# M-Tool Manual

*Web-based version*

Welcome to M-Tool!

This manual lays out the key features and information on how to use M-Tool and tailor it to your needs.

## What is M-Tool?

M-Tool is the Mental Model Mapping Tool developed by Dr. Karlijn van den Broek, Dr. Helen Fischer and Dr. Sina Klein at University of Heidelberg, and Joseph Luomba, researcher at Tanzania Fisheries Research Institute (van den Broek et al, 2021a). M-Tool is designed to capture mental models, internal representations that describe an external environment. The external environment can be any type of system that consists of factors and causal links between those factors. This tool has been validated with rural fishing communities, demonstrating both convergent and external validity (van den Broek et al., 2021b).

M-Tool allows respondents to create models of a particular system by organizing relevant factors and linking them. M-Tool is available as a free app that can be downloaded in the google and apple app stores, and as a web-based version which can be used in a browser. The latter version also includes a bar chart drawing feature, in which participants display their views on their relation between two variables, for example the fluctuation of a particular resource over time. This manual lays out how to use the web-based version.

The left example below illustrates a fisher's mental model of the drivers of the changes of the Nile perch stock (van den Broek et al., 2021b). It shows that this fisher believes that the strongest influence on the fish stock is fishing in breeding grounds (thick arrow), which is influenced by climate change, which in turn also has a direct influence on the Nile perch stock, as well as the use of illegal gear. The example on the right illustrates a more complex mental model captured with M-Tool. For more examples of applications of M-Tool in research projects see https://www.m-tool.org/Publications/
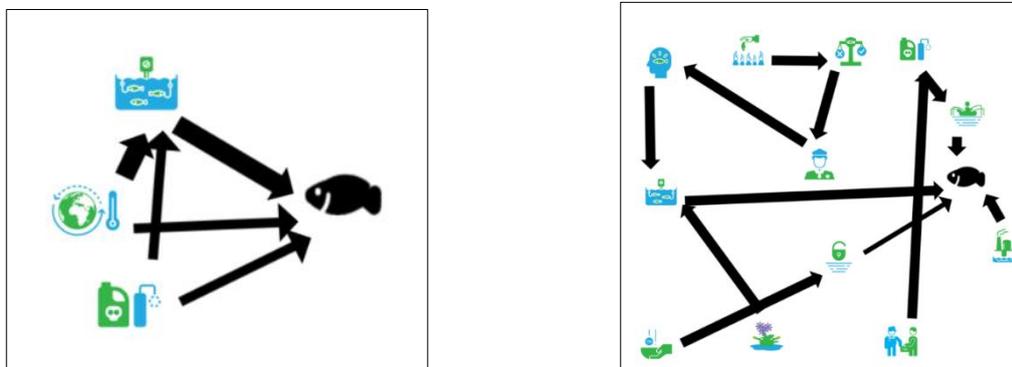


*Figure 1. Examples of a simple (left) and complex (right) mental model created with M-Tool. The figure shows mental models of Tanzanian fishermen of the drivers that influence the target variable, the Nile perch stock.*

**Why use M-Tool?**

- A standardized tool – for comparing mental models
- Suitable for large sample sizes
- Does not require respondents' literacy
- Available online as well as offline
- Can be tailored to map perceptions of any system or phenomenon

In contrast to other mental model elicitation methods, M-Tool uses a fully computerized approach that allows rapid collection of large samples. M-Tool's standardized approach ensures respondents will use the same system variables with which they draw their mental model. M-Tool hence gives you the unique benefit of comparing the mental models across and within (groups of) respondents. M-Tool is the first mental modelling tool to allow users to uncover differences in mental models which may keep stakeholder groups from addressing challenges jointly and effectively (van den Broek, 2018).

Because you can populate the tool with icons representing different system variables yourself, mental models of any kind of system can be captured. Some examples of how M-Tool can be used:

- Comparing mental models between groups of respondents (e.g. different types of stakeholders, experts vs. the general public, across cultures, communities from different geographical areas, comparing children's mental models).
- Assess changes in mental models over time, to investigate the stability of mental models or the impact of an intervention on the respondents' mental model.
- To start a conversation between stakeholders on the functioning of a system and how to address challenges within the system.

Compared to interviewing techniques, M-Tool allows respondents to draw more complex mental models, thereby giving more detailed insights into their understanding of a system (van den Broek et al., 2021b). Moreover, by including video instructions, icons to display the relevant system variables, and accompanying audio files explaining each icon, M-Tool can be used without relying on respondents' literacy.

**Tailoring M-Tool to your needs**

With M-Tool you can include the system variables that are relevant for your project. These variables can be generated by your mental model target group, for example through short interviews or surveys (e.g. What are the elements of [a system], What factors do you think drive…, what are the consequences of …).

Alternatively, you may be interested to see if your target group would make certain connections based on an existing set of variables. These factors may be informed by pre-existing knowledge of a system, i.e. to assess if you target group can draw up the 'correct' dynamics between factors. Furthermore, you can replace the audio instructions and videos with your own files to adapt the instructions to your needs, or to translate it to the relevant language.

M-Tool can be set up in various ways:

1. The drivers and consequences of a target variable (i.e. the fixed factor: the fish in Fig. 1 or "Y" in the app) can be mapped separately (by placing the target variable on the left for mapping screen 1 and on the right for mapping screen 2). This eases the cognitive demands on the respondents.
2. The drivers and consequences of a target variable can be mapped at once, so a respondent can show how the drivers and consequences can influence each other (e.g. by placing the target variable in the middle).
3. The tool can be set up without a target variable/fixed factor, so the respondent maps the entire system.

This means that you can map any aspects of any system (e.g. network of actors, dynamics of an ecosystem etc.).

**How to use M-Tool?**

To get started using M-Tool, follow these simple steps:

1. Generate a list of relevant variables for the respective system.
2. Turn these factors, as well as your 'target variable' (if applicable) into images (e.g. through a freelance graphic designer platform like Fiverr or use images with text).
3. Create a video that explains the meaning of each image (e.g. with PowerPoint)
4. Extract the audio files from this video for each image (e.g. with PowerPoint)
5. Upload these files in M-Tool under *media, upload media.*
   Make sure you select the right type of format for the media file you uploaded, if this is incorrect, you will not be able to use it in the study creation. We recommend .mp4 for videos, .mp3 for audio, and .png for images. the files to be uploaded should not exceed 100MB, and can take a few moments to upload. The file names for the system variables will also be used in the data output. You can test your files under *media preview*

6. Next, create a study by going to *studies*, and *add new study*.



Here, you can add a name and description of your study, add text for informed consent, and add an external link for a more detailed consent form. You can specify the welcome and end message the participant views.

Here you can add a link to an external survey that the participants completes after completing the M-Tool tasks. You can match the participant ID between the M-Tool data and the survey data by adding "?id={USER_ID}" to the survey link. This may work differently depending on your survey software. For example, for Qualtrics, see instructions on how to embed the user ID here.

You can choose whether you want to include 1 or 2 mapping screens, and whether to include the bar chart task, and the type of arrows you want your participant to use.

Select your media files (previously uploaded under *media*) that you under the respective headings

**Mapping Screen 1**

Fixed icon?                     None ▾

Fixed icon position?            left ▾

| Use? | Image file | Audio explanation (optional) | |
|------|-----------|------------------------------|---|
| ☑ | Default ▾ | Default ▾ | ⊗ |
| ☑ | Default ▾ | Default ▾ | ⊗ |
| ☑ | Default ▾ | Default ▾ | ⊗ |
| ☑ | Default ▾ | Default ▾ | ⊗ |
| ☑ | Default ▾ | Default ▾ | ⊗ |

Add icon

You can set-up the mental model mapping task by indicating if you would like to include a fixed/target icon, and if so, where you would like to position this icon.

Next, add the system variables that the participant will use, including the image and audio explanation files. Click add icon to include as many variables as you like. Click on the cross to remove a variable.

**Bar Chart**

Please be aware that the size of the icon adapts to the number of increments. That is, many increments will result in very small icons in the bar chart.

Icon                    Default ▾

Title                   [                    ]
                        Required

X-Axis Title            [                    ]
                        Required

X-Axis Start            [                    ]
                        Required

X-Axis End              [                    ]
                        Required

X-Axis Increment        [                    ]
                        Required

Y-Axis Title            [                    ]
                        Required

Y-Axis Start            [                    ]
                        Required

Y-Axis End              [                    ]
                        Required

Here you can select the icon that will be used by the participant to create the bars. Include a title for the graph, x-axis and y-axis, and define the start and end value of the axes.

Define the increment of the x-axis, meaning the steps with which the bars will be created by the participants (for example, the x-axis starts at 2010 and ends at 2020, with increments of 1 year, so

Cancel     Create study

Click create study, and your study will be listed in the study overview.

5

7. You can now share the link with your participants and collect data.
   NB: if you collect the data for several participants on one device (e.g. a tablet), we recommend using the app version of M-Tool. If you use this web-based version, please note that you need to transform the participant link (add "?persist=false" to the end of the participant link), to avoid overriding the participant data by the data of the subsequent participant.
8. You can down your data in the study overview me. This CSV-file consists of a long data structure with an edge list of the data. The data consists of a row for each connection drawn in the model for each participant, showing where the connection started and ended, and the weight given to each connection.
   NB: double headed arrows are listed with the weight ''0''.
9. You can use the M-Tool data analysis script (van Boxtel & van den Broek, 2021) for R to transform the edge list into complexity and centrality indicators.
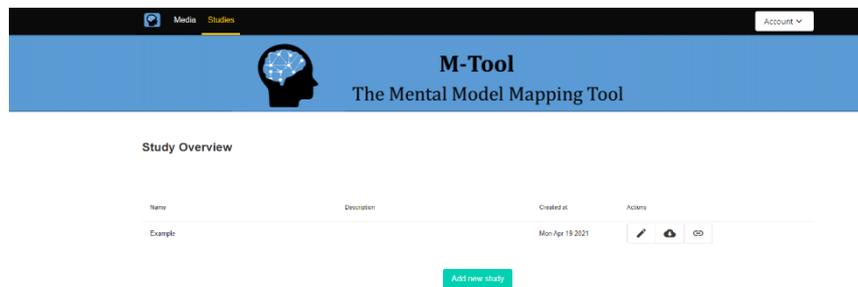


In the study overview, you can modify your study, download the data, or access the link to the study that can be shared with participants.

**Data safety**

The data generated with M-Tool can be downloaded by the account holder only. The data is stored safely on the Heidelberg University server, complying with GDPR guidelines. No third parties (neither the creators) have access to this data.

**Recommendations for using M-Tool**

M-Tool works best on Chrome, as Firefox and Safari block audio auto-start. This means that participants using Firefox or Safari may not automatically hear the audio welcome message when they start the tool, unless they activate this in their browser. All other audio files will not have this issue. We therefore advise users to include all necessary information on the welcome page.

We have developed the tool so that a participant can close the window of the study and continue working on the tasks at another time. This ensures the data is not lost when losing connectivity. However, this does mean that the data of second session overrides the previous session. If you would like to collect several responses from one device (e.g. a tablet or PC), add "?persist=false" to the end of the participant link to ensure the data of the next participant does not override the data of the previous participant.

**Acknowledgements**

**References**

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**Contact**

For more information on M-Tool, go to www.m-tool.org

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