



# InSIDE: Including Students with Impairments in Distance Education

**Deliverable  
DEV2.3**

**Final adaptations on the  
educational material**

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## Abbreviations

Acronym	Term
A.##.##	Activity ##.##
Del.##	Deliverable ##
HE	Higher education
HEI	Higher education institution
ICT	Information and communications technology
InSIDE	Including Students with Impairments in Distance Education
Iwl	Individual with impairments
JKU	Johannes Kepler University
LMD	Licence, Master, and Doctorate
MS-Word	Microsoft Word
UABT	University of Aboubekr Belkaid Tlemcen
UAE	Abdelmalek Essaadi University
UB2LA	Blida 2 University
UCA	Cadi Ayyad University
UIT	Ibn Tofail University
UM5R	University of Mohammed V in Rabat
UMMTO	Mouloud Mammeri University of Tizi-Ouzou
UOA	National and Kapodistrian University of Athens
UOM	University of Macedonia
US	University of Sousse
USFAX	University of Sfax
USTO	University of Sciences and Technology of Oran Mohamed Boudiaf
UTM	University of Tunis El Manar
ViHeMo	Visual, hearing, mobility/physical
WP	Work Package

## About InSIDE

The aim of the project is to develop accessible DE programmes for individuals with ViHeMo impairments. The concrete aims are to: a) develop an accessible, inclusive and educationally effective model of DE that will deliver key competences for vocational rehabilitation, and provide opportunities for lifelong learning, skills enhancement, and personal fulfilment with the ultimate aim of suggesting an intelligent solution against the problems of limited access or high percentage of dropouts in HE in Iwl, b) structure a strong cooperation between organisations with sound expertise in accessible and inclusive HE and organisations where both the modernisation of HE and the promotion of the right to education of Iwl is imperative, and c) widen the horizons of local HE towards an international and intercultural education through DE programmes.

The overall objectives of the project are to:

- 1) Develop new and innovative, accessible and inclusive DE programmes improving the quality of HE for individuals with ViHeMo impairments and offering flexible learning and virtual mobility
- 2) Upgrade the facilities through establishing accessibility offices and acquiring assistive technology resulting in modernization of university services
- 3) Build capacity and professional development in administrative and teaching staff in developing and carrying out accessible and inclusive DE programmes, and operating the accessibility offices
- 4) Involve individuals with ViHeMo impairments in a user-center design so that accessibility and usability are achieved in conjunction, and the links between education and society are strengthened

The specific objectives of the project are:

- The preparation of the development stage through an extended literature review for precedent trials in DE for Iwl
- The development of the most suitable educational material for Iwl (ViHeMo) in terms of accessibility, usability and educational efficacy through the study of end-user requirements
- The adaptation of a course delivery system that best serves the needs of Iwl (ViHeMo) in DE
- The foundation of accessibility services in HE so that SwI would be supported during their attendance in HE
- The training of advisors in the services of the accessibility offices, and the training of the trainers (advisors and representatives) so that they will be able to train the end-users (teaching staff and Iwl)
- The examination of the regular co-operation of all the above to deliver inclusive DE courses effectively when learning and skill enhancement are concerned, considering end-users feedback too
- The dissemination and exploitation of the project deliverables on an international level.

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## 1. Introduction

The present work resulted by the assessment of the accessible educational material by the end-users themselves on two stages: a) the pilot testing with the participation of 5 individuals with visual impairments, 5 individuals with hearing impairments and 5 individuals with mobility impairments (A.2.2.3, Del. 2.2), and b) the research on user requirements with the participation of 63 individuals with visual impairments, 19 individuals with hearing impairments, and 35 individuals with mobility impairments, coming from two countries of Africa, Algeria and Tunisia (A.2.2.7, Del. 2.2). The two-stages assessment of the accessible educational material lead to the emergence of the specific needs and the preferences of the end-users. As a result, more special and specific standards for the development of accessible educational material per impairment category and kind of material, emerged and are presented in this report. Based on these standards, transformations of the preliminary version of the accessible educational material were completed (wherever that was possible) to deliver a more appropriate version of the material for the end users.

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## 2. Conclusions & Changes

### 2.1. Individuals with Visual Impairments

#### 2.1.1. MS-WORD Textbook

Participants appreciated the helpful document navigation features, including shortcuts (Ctrl + F), headings, and table of contents, as well as the clarity of content with clear descriptions of links and references and the use of bold for headings. The glossary for unfamiliar terms and organizations was also valued. However, changes were suggested, such as relocating and enlarging the page numbering in the left corner and addressing usability issues related to the heaviness and slowness of the accessibility program (Supernova + NVDA) and difficulty with bullet point symbols on mobile devices. Suggestions for improvements included maintaining the helpful navigation features, considering placing the glossary at the end of the book, slightly increasing the font size of titles, using numbered lists instead of bullet points for better mobile readability, ensuring consistent and clear page numbering. Additionally, participants mentioned the robotic voice from the screen reader (NVDA) as a disadvantage.

#### Changes

- Slightly increasing the font size of the titles.
- Enlarging the page numbering.

#### 2.1.2. DAISY Textbook

Participants expressed various opinions on the accessibility of the DAISY format. Some appreciated its organization and convenience, finding it well-organized and allowing for quick movement. However, others found it more difficult to navigate compared to Word and had issues with page numbering. On the other hand, many participants appreciated the navigation bar and yellow text highlighting during screen reading. Suggestions for improvements included announcing page numbers during screen reading, placing annotations at the end of each page, and adding space or a horizontal line for page changes. Disadvantages mentioned included the inability to open links, difficulties in taking notes by copy-pasting, loss of page numbering within the text, and confusion regarding page changes. It is important to note that participants listed both shared and unique advantages and disadvantages, highlighting the format's suitability based on individual preferences and needs.

#### Changes

- Page numbers should be announced within the book during screen reading, similar to Word.
- Page change should happen with some space and maybe a horizontal line from edge to edge.
- A table of contents at the beginning of the book with the same format as in a Word file would be helpful. (software customization)
- Annotations should be placed at the end of each page, rather than at the end of the book. (software customization)

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### 2.1.3. EPUB Textbook

Participants shared their feedback on various aspects of the EPUB document. They discussed navigation, suggesting improvements like better positioning of the table of contents. Appearance was another point of discussion, with participants recommending maintaining a book-like appearance while enhancing navigation methods. The addition of page numbers within the document was suggested for easier navigation. Changes to the placement of footnotes to avoid confusion were also proposed. Advantages highlighted included proper chapter distribution, an integrated reader, appealing appearance, and ease of page finding. Disadvantages mentioned encompassed the inability to copy-paste, difficulties with menu navigation, slower speed compared to Word, lack of specified page numbers within the text, single-page view, and font issues.

#### Changes

- Adding page numbers within the document for ease of navigation.
- Modifying the font styling of the text (software customization)

### 2.1.4. MS-WORD Sample book

The participants emphasized the importance of using headings, graphs, links, and alternative text for accessibility purposes. They preferred working with Word due to its accessibility features and found asterisks helpful in indicating important sentences. Verbal descriptions for images and graphs were considered crucial, with participants suggesting the use of boundaries to distinguish images from text and placing images at the end of chapters to maintain the flow of text. Tables were found to be more useful than verbal descriptions for presenting data, while bullet points were preferred over table structures. The convenience of defining the beginning and end of an image was highlighted. Suggestions for improvements included adjusting the layout to place images after each chapter and moving the asterisk to the beginning of important sentences. Overall, participants expressed satisfaction with the book's design and content, appreciating its ease of use and accessibility features.

#### Changes

- The asterisk should be placed at the beginning of an important sentence for better comprehension. Keeping the repetition of the word 'asterisk' at the beginning and end of the important sentence.
- Placing images at the end of a chapter or book to avoid interrupting the flow of text.
- Less description for simple images.
- Placing images after each chapter for better readability

### 2.1.5. DAISY Sample book

During the exploration of the DAISY samplebook, participants focused on the quality of graphs and images in the digital format, particularly in comparison to the Daisy textbook format. They noted that the digital format's graphs were comparable to those in Word and that images had clear boundaries. Participants suggested that this digital format may be superior to the Daisy textbook due to its easier navigation without the need to find specific pages. However, they acknowledged the disadvantage of navigating pages in the Daisy format. The respondents also commented on the distinctness, size, and vividness of the graphs, as well as the quality of the letters. They observed a positive trend in the popularity of Daisy books. Suggestions for improvement included image placement at the end of each chapter, maintaining image boundaries but relocating them, and adding page numbering within

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the text. Participants appreciated features such as voice options, easy navigation with arrow keys and Ctrl + I, underlining in the integrated screen reader, and the availability of the contents bar. Advantages of the DAISY format included ease of navigation, clear images and fonts, underlining and the navigation bar, and compatibility with mobile phones, while disadvantages included the inability to make text changes, lack of page numbering, and the inability to add pages.

#### Changes

- Placing images after each chapter for better readability.
- Adding page numbering within the text.

#### 2.1.6. EPUB Sample book

The participants have highlighted that the EPUB Thorium reader, an application for reading EPUB books, consistently uses the term "caption" when referring to captions, which is appreciated and seen as appropriate by the participants. This suggests that the use of clear and accurate terminology in instructional materials holds importance for them. In terms of navigation, participants expressed a desire to change the navigation to the contents, finding it difficult to use, and also suggested altering the page numbering. They emphasized the importance of having an asterisk at the beginning of important sentences. Regarding visual elements, participants favored keeping bullets and the mention of "caption" from the screen reader when reading image captions. They recommended moving images to the end of each chapter and expressed dissatisfaction with the font used in the material. In terms of the general structure, participants wished to modify page numbering, address color loss in important sentences, and improve the appearance of bold writing. Advantages of the EPUB Thorium reader included its easy use on mobile devices, the small file format suitable for portable devices, the use of the term "caption" for image captions, and its modern and visually appealing appearance. Disadvantages mentioned were the inability to edit text, the difficulty and complexity of navigation, the separation of the beginning of an image from the rest of the content, and the absence of pages.

#### Changes

- Adding page numbering within the text.
- Changing the images at the end of each chapter.
- Modifying the visual appearance of the text such as font styling, color loss in the important sentence and the bold writing, which doesn't look good (software customization).
- Changing the navigation to the contents (software customization).

#### 2.1.7. PowerPoint

Participants expressed surprise and praised the accessibility of the PowerPoint presentation (ppt), particularly its ability to describe images. They found the ppt to be very helpful and fulfilling its purpose effectively. The overall evaluation of the ppt was positive, with participants stating that they really liked it and considering it to be of high quality. Feedback included suggestions to keep the material as it is, make minor changes like adjusting the background color to gray, or improving certain aspects such as making tables more recognizable like in Word. The advantages of the ppt mentioned by participants included clear images and font, the ability to create lists and include audio, text, and video, as well as the flexibility to make it accessible in terms of images. Bullets, numbering, and lists were also appreciated for facilitating understanding. The main disadvantage mentioned was the inability to make changes to the text. Overall, the participants highlighted more

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advantages than disadvantages of this form of material, with one participant noting a lack of familiarity with some features like alternative text for images.

#### Changes

- Making the table more recognizable, like in Word.
- Changing the background colour to gray (n=1).

#### 2.1.8. Verbal descriptions

The participants provided a positive evaluation of the material, describing it as helpful and satisfying. While most participants expressed a desire to keep the material mostly unchanged, some minor changes were suggested, such as making the text shorter or reducing the amount of information presented. Overall, the material was praised for its detailed information and descriptions, which were found to be very helpful in understanding the content. It was also appreciated for being understandable and concise, providing a comprehensive picture of the subject matter and delivering information quickly. However, some participants felt that there was too much information, with lengthy and detailed descriptions that could be overwhelming. Complex graphs were also mentioned as a potential challenge in understanding the material. Additionally, a few participants felt that certain information provided was unnecessary or not useful. In summary, while the detailed nature of the material was generally appreciated, there were varying opinions on its length, complexity, and relevance to the overall content.

#### Changes

- The verbal description could be shorter, removing unnecessary information.

#### 2.1.9. Video

All participants expressed a positive evaluation of the material, acknowledging its usefulness. Some participants recommended minor changes, such as adding an audio description to the video instead of a separate Word file to avoid fatigue or/and distracting when listening to both files (video file and word file). They also suggested modifying the reader screen description in the Word document's table for better clarity (the screen reader table description using terms like "row 1, row 2" considered confusing or tiresome by some participants). The material was praised for providing detailed information and descriptions that aided understanding, especially for aspects that may have been missed in the video alone. Overall, the material was regarded positively, with suggestions for improvements to enhance integration and usability.

#### Changes

- Adding an audio description to the video instead of a separate Word file.
- Modifying the reader screen description in the Word document's table for better clarity (the screen reader table description using terms like "row 1, row 2" considered confusing or tiresome by some participants). (software customization)

#### 2.1.10. Tactile microcapsule

All participants reviewed the tactile material positively. Information in more specialized subjects can become accessible. The different textures in different regions were very helpful for some of them. One participant mentioned that small details were more understandable in microcapsule paper. They mentioned they could understand the shapes easily and would keep the graphs and textures.

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However, some changes and improvements were suggested. One participant mentioned that the Braille language was too close to the signs and the small signs were not very clear to him. They recommended the division of the material in smaller parts, zoomed in with more details and the addition of legends describing each region. Most of the participants mentioned that they would use the tactile material in combination with another type of accessible material like verbal description or audio tactile material.

#### Changes

- Division of images into smaller zoomed-in parts therefore more details appear
- Moving the Braille text further away from the surfaces makes them more readable

#### 2.1.11. Tactile tiger prints

Participants provided positive feedback on the tiger tactile material. They mentioned the positive impact of the surface textures of the tiger prints. Separate details were clearer and more intense. The lines were bold and the regions were understood better. However, in some cases they could not understand the details accurately. In regions overwhelmed with information they had difficulties distinguishing each element. Again, the division of material in smaller parts zoomed in with more details was recommended. The combination of the Tiger prints with an audio element seems to be preferable. Lastly some participants mentioned that familiarization is needed to use tiger tactile prints.

#### Changes

- The elements can be more distinguishable from one another by leaving adequate space between them
- Division of images into smaller zoomed-in parts therefore more details are present

#### 2.1.12. Audio tactile

All the participants expressed a positive evaluation of the material. Many mentioned this was their favorite type of material because of how easy it was to get the information and perceive each area. While most of the participants mentioned they would find it helpful to have a verbal description in the beginning, one participant preferred to receive a tactile copy initially and then proceed to the audio tactile one. Lastly it was mentioned that some individuals might find it difficult to use the material on their own because of the devices that are needed and, in some cases, the tactile touchpad may be unaffordable.

#### Changes

- Adding verbal description in the beginning of the exploration of image allows the participants to get a better understanding of the explored image.

#### 2.1.13. Math

The feedback for mathematical content was mainly positive but some had neutral feelings. Most of the participants expressed positive opinion about the mathematical equations being accessible and the fact that they do not need printed content in braille or nemeth. However, they also mentioned that the screen readers need to be updated. Some letters were not spelled correctly and the participants could not understand the content.

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#### 2.1.14. Chem

Most of the opinions were neutral but also there were positive ones. The participants struggled to understand the chemical equations. They mentioned that signs were read as letters and confused them. However, on the positive side this material is easy to distribute to more students and there is no need for printing.

#### 2.1.15. Visual image (for low vision)

The participants mentioned that this type of material was almost ideal and all of them gave a positive review. The colors were good and the information was easy to get visually. Some recommendations were made. While this type of material is good when there is not a lot of information, when there are more elements, changes are needed. Verbal descriptions in the beginning of the exploration would be helpful. The shapes and the structures should be minimal. Generally, all participants mentioned that an audio element would be helpful in combination with this material.

Changes

- Different contrasts, for example black background and white letters are equally readable.
- An audio description can supplement information obtained visually

#### 2.1.16. Visual audio-tactile image (for low vision)

Most of the feedback was positive however there were negative opinions also regarding this material. Generally, the participants found the material useful and commented that they could get the information easily and could read shapes that would be difficult in other occasions. Having the remaining vision some participants mentioned that the tactile feedback was unnecessary for them. However, in some it helped. One participant mentioned that she would keep two types of sensory feedback, not three. Either tactile and audio or Visual and audio.

Changes

- An audio/verbal description can supplement information obtained visually and haptically

### 2.2. Individuals with Mobility Impairments

#### 2.2.1. 1. MS-WORD Textbook

Participants expressed their preferences regarding the material and suggested changes to enhance its usability. They appreciate the headers for document navigation, find the description of links helpful, and prefer keeping the page numbering at the top left. However, they recommend improving the navigation bar by increasing the font size and allowing simultaneous visibility of the page for each header. Participants also suggest total alignment, more spacing and indentation for improved readability, and changing the hyperlink functionality (single-click instead of double-click for opening links) and table of contents for easier access. One participant expressed satisfaction with the material's structure and wouldn't make any changes. They highlight the user-friendly nature of the material, its accessibility for individuals with mobility impairments, and the advantage of being able to edit the text. No specific disadvantages were mentioned. Overall, the participants provide valuable feedback on the material and its usability.

Changes

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- Total alignment in the text.
- More spacing in the text as it can be dense.
- Adding more space between titles and text, and adding indentation for improved user-friendliness
- Improving the navigation bar by increasing the font size and allowing simultaneous visibility of the page for each header (software customization).
- Changing the hyperlink functionality and table of contents to require only one click for opening links. (software customization).

### 2.2.2. DAISY Textbook

Participants provided feedback on the navigation and features of the DAISY textbook, as well as comparisons with Word. They found the navigation bar easier to use compared to Word and suggested clearer visual distinctions between levels of indentation in bullet points. Clicking on hyperlinks was convenient, and they desired a feature to easily return to previous locations. Page references within the document for easier navigation and footnotes placed at the end of the page were also suggested. Participants mentioned that footnotes are better in Word, but appreciated the single-click access to hyperlinks and the integrated screen reader in the DAISY textbook. One participant found the application appealing and liked the larger font size in the navigation bar. They recommended keeping the large font size, content navigation bar, page locator bar, and single-click link opening. Changes suggested included adjusting the highlighting color and style, adding a visual indicator for page transitions, including a "back" option, incorporating page numbering, adjusting spacing and indentation, moving footnotes to the end of each page, and adding Greek language support. The advantages of the DAISY textbook mentioned by participants included the content navigation bar, single-click link opening, larger font size, integrated screen reader, and color-coded sections. Disadvantages mentioned included difficulty in changing pages within the document, absence of page numbers, limited zooming options, footnotes located at the end of the book, lack of Greek language settings, and the loss of the free embedded voice. Overall, participants provided valuable feedback to enhance the usability and features of the DAISY textbook.

#### Changes

- It would be ideal to have a feature that allows returning to the previous "location", especially when there are multiple footnotes, links, and references.
- Adding page numbering within the text.
- Placing footnotes at the end of each page.
- Lack of Greek language settings, and the loss of the free embedded voice in the EasyReader (software customization).

### 2.2.3. EPUB Textbook

Participants provided feedback on what elements to keep and what changes to make for the EPUB format. They suggested keeping the eye-friendly and easy-to-read font, references, spacing between titles and paragraphs, readability of annotations, distances between titles and paragraphs, highlighting and color scheme during reading, embedded screen reader, and the progress bar indicating the percentage of the book read. Changes and modifications suggested included changing the color of the highlighting to blue, adding a page finding bar at the bottom right of the document similar to the Daisy format, adding paragraph indentations and page numbering within the document, making changes to the way pages are navigated, modifying the navigation bar to improve the accessibility of the table of contents, changing the language settings to include Greek, and

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altering the appearance of annotations in the EPUB format. The advantages of the EPUB format mentioned by participants included useful references, the book-like appearance, integrated screen reader, highlighting and color-coding during reading, and the progress bar. Disadvantages mentioned included the absence of page numbering within the document, lack of a free embedded Greek voice, challenges with table of contents accessibility, annotations that don't facilitate the reading experience, and difficulty in finding specific pages due to the need to open a separate tab and navigate to the page search bar. The participants' feedback provides insights into improving the EPUB format for better readability and user experience.

#### Changes

- Adding paragraph indentations.
- Adding page numbering within the text.
- Modify the navigation bar to eliminate the need for opening a tab. (software customization).
- Changing the language in the settings in the Thorium Reader to include Greek as an option. (software customization).
- Altering the appearance of annotations as they are displayed in the ePub format. (software customization).

### 2.3. Individuals with Hearing Impairments

#### 2.3.1. Open captions

All the participants reviewed the open captions material positively. The context was well understood and they liked the color of the captions. The black background of the captions received mixed reviews. Some participants liked the contrast with the white captions and could read them clearly, while others mentioned that it hides information from the video. A proposition that was made was to turn the black background transparent. The speed of the captions was considered a little high and some individuals might find it difficult to catch up. Lastly, one participant mentioned that he would like to get more information from the captions, not only the dialogs and voices.

#### Changes

- In some cases, the black background can be transparent so that it does not hide information
- The speed of the captions can be ideal for the participants to catch up
- More information can be conveyed by the captions, such as surrounding sounds

#### 2.3.2. Closed captions

The Closed captions in this case received mixed evaluation. Some reviewed it positively, while others negatively. The functions provided by the closed captions received the most positive feedback. Most of the participants liked the fact that they could control the captions properties, like color, size, speed, appearance. What bothered almost all of the participants was the position of the captions. It would change positions in different dialogs. Most preferred the caption position on the bottom of the screen. The speed of the captions while it was fine for most of the participants, some found it high.

#### Changes

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- The speed of the captions can be ideal for the participants to catch up
- More information can be conveyed by the captions, such as surrounding sounds
- The position of the captions can be fixed, at the bottom of the screen

### 2.3.3. Sign language

All the participants commented positively on the presence of sign language. The information is understood faster with sign language. However, many did not like the translation made by the translator and recommendations were made. Firstly, the translator, being from another city, signed words that were difficult to understand by some participants. Some mentioned they felt the signing was a direct translation of the dialogs and would not give more information on the context of the video. Recommendations were made on the size and position of the translation video. Many participants preferred a smaller window located on the bottom right part of the image and not hiding information from the video. Regarding the translator, he or she should be visible from the waist and above, with the background having a good contrast with the translator, wearing dark or black clothes, with hair pulled back.

#### Changes

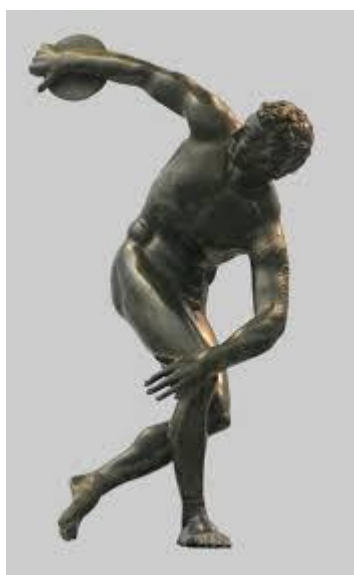
- The translation can include surrounding sounds, not only dialogues.
- The translator window can be located at the bottom right corner so that it does not hide information.
- More focus should be placed on the hand signs of the translator, therefore good contrast can be present such as black background and dark clothes.

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### 3. Transformations of the preliminary version of the accessible educational material

#### 3.1. Verbal descriptions of images

Based on the participants suggestions the verbal descriptions were shortened and unnecessary information was removed.



*Figure 1 The Discobolus of Myron*

**Short verbal description:** The “Discobolus of Myron” is a bronze statue of a fit, muscular man poised to throw a discus. The sculpture exudes tension and athleticism with its dynamic pose and detailed depiction of the man’s muscular physique.

**Long verbal description:** The “Discobolus of Myron” is a bronze statue. The Discobolus is a young and fit man frozen in the pose of launching his discus by holding it in his right hand. He has muscular arms and legs and a toned torso. His face turned back towards the hand that holds the discus. Discobolus bends his knees, throwing his body’s center of gravity to his right foot while turning his torso slightly to the right. The left foot is behind the right in a crossed position with the left heel raised from the ground while the right heel stays firmly on the ground. His right arm, parallel to the ground, is extended outwards slightly bent at the elbow. The left hand is slightly resting on his right knee. The tension is highly apparent on his body.

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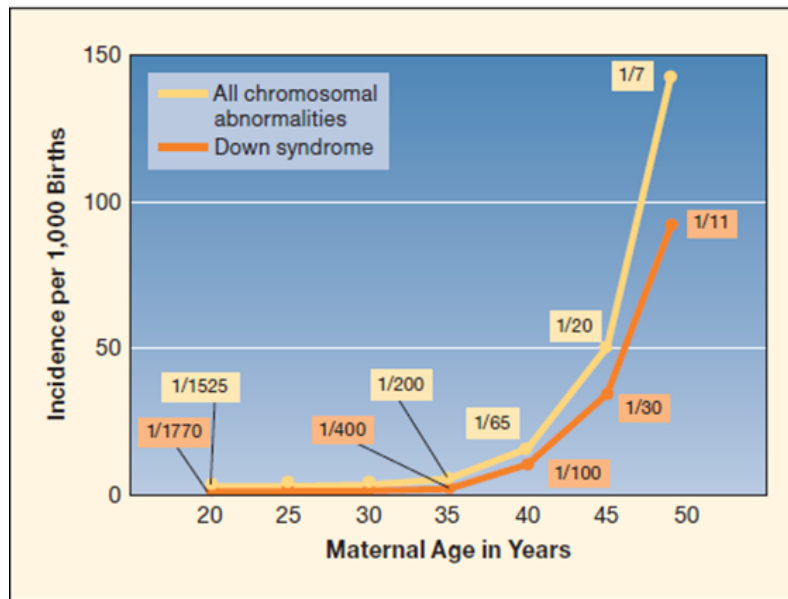


Figure 2 Down Syndrome and all chromosomal abnormalities

**Short verbal description:** This line graph compares the incidence of Down syndrome and all chromosomal abnormalities based on the maternal age. The risk for both conditions increases as the mother's age exceeds 35.

**Long verbal description:** This is a line graph. There are two lines in the graph. The first line concerns Down syndrome, while the other one concerns all chromosomal abnormalities. The vertical axis refers to the incidence per 1000 births and the horizontal axis to the maternal age in years. In the vertical axis, the course line representing Down syndrome seems to be on a lower level than the other one, however as the age of the mother increases, the distance between the two lines seems to grow. According to the graph, for a 20-year-old mother, the risk of Down syndrome is at 1 in 1770 births, while the respective risk for all chromosomal abnormalities is at 1 in 1525 births. For a 35-year-old mother, the risk of Down syndrome is at 1 in 400 births, while for all chromosomal abnormalities is at 1 in 200. For a 40-year-old mother, the risk of Down syndrome is at 1 in 100 births, while for all chromosomal abnormalities is at 1 in 65. For a 45-year-old mother, the risk of Down syndrome is at 1 in 30 births, while for all chromosomal abnormalities is 1 in 20 births. Finally, for a 50-year-old mother, the risk of Down syndrome is at 1 in 11 births, while for all chromosomal abnormalities it is at 1 in 7 births. Both course lines, the one referring to Down syndrome and the other to all chromosomal abnormalities, follow an upward trend due to the fact that when the mother's age exceeds 35 years the risk for Down syndrome and all chromosomal abnormalities is also increased.

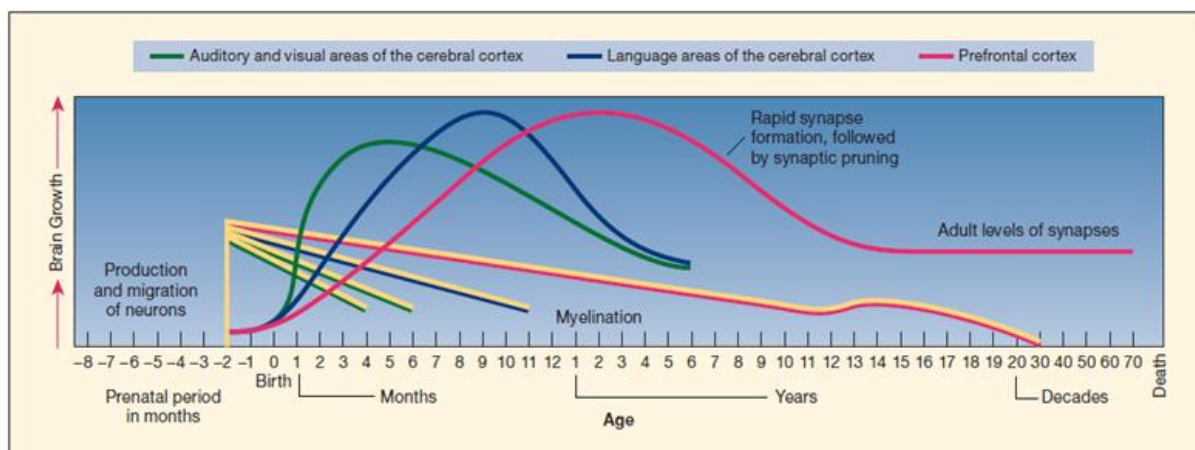


Figure 3 Brain Development

**Short verbal description:** This line graph shows the brain development over time. The vertical axis represents the level of development, with higher positions indicating greater development. The horizontal axis represents age, starting from prenatal stages and progressing to adulthood. The graph consists of two parts: the upper part with curved lines representing neuron production, migration, and synapse formation, and the bottom part with straight lines representing myelination. The curved lines show the development of auditory, visual, and language areas, with different patterns of growth and decline. The prefrontal cortex line follows an upward trend until age 3, then declines until age 13, and remains stable thereafter. The myelination lines indicate the time frame for myelination in the corresponding areas.

**Long verbal description:** This is a line graph that refers to the development of the brain. The vertical axis of the graph refers to the development of the brain, that is, the higher the course of each line, the more developed the area or areas represented by each line. The horizontal axis refers to the age which starts from the prenatal period, 8 months before the birth, and is depicted in the graph in months. Following a) the birth at the zero point, b) the first 12 months after the birth, c) the age in years, starting from first year and reaching up to 20 years, d) age in decades, starting from 20 and reaching up to 70, and finally e) death. The graph consists of two parts. The upper part of the graph shows three curved lines and the bottom part shows three straight lines. The neurodevelopmental processes depicted include the production and migration of neurons, the rapid synapse formation by synaptic pruning, and myelination. Neuron production begins in the eighth month before birth. This is followed by the migration of neurons where the auditory, visual and language area of the cerebral cortex and the prefrontal cortex are formed. The first curved line represents the auditory and visual areas of the cerebral cortex which develop faster than the other areas. The development of the auditory and visual areas is rapid from birth to 5 months, while after 5 months it follows a downward trend and finally the development of these areas stops at 6 years. The second curved line represents the language area of the cerebral cortex. The second curved line follows an upward trend up to 9 months, then the downward trend begins, and finally the development of the language areas stops at 6 years. The third curved line represents the prefrontal cortex. It follows an upward trend up to 3 years, a downward trend up to 13 years and a steady trend from 13 years to death.

The curved lines representing the language areas of the cerebral cortex and the prefrontal cortex show their maximum at a higher level in the graph compared to the auditory and visual areas of the cerebral cortex.

As for the second part of the graph, there are four straight lines to indicate the time of myelination. These lines represent the same areas of the cerebral cortex that the Top of the graph represents. In

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this part of the graph, the acoustic and visual areas are rendered with two lines. All lines start at their maximum value 2 months before birth. Then follows a downward trend. Myelination lasts up to 30 years in the prefrontal cortex, up to 11 years in the language areas and up to 4 and 6 years in the visual and auditory areas.

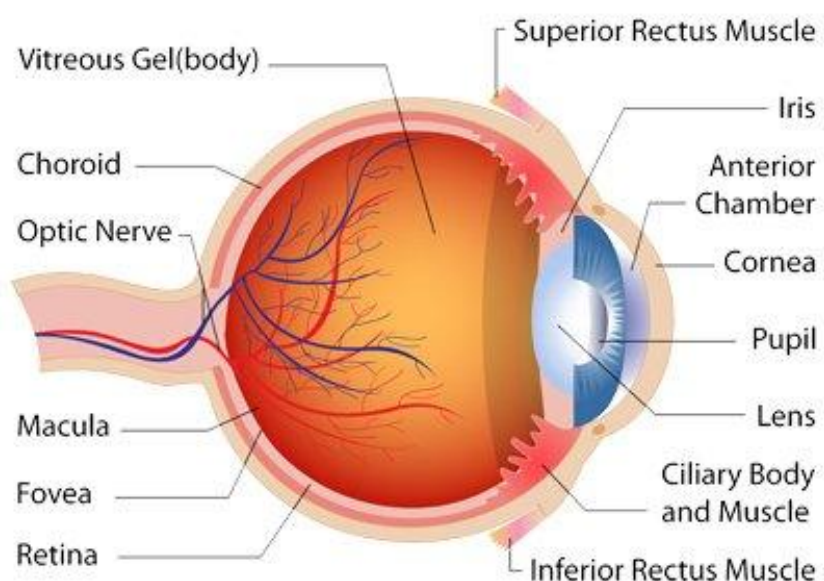


Figure 4 Eye

**Short verbal description:** This is an anatomical image of the eye bulb. It has an irregularly spherical shape with various components including muscles, cornea, iris, lens, vitreous gel, sclera, choroid, retina, fovea, macula, and optic nerve.

**Long verbal description:** Anatomical image of the eye bulb. Its shape is irregularly spherical. In the upper right part of the bulb there is the superior rectus muscle, while in the bottom right part there is the inferior rectus muscle. Next to the inferior rectus muscle there is the ciliary body and muscle. In the anterior part of the bulb there is the cornea, which protrudes from the rest of the bulb and has the shape of a sphere of smaller radius. Between the posterior surface of the cornea and the iris is the anterior chamber. The iris behind the anterior chamber leaves a round opening in the middle, the pupil. Behind the iris is the lens of the eye. Behind the lens, the back of the bulb is made up of vitreous gel (body). The sclera is surrounded internally by the choroid. Inside the bulb there is the retina, the fovea, the macula and the optic nerve.

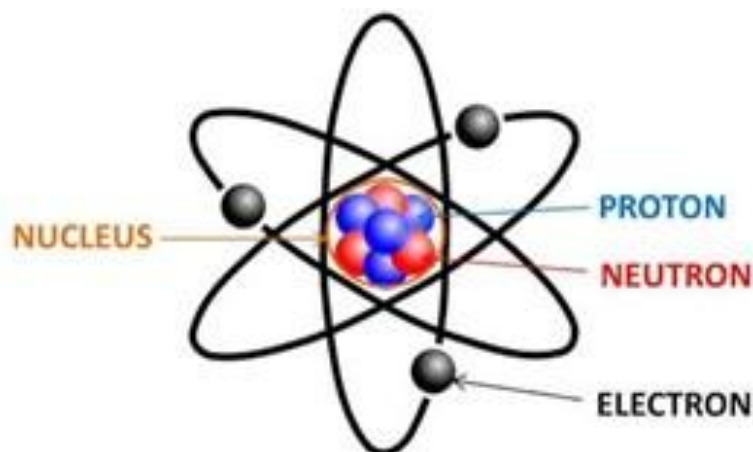


Figure 5 The structure of the atom

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**Verbal description:** The structure of the atom. At the center is the atomic nucleus, which consists of protons and neutrons. Electrons orbit the nucleus in defined orbits around the nucleus and over long distances. Electrons, neutrons and protons are represented by spheres.

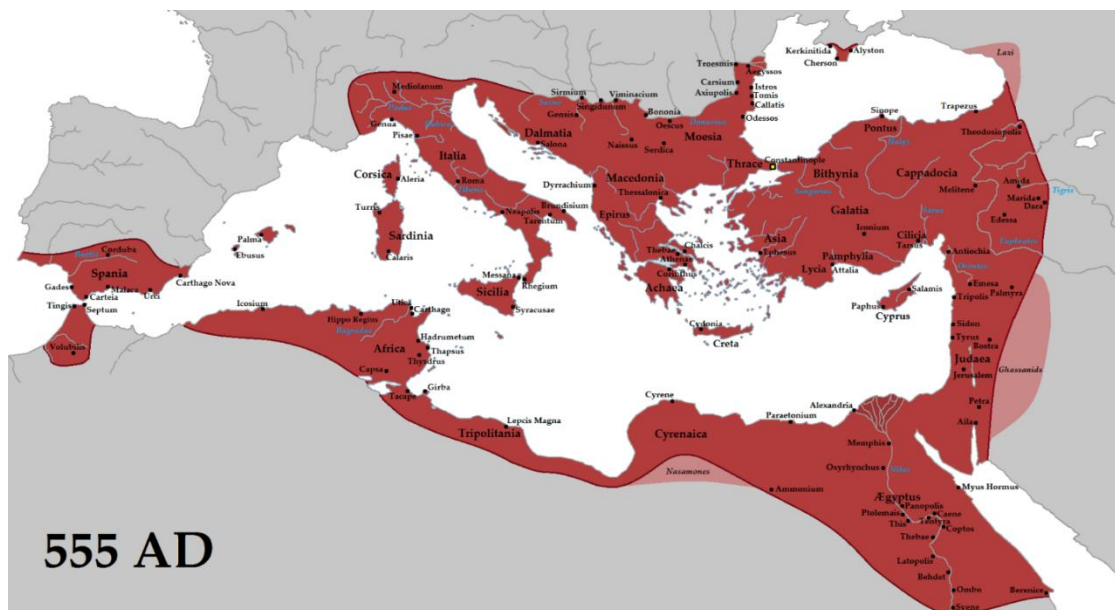


Figure 6 Map of the Byzantine Empire

**Short verbal description:** This is a map of the Byzantine Empire in 555 AD. It includes Spain, Italy, North African countries, Balkan Peninsula, Cyprus, Turkey, Syria, Lebanon, and Israel.

**Long verbal description:** Map of the Byzantine Empire in 555 AD. As part of the empire, the southern part of Spain (Spania), Italy (Italia) with Rome (Rome), Sardinia (Sardinia) and Sicily (Sicilia) are depicted west on the map. The southern part of the empire includes areas of North African countries, from west to east, such as Morocco with the ancient region of Tangier (Tingis), Algeria, Tunisia, Libya and the ancient cities of Leptis Magna and Kyrenia (Cyrene), Egypt (Aegiptus) with the ancient cities of Alexandria (Alexandria), Memphis (Memphis) and Latopolis (Latopolis). In the central and northern part of the empire is the Balkan Peninsula, which on the map includes the cities of Durrës (Dyrrachium) and Odessa (Odessos), the regions of Dalmatia (Dalmatia) and Macedonia (Macedonia), Crete (Creta) and the capital of the Byzantine Empire Constantinople (Constantinople). Also, Cyprus and Turkey, with the cities of Ephesus (Ephesus), Konya (Iconium) and Antioch (Antiochia) and the areas of Pontus (Pontus), Cappadocia (Cappadokia), Galatia and Bithynia (Bithynia) are located east on the map. East of the map is located also Syria, Lebanon and Israel with Jerusalem (Jerusalem) are also located east on the map.

### 3.2. Tactile graphics

Based on the participants suggestions the tactile graphics were divided into smaller parts zoomed in with more details.

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### 3.2.1. Microcapsule tactile

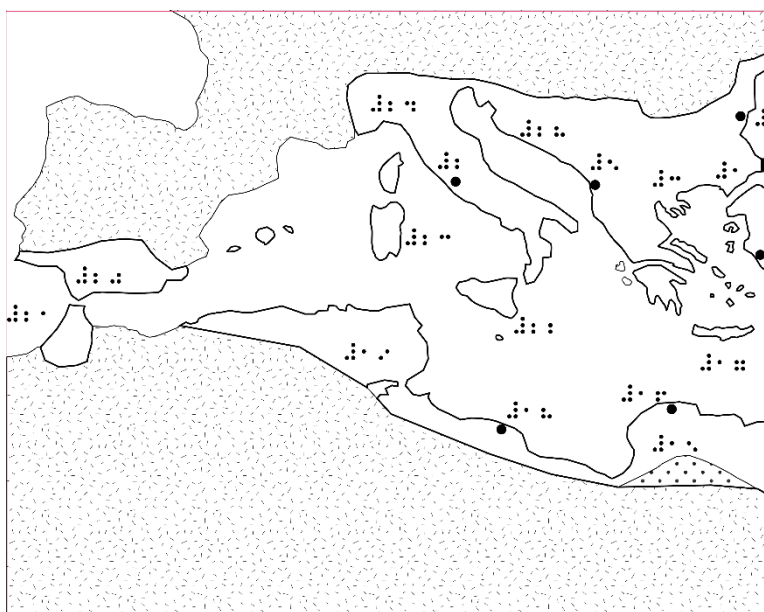


Figure 7 Transformed material map of the byzantine empire 1

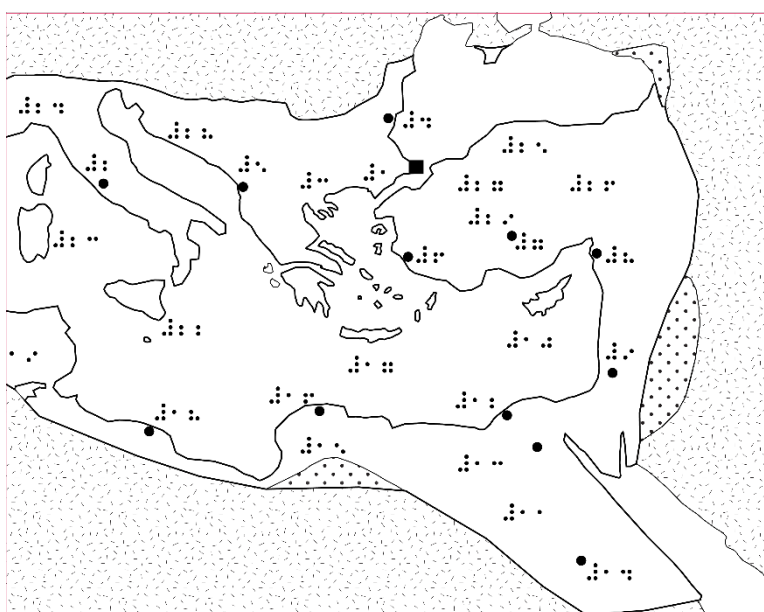


Figure 8 Transformed material map of the byzantine empire 2



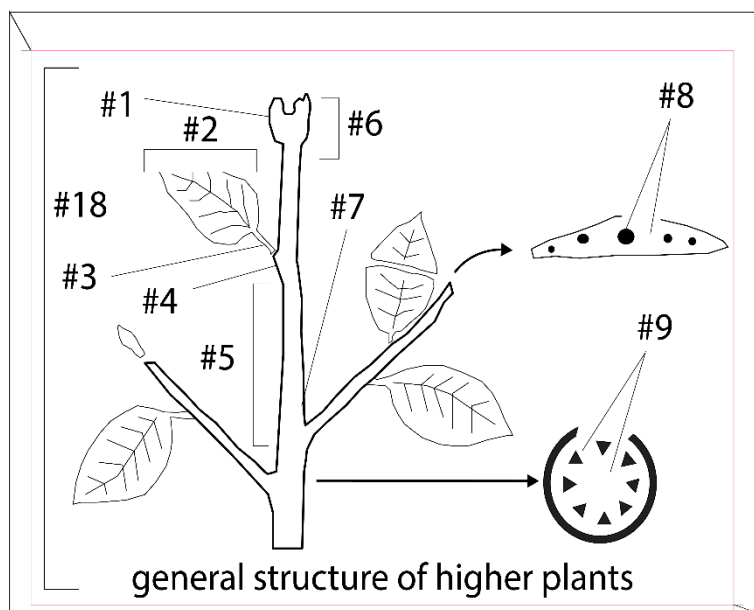


Figure 9 Transformed material structured of plant 1

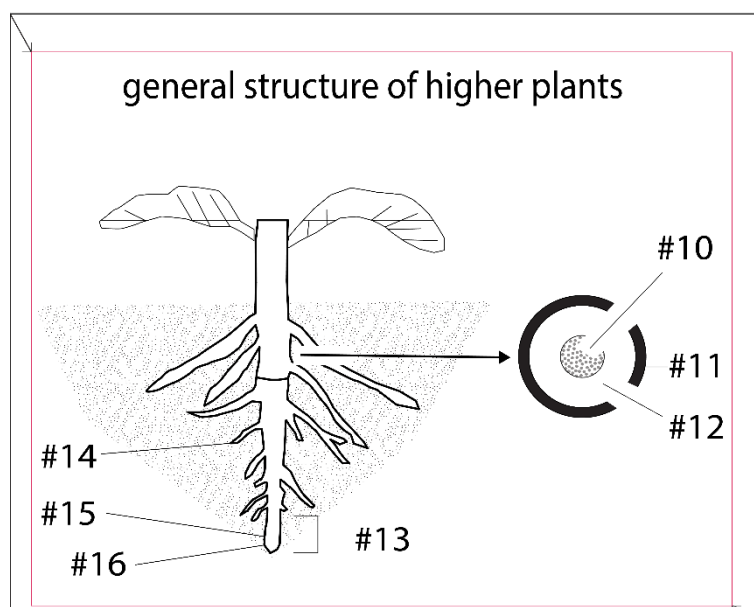


Figure 10 Transformed material structured of plant 2

### 3.2.2. Tiger tactile

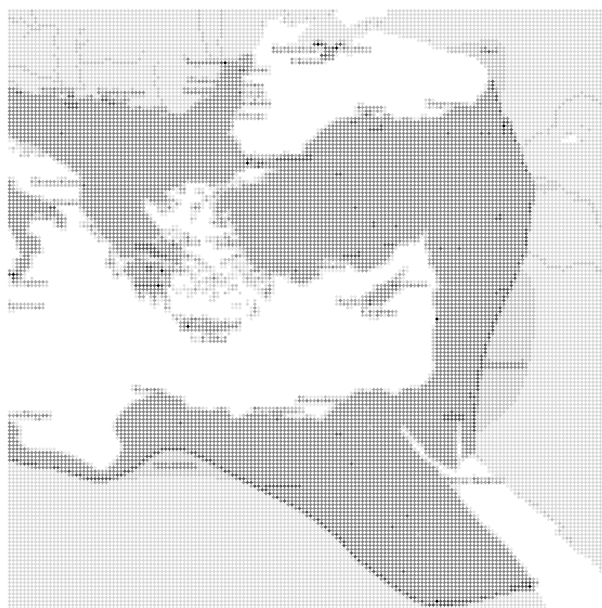


Figure 11 Tiger Transformed material Map of Byzantine empire 1



Figure 12 Tiger Transformed material Map of Byzantine empire 2

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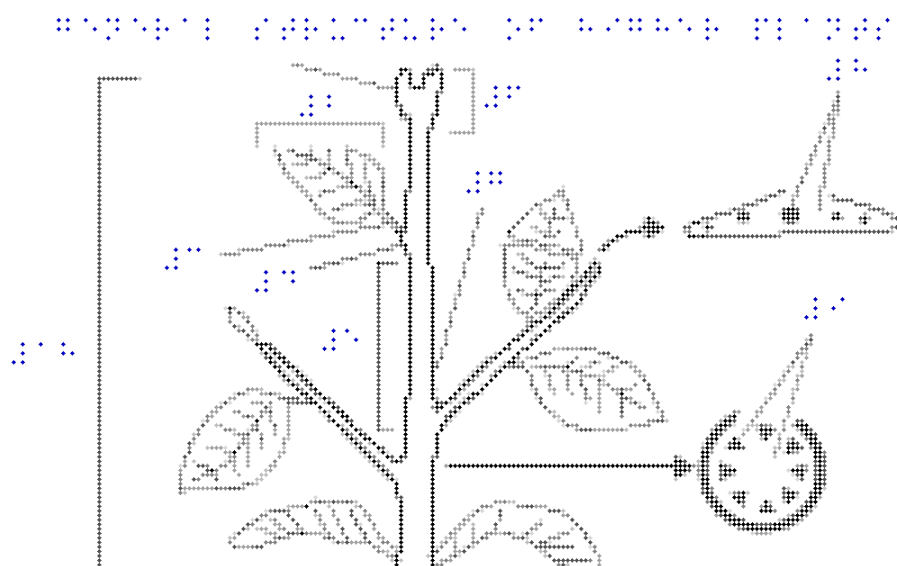


Figure 13 Tiger Transformed material structure of a plant 1

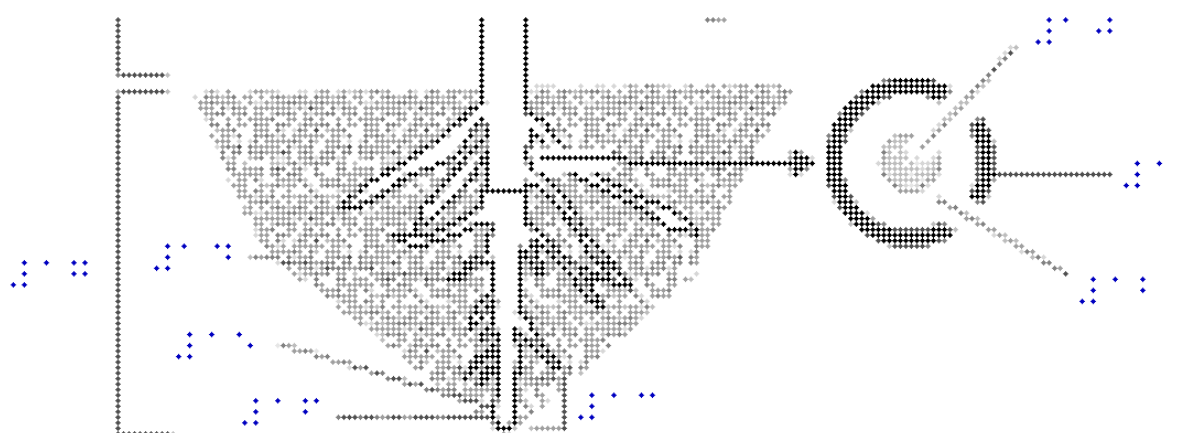


Figure 14 Tiger Transformed material structure of a plant 2

### 3.3. Visual image

Based on the participants proposition the visual image was edited and a different contrast was selected.

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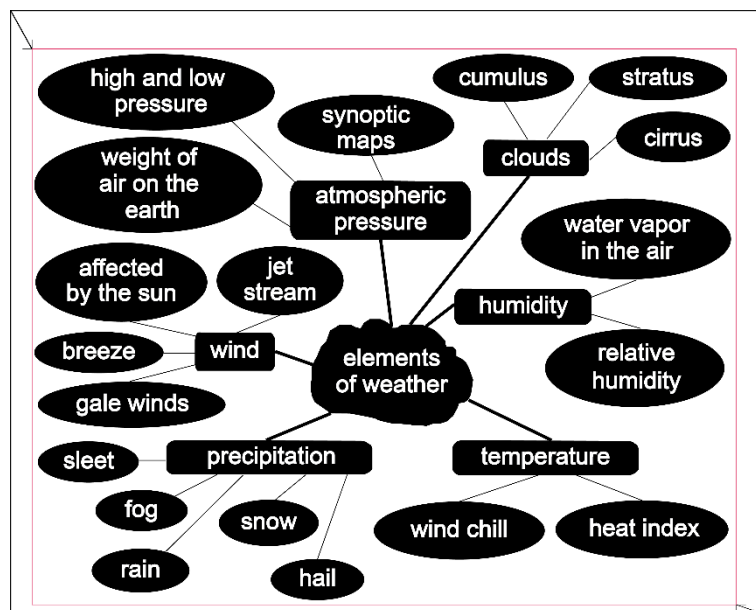


Figure 14 Figure 15 Transformed material Visual image

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