Tips for Authoring Sero! Maps to Assess Learning

A GUIDE FOR EDUCATORS AND RESEARCHERS

By Sero! Learning Assessments, Inc.

What Are Sero! Maps?

Sero! maps are concept maps for use in learning assessment. **Sero!** v.2.0 offers two styles of assessment maps: **Build-a-Map** and **Skeleton Map**. Each offer sets of features that can be applied to a variety of assessment contexts and both make use of **MasterMaps**.

MasterMaps

Creating **Sero!** assessments starts with crafting a **MasterMaps** — a concept map that serves as the basis for assessments. The **MasterMaps** should capture standard, generally-agreed-to, learning-case-specific, or expert knowledge. For **Sero!** v.2.0, **MasterMaps** are necessary for authoring **Build-a-Maps** and **Skeleton Maps**.

Best Practices | Authoring Good MasterMaps

The features that make for a good concept map are generally agreed to be:

- ✔ Use of a specific focus question,
- ✔ Concisely stated propositions that express valid statements of knowledge,
- ✔ Semi-hierarchical shape, including some cross-links.

Numerous publications describe the guidelines and processes for creating good concept maps — our top recommendations for further reading are listed on the last page. Authoring **MasterMaps** for assessment starts with these guidelines. But for maps that are ready-made for assessment, you'll want to keep a few additional considerations in mind about the context, structure, and content of your **MasterMaps**.

Element		Guidance
Context	Focus question	Match to the tenor of map — e.g., a closed question for mostly classificatory propositions; an open question for mostly explanatory; a dynamic question for systemic and holistic thinking
		Specify desired target of abstraction and specific contexts
Structure		Mostly hierarchical, with general propositions toward top and specifics toward the bottom
		Balance of branches and branch size
		Crosslinks that are integral and necessary
		Inclusion of complex networks, including cycles where appropriate
		Connectors that clearly show lines and arrowheads — not too close, not too distant
Content	Concepts	As concise as possible
		Non-recurring within the map
	Linking phrases	As succinct as possible
		Highly descriptive
		Non-recurring within the map (to the extent possible)
	Connectors	Arrowheads to show the directionality of the proposition reading, e.g., (ConceptA – comes before → ConceptB, or ConceptA ← comes before – ConceptB)
	Propositions	As few a number as necessary; More than 40 propositions may require multiple maps; fewer than 30 is best for Build-a-Map
		Each proposition should make sense if read independently from the rest of the map
		Avoid dependencies that produce run-on sentences across propositions
		Mix of: static | defining | organizational | categorical dynamic | dependencies | functional | causal | quantity/quality

Sero! Maps | Build-a-Map & Skeleton Map

A **Sero! Build-a-Map** is a type of assessment that provides Takers with a set of concepts and linking phrases from which they are to build a concept map. A **Sero! Skeleton Map** provides Takers with a partial concept map including assessment items to be completed or corrected.

For both styles, the Takers' goal is to match the **MasterMaps**. Takers are scored by how close they match, and you can decide whether you want them to see the **MasterMaps**, depending on the context of the assessment.

While both styles can be used for diagnostic, formative, and summative assessments, authoring for each requires some special attention as you go about authoring.

Best Practices | Build-a-Map

Two considerations are critical for authoring **Build-a-Maps** that are valid and reliable.

- Size | Generally speaking, the more propositions included in a Build-a-Map, the more difficult it will be for Takers to match the MasterMap. Definitely keep the count under 30 and for most cases, 15 – 25 will work best.
- Highly specified linking phrases | The more precisely the linking phrases are stated, the lower the potential confusion for Takers. ***Avoid*** linking phrases that ***only*** state helping verbs, such "is" and "has," which might apply equally well for making numerous propositions. But ***do use*** helping verbs when they help specify the relationship, like "must" and "should." Add other qualifiers to home in on the exact nature of the relation, such as "only," "always," or "never."

Best Practices | Skeleton Map

Sero! v.2.0 offers six assessment item types that can be used to craft a **Skeleton Map**. Many of the items are based on prior research — our top recommendations for further reading are listed on the last page.

Sero! is the first tool that enables using all of the item types in a single map. But just because you can doesn't necessarily mean you should! Here are some tips for using items in a Skeleton Map, followed by considerations for each item type.

- Difficulty | You can increase the difficulty of a map by increasing the number of assessment items. And it's safe to say that some items are more difficult than others — for example, it may be more challenging to spot and correct an error than selecting from a list of options. Vary the number *and* types of items to find a difficulty that is appropriate for your purpose and learners.
- Dependencies | One of the most powerful aspects of Skeleton Maps is that they can introduce dependencies across assessment items — an assessment challenge feature that is awkward to achieve in standard discrete item tests. As you introduce items, consider how answering some items may *depend on* how other items are answered. Building in such dependencies offers an even deeper assessment of what learners truly know.
- High-value items | While any element of a map can become an assessment item, you'll definitely want the elements that are particularly important for understanding to be assessed. These might be concepts that learners *must* know, concepts and linking phrases that tie together major sections, and crosslinks that express important, holistic relations.

Item | Requires Takers to…	Musts & Cans	Tips	Avoid Using if…
Multiple choice | select an option from a list to complete a proposition	*Must* provide at least one optional choice	Use other concepts or linking phrases in the map for options; From fans that lead to branches, use concepts as options for the others	Distractors make correct concept the obvious choice
Fill-in | fill in content to complete a proposition	*Can* show the number of characters as a hint	Only use where concepts or linking phrases *should be* well known	Complex linking phrases; Concepts could be stated in multiple, acceptable ways
Drag-and-drop | drag and drop concepts from a word bank to complete a proposition	*Must* only be used at the end of a branch; *Can* provide distractor nodes	For fans, only pick one or two concepts; Add several distractors	Only one drag-and-drop item in the assessment map
Connect-to | create connectors to complete a proposition	*Can de*-select connectors to *not* include	If fan, only pick one or two, not all possible connections	Connections that are directly below; A branch is not otherwise connected in the map
Arrowhead direction | select which connector should include an arrowhead to state the direction of a proposition	*Can* use with propositions that implicate three concepts	Use for propositions that express causal, sequential, processual and dependency statements	Directionality is not important
Error correct | select an option from a list to correct a proposition	*Must* provide at least one erroneous option	Add more than one erroneous option	Avoid options that could also be true

Further Reading | Top Recommendations

For authoring good concept maps:

- *Applied Concept Mapping: Capturing, Analyzing, and Organizing Knowledge*
- *Learning, Creating, and Using Knowledge: Concept Maps as Facilitative Tools in Schools and Corporations*
- *Working Minds: A Practitioner's Guide to Cognitive Task Analysis*

For using concept maps for learning assessment:

- *Concept Map-Based Formative Assessment of Students Structural Knowledge*
- Proceedings from the International Conference on Concept Mapping — available at cmc.ihmc.us

For item types in Skeleton Maps:

- Multiple-choice | Moon, B., Ross, K., & Phillips, J. (2010). Concept Map-based Assessment for Adult Learners. In *Proceedings of the Fourth International Concept Mapping Conference.*
- Fill in | Ruiz-Primo, M. A., Schultz, S., Li, M., & Shavelson, R. J. (2001). Comparison of the reliability and validity of scores from two concept-mapping techniques. *Journal of Research in Science Teaching*, 8, 260-278.
- Drag-and-drop | Schau, C., Mattern, N., Zelik, M., Teague, W. & Weber, R.J. (2001). Select and fill-in concept map scores as measure of students' connected understanding of science. *Educational and Psychological Measurement*, 61, 136-158.
- Error correct | Correia, P., Cabral, G., & Aguiar, J. (2016). Cmaps with Errors: Why not? Comparing Two Cmap-Based Assessment Tasks to Evaluate Conceptual Understanding. In *International Conference on Concept Mapping* (pp. 1-15). Springer, Cham.