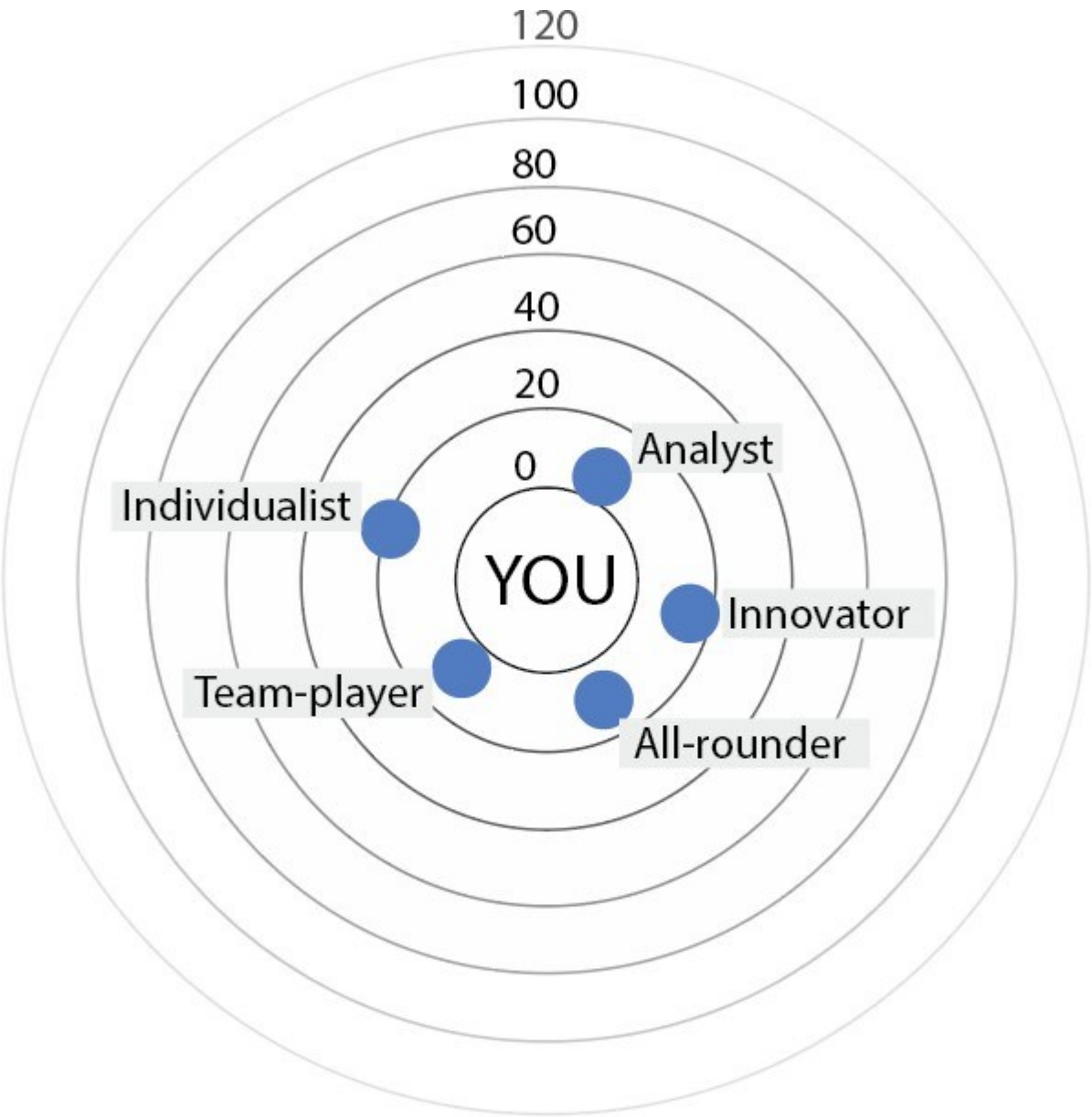
- ○ Option 1
- ○ Option 2
- ○ Option 3

Which graph best depicts someone who does not have a lot of overlap with any profile?

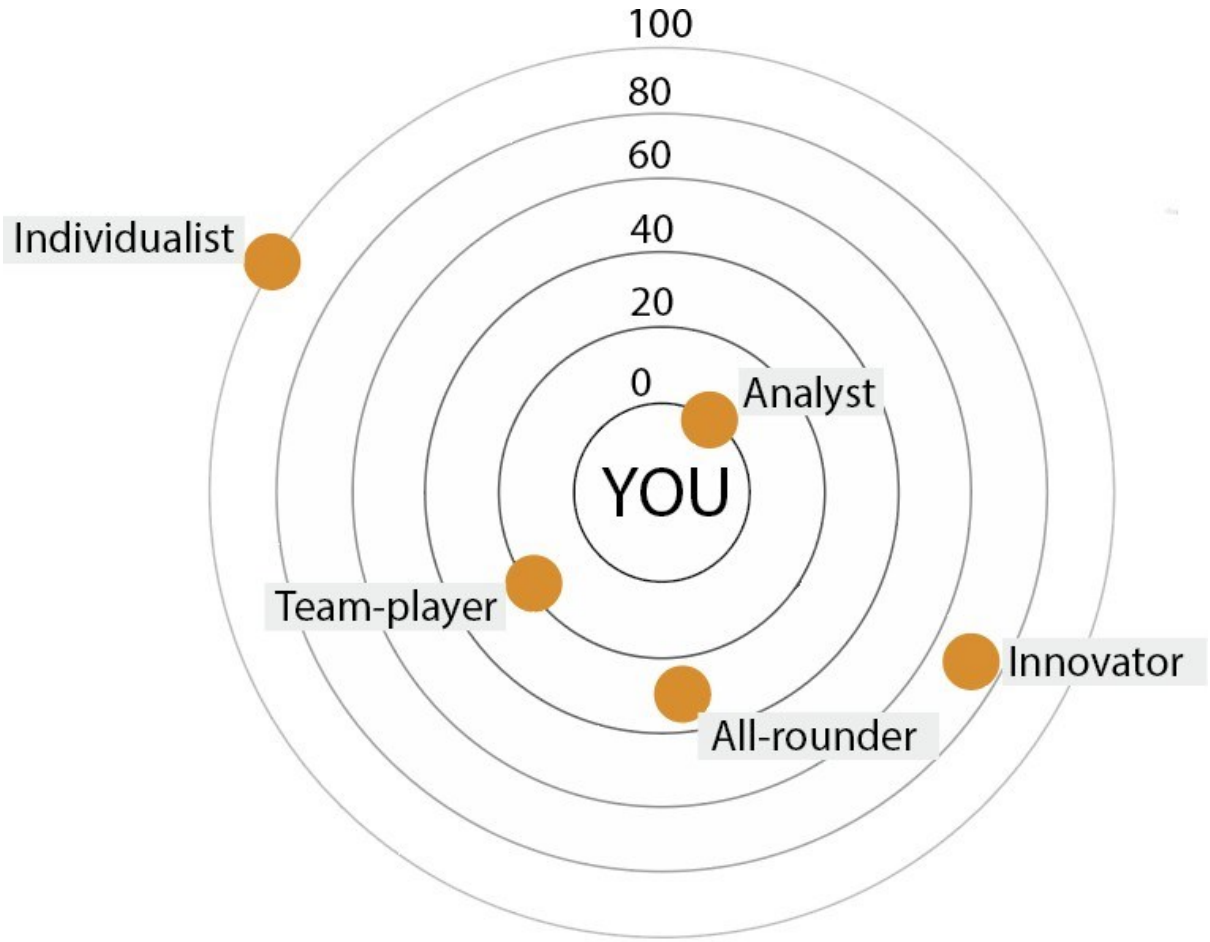
- ○ Option 1
- ○ Option 2
- ○ Option 3

## Block 6 - sterk profiel

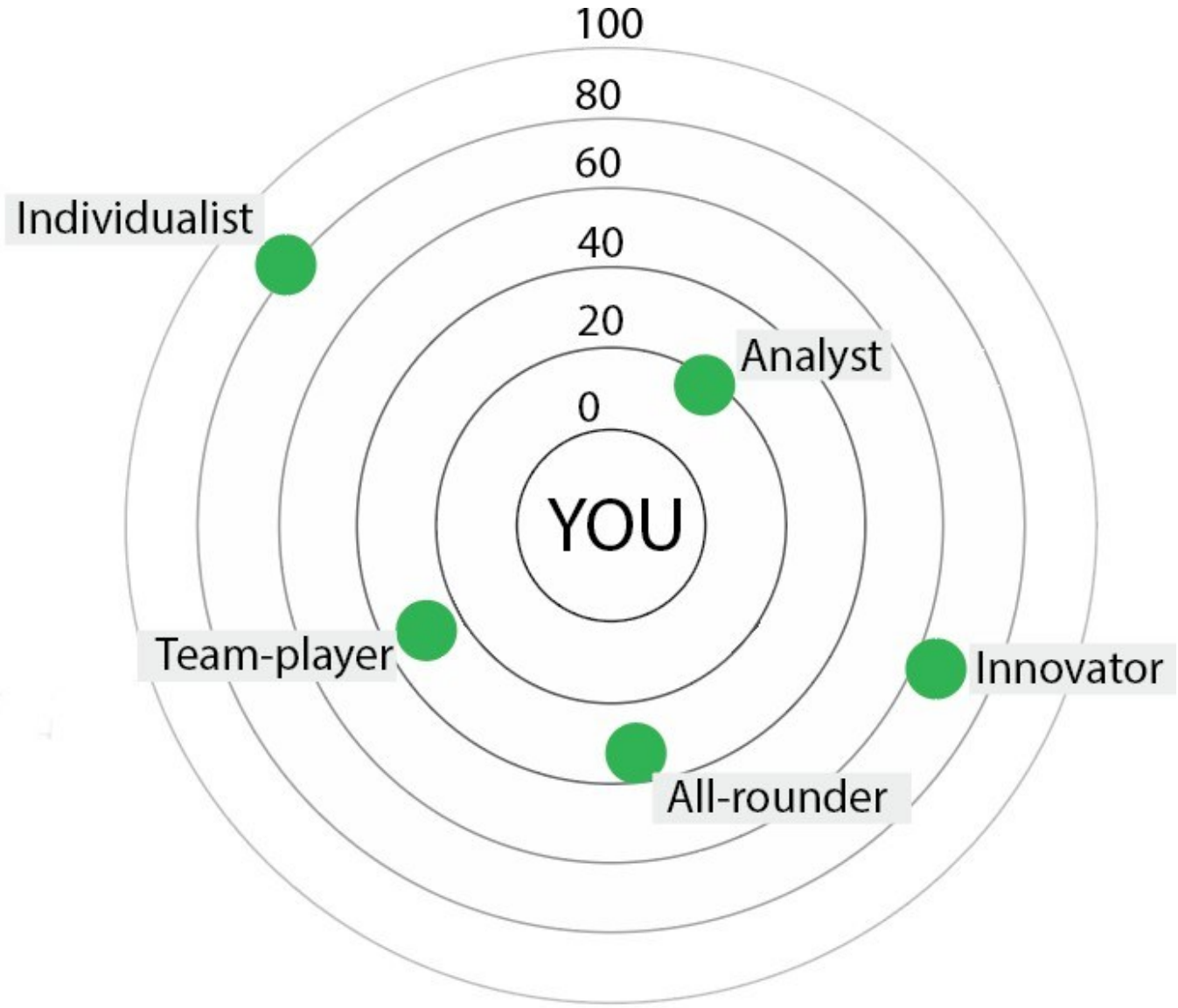
This question contains another set of graphs, with different results. Please answer the questions posed underneath the graphs. [4/4]


120
100
80
60
40
20
0
Analyst
Individualist
YOU
Innovator
Team-player
All-rounder

Option 1


100
80
60
40
20
0
Individualist
Analyst
YOU
Team-player
Innovator
All-rounder

Option 2




Option 3

Please pick one of the images above for every question below:

Which graph best depicts someone with an outspoken profile?

- ○ Option 1
- ○ Option 2
- ○ Option 3

Which graph best depicts a profile where one profile clearly fits the user the best?

- Option 1
- Option 2
- Option 3

Which graph best depicts someone who has a lot of overlap with all profiles?

- Option 1
- Option 2
- Option 3

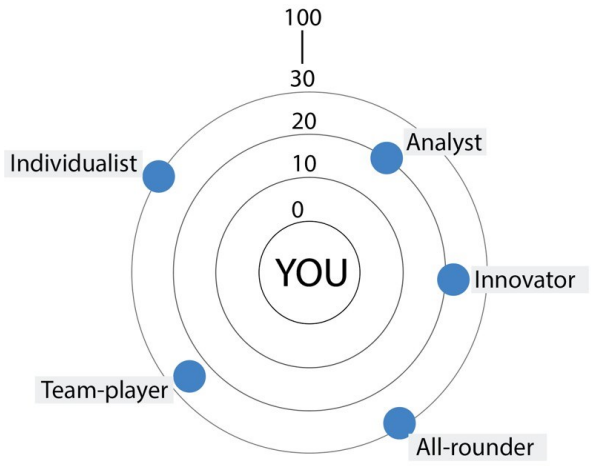
Which graph best depicts someone who does not have a lot of overlap with any profile?

- Option 1
- Option 2
- Option 3

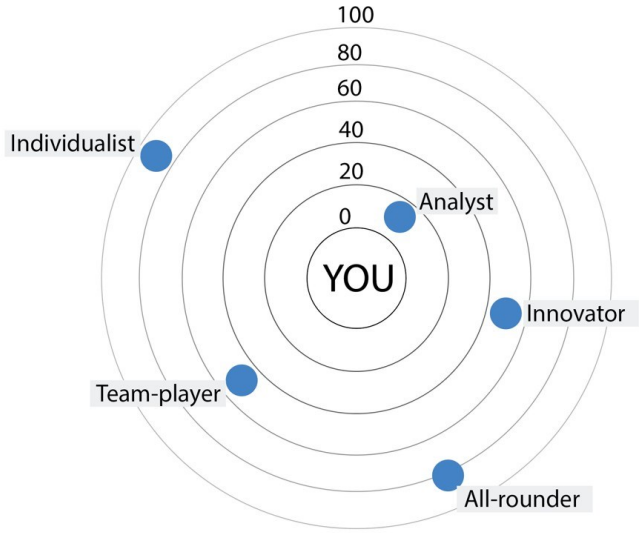
## Block 2

For every person, the outcome of the career compass is different. To stimulate the development of a students' professional identity, it could be helpful to clearly identify the profile that fits best to the user.

One of the methods that could possibly be used is to artificially enlarge the distances between the profiles to make the differences bigger and therefore bringing forth a more clear result of the profile. An example of such an alteration is given below.




Old situation (unaltered scores)




New situation (altered scores)

Out of the two options, please pick one which you prefer

◯ Option 1 (Old situation) ◯

Option 2 (New situation)

Please elaborate on your choice: (responding in Dutch allowed - antwoorden in het Nederlands toegestaan)

Please state your opinion on the next statement by using the slider below:

"Altering the scores leads to more clarity of the profile".

◯ Totally disagree ◯

Disagree

◯ Neutral◯

Agree

◯ Totally agree

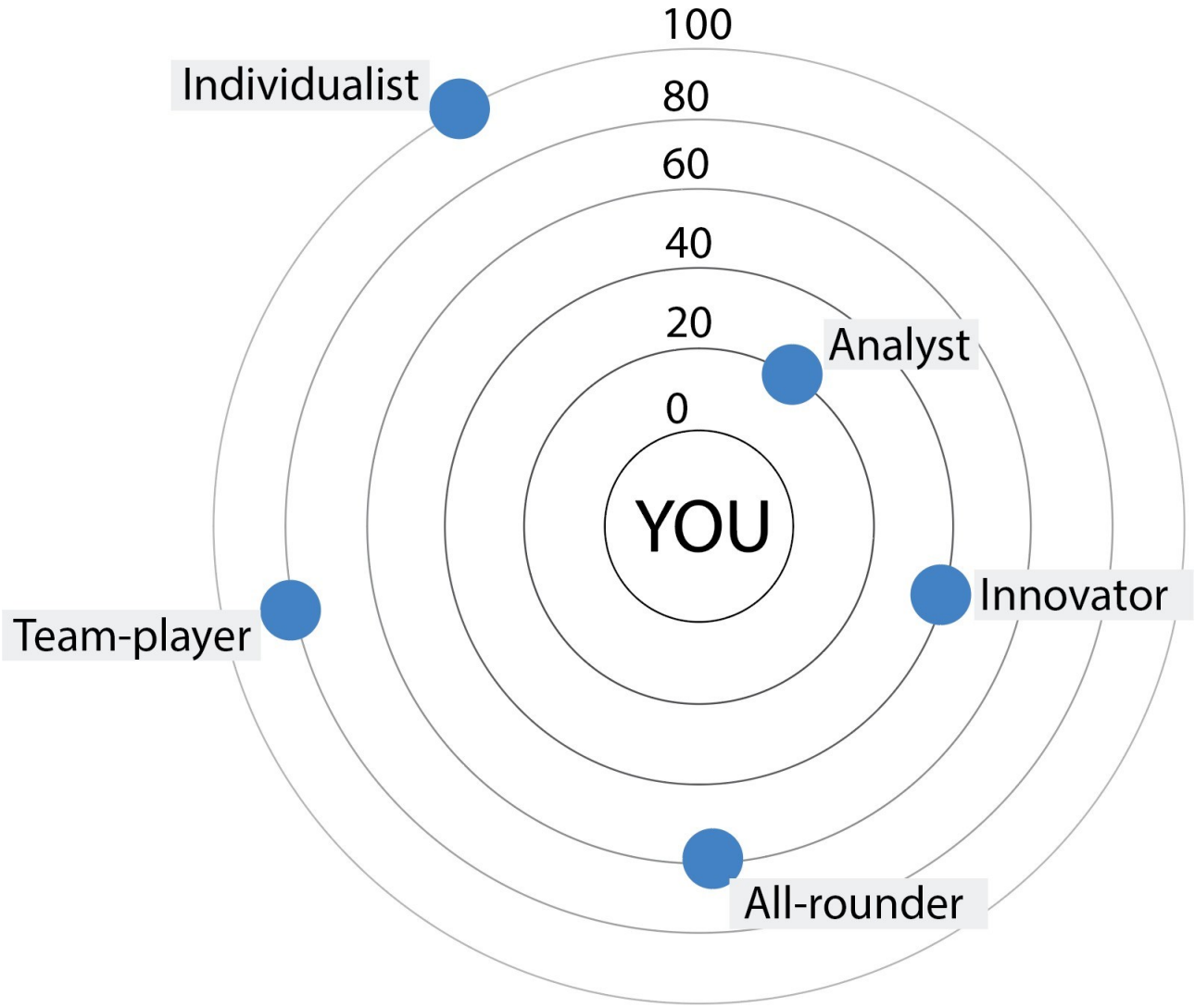
"I would prefer an altered, clear score over an unaltered, possibly unclear score."

- ○ Totally disagree
- ○ Disagree
- ○ Neutral
- ○ Agree
- ○ Totally agree

## Block 3

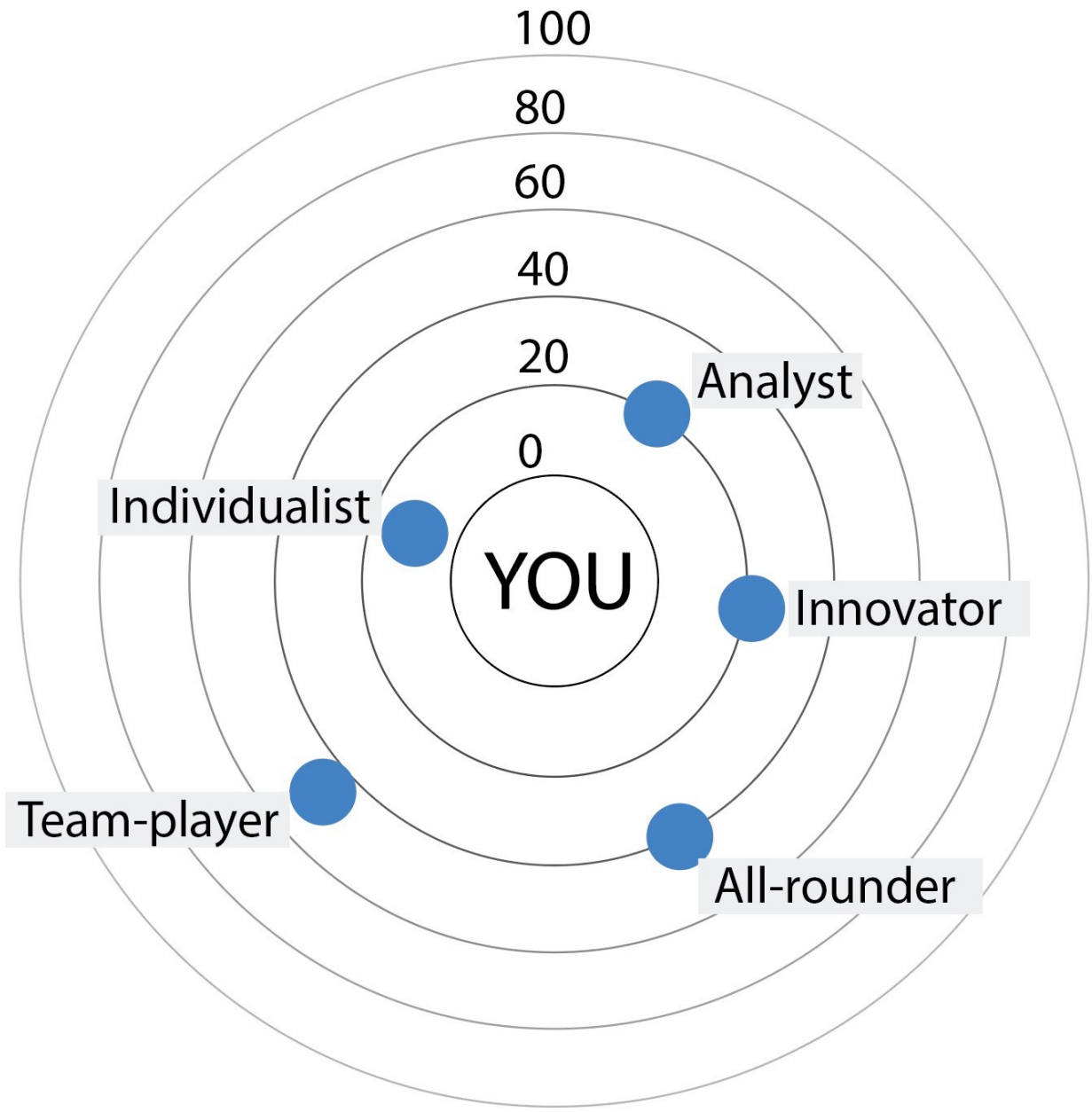
Next to the earlier option of modifying the distance, another option is to - for every student - make the distances equal to enhance visibility of profiles and to remove the possibility of clustered data. An example of such an 'equal distance' graph is given below. This is done because it is also important to show the user his second-best fitting profile and what profile is furthest away, next to his best fitting profile.

In such a graph, the first option starts at 20%, the second starts at 40%, the third at 60%, the fourth at 80% and the fifth at 100%.

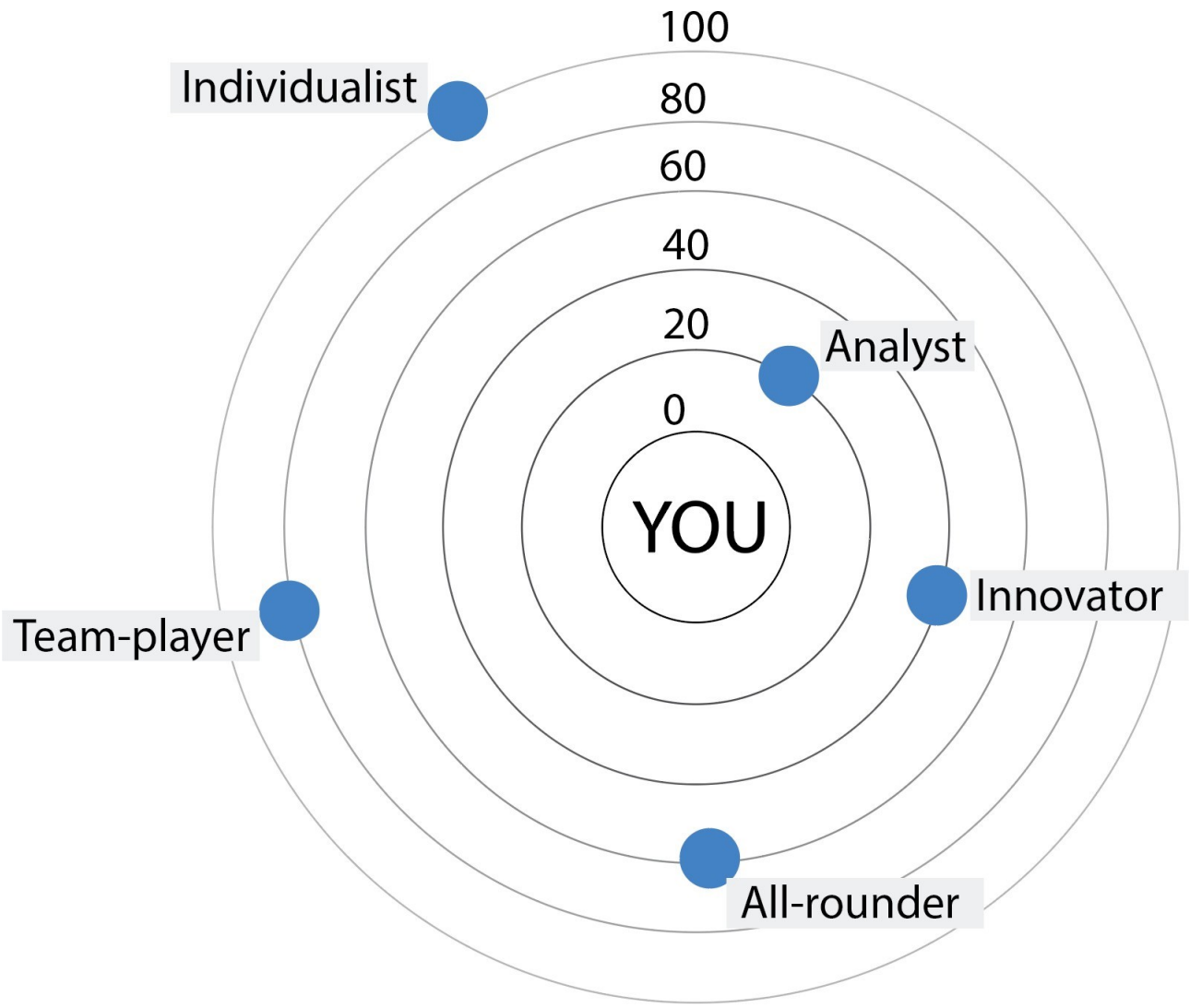



When presented with both the original style graph and this equal-distance graph, my preference goes out to:

○ Option 1 (regular distance)



○ Option 2 (equal-distance)




Please elaborate upon your previous answer (responding in Dutch allowed - antwoorden in het Nederlands toegestaan)

Please answer the following questions about the equal-distance graph. What is your opinion about the following statements:

"I think you should show people the real accurate distance"

○ Completely disagree ○

Disagree

○ Neutral

- ○ Agree Completely
- ○ agree

"I think fixed equal distances would make the differences more clear for everybody"

- ○ Completely disagree ○

Disagree

- ○ Neutral ○

Agree

- ○ Completely agree

"I think that the actual distance has no real influence on the clarity of the profiles"

- ○ Completely disagree ○

Disagree

- ○ Neutral
- ○ Agree Completely
- ○ agree

## Block 7

I am

- ○ Male
- ○ Female
- ○ Rather not say

My age is

Student at

◯ Saxion Enschede ◯

University of Twente

○ Other

# Appendix D: Consent form first research

**Consentformulier feedback-sessies & aanvullende informatie**

Beste deelnemer,

Allereerst, bedankt dat u mee wilt doen aan dit onderzoek. Mijn afstudeeropdracht gaat over het herontwerpen en mogelijk verbeteren van het Carrière Kompas, een online tool die je helpt om je als professional te ontwikkelen en die je feedback geeft over je personaliteit als professional. Om aan de slag te gaan met het design van dit kompas zal ik u drie verschillende visualisaties van één dataset voorleggen om te vragen wat uw gedachten en op-/aanmerkingen over dit ontwerp zijn. Dit gebeurt in de vorm van een gesprek met vooraf geformuleerde vragen (semigestructureerd interview). Deze ontwerpen zullen in de vorm van afbeeldingen/ video's aan u worden laten zien. De getoonde afbeeldingen en video's zullen niet schokkend van aard zijn. Dit onderzoek duurt maximaal drie kwartier, en de resultaten van dit onderzoek mag u na afloop inzien wanneer gewenst. Ik wil u vragen de volgende punten in acht te nemen en dit formulier ondertekend terug te sturen.

*Als deelnemer van deze feedback-sessies zal u:*

-Gevraagd worden toegestuurde bestanden in de vorm van afbeeldingen of video's te openen op uw eigen computer.

-Worden gevraagd om een videobel verbinding aan te gaan

-Eenmalig deelnemen aan deze sessie van 45 minuten

Deelname is geheel vrijwillig. Tijdens de interviews zal er worden meegeschreven. Citaten en fragmenten uit de feedback-sessies worden geanonimiseerd, en uw naam zal niet in het uiteindelijke verslag worden opgenomen. Op elk moment kan u uw consent innemen en zal de deelname per direct worden stopgezet zonder een reden op te hoeven geven.

Voor vragen kunt u bij mij terecht, of bij mijn begeleider (Job Zwiers) of de ethische commissie van de Universiteit Twente, van wie de contactgegevens onderaan deze brief te vinden zijn.

*Ik neem deel aan dit onderzoek en weet dat ik elk moment het onderzoek mag beëindigen, ik begrijp de bovenstaande informatie en ik geef toestemming aan de onderzoeker om mijn geanonimiseerde gegevens te gebruiken. Ik heb de informatie gelezen en heb geen vragen meer.*

_____ _____

Hermen Pastoor - s1839314

Handtekening deelnemer Datum

Met vriendelijke groet,

Hermen Pastoor (g.h.pastoor@student.utwente.nl)

Begeleider: Job Zwiers (j.zwiers@utwente.nl)

Ethische Commissie Universiteit Twente (ethics-comm-ewi@uwente.nl)