

A structured approach to evidence-based software engineering in empirical software engineering research for students

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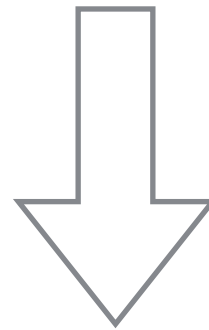
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Original Question

How can students compare software in experiments?

Students' Issues with Scientific Working

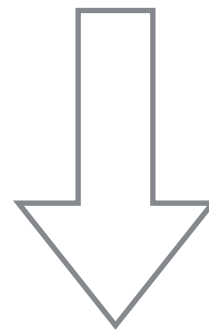
- “Students had problems constructing well-formulated [...] questions.”
- “Students used limited criteria for identifying the best or better evidence [...]”
- “Students used a very limited number of search terms.”
- ...



Many students lack knowledge about scientific working and experiment design.

Original Question Revised

How can students compare software in experiments?



How to support students in scientific working and experiment design?

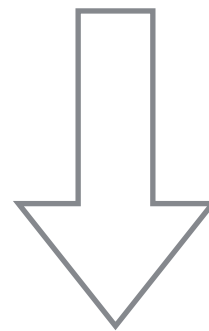
How to Support Students in Scientific Working and Experiment Design?

- Evidence-Based Software Engineering (EBSE)
- Scientific Method

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Tools not tailored for students

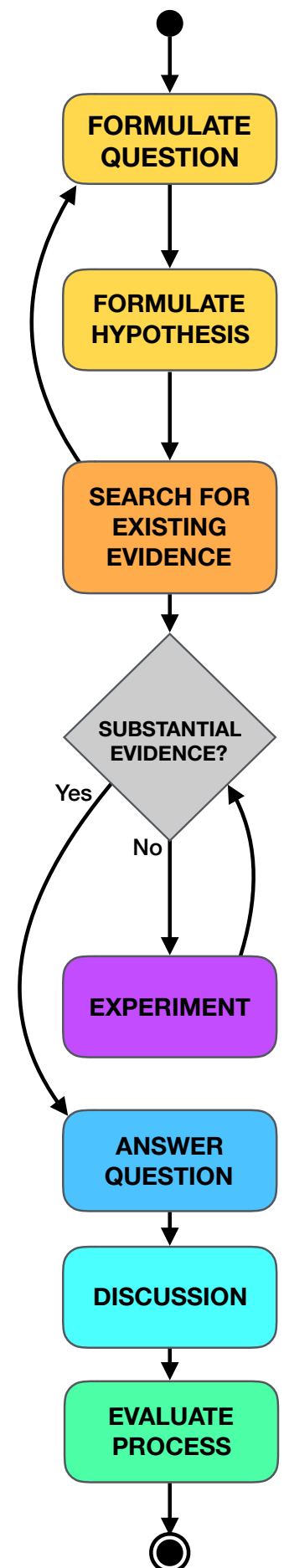
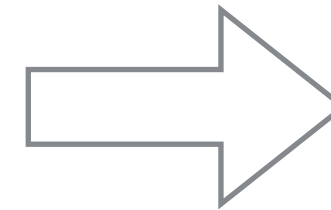


Process and guiding documents for students.

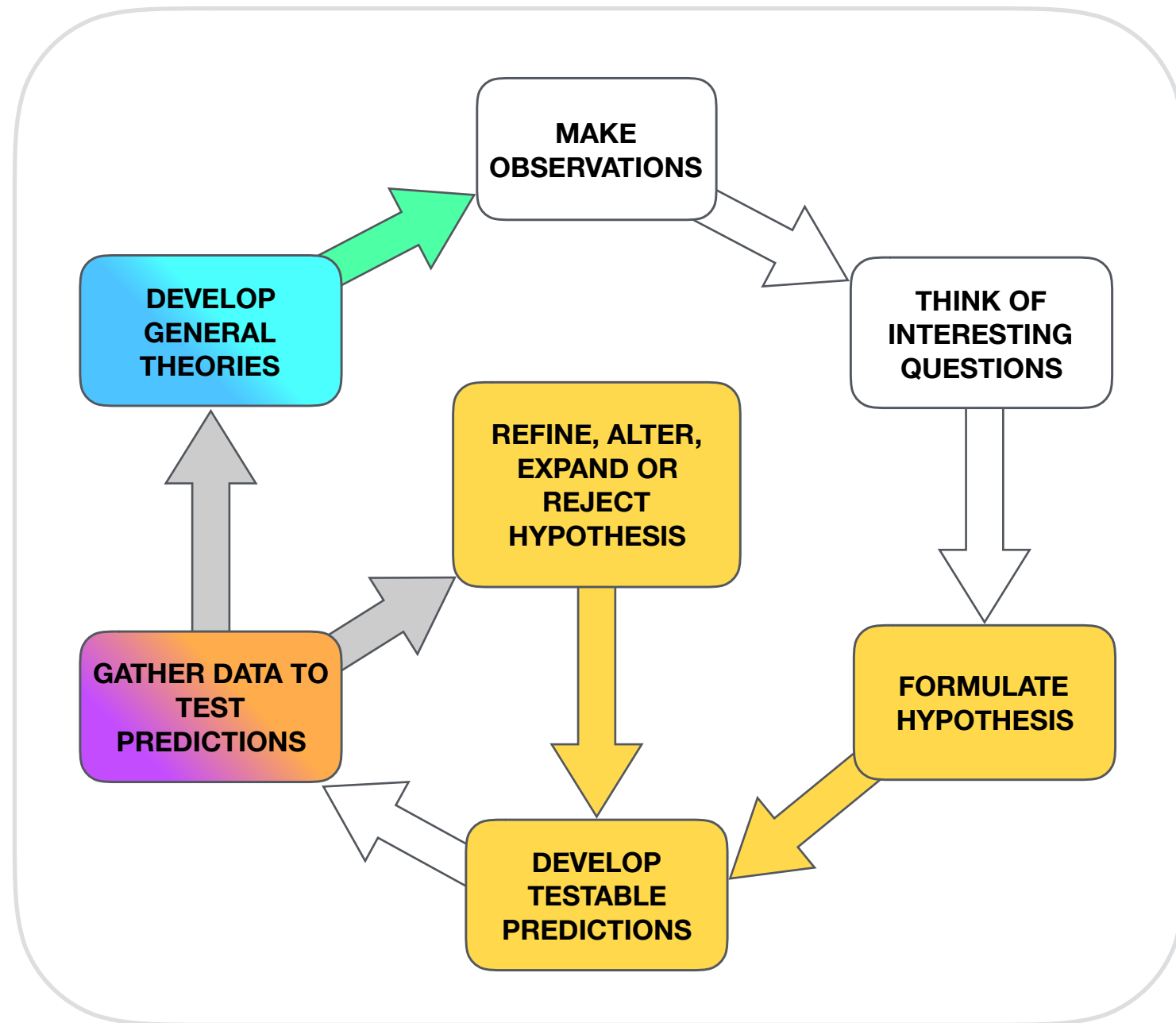
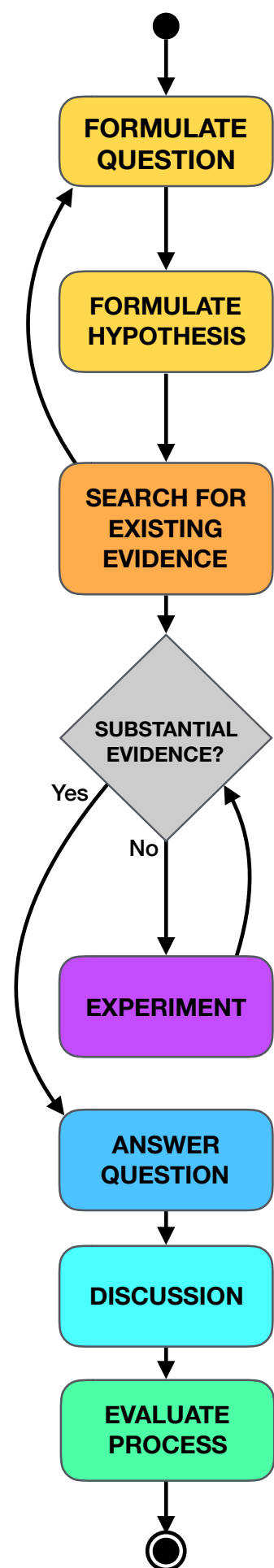
Process and Documents as Guidelines for Students

EBSE Process Steps:

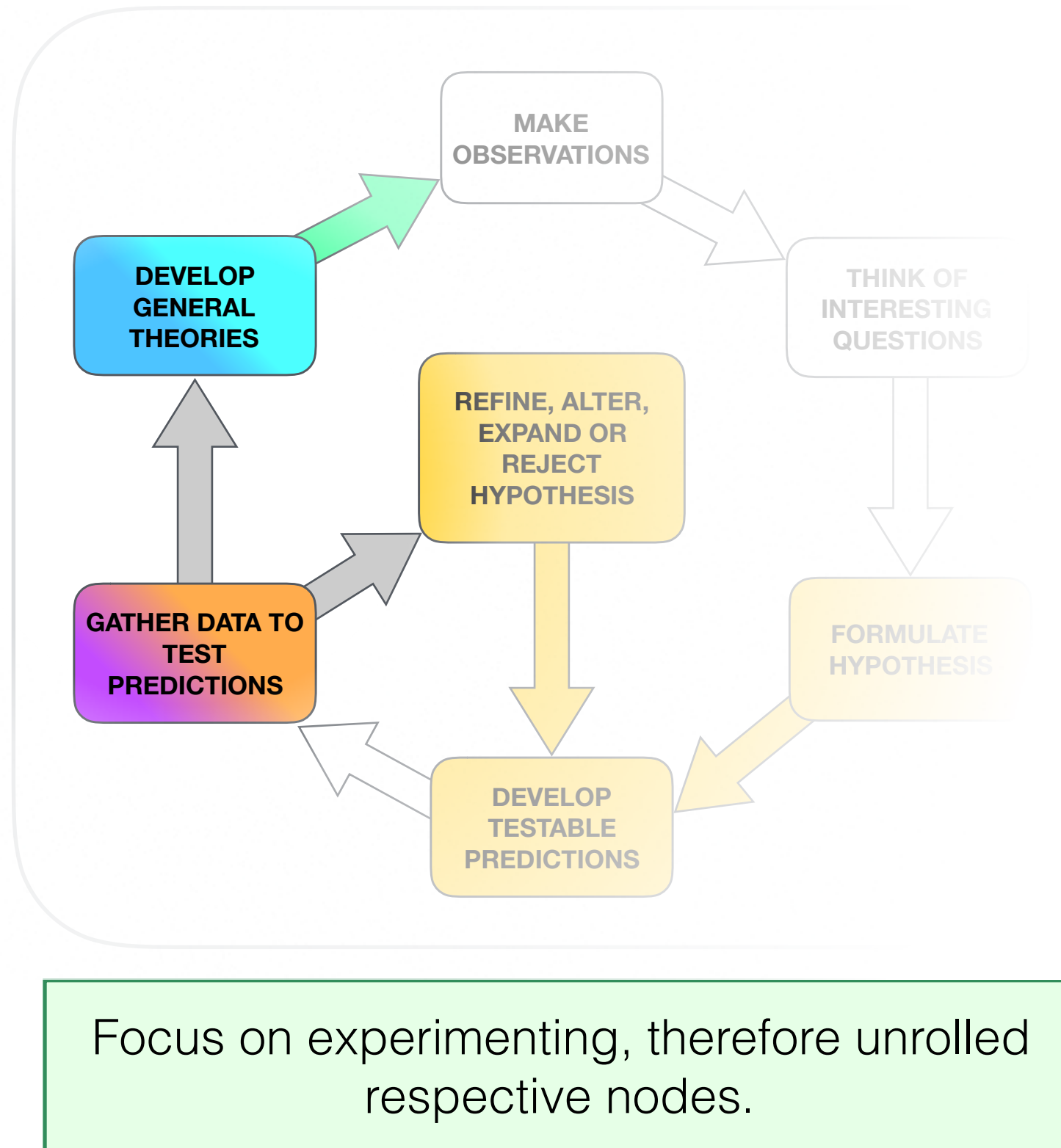
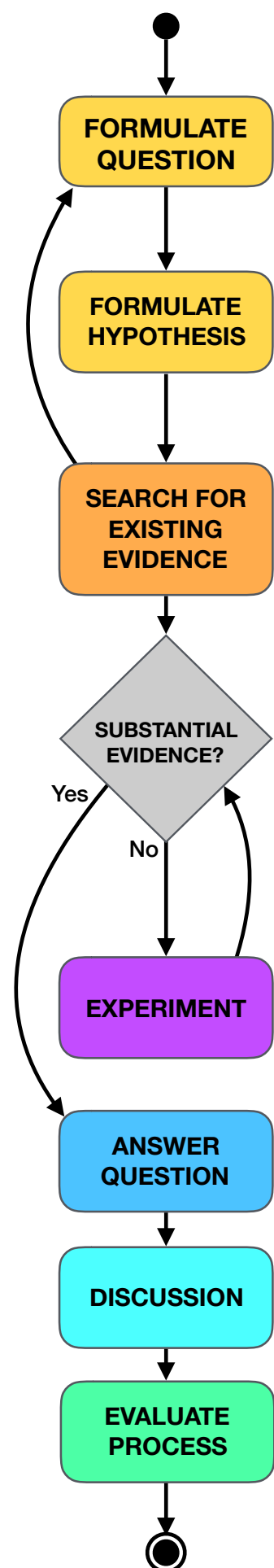
1. Ask an answerable question.
2. Find the best evidence that answers that question.
3. Critically appraise this evidence.
4. Apply the evidence (and critical appraisal).
5. Evaluate the performance in previous steps.



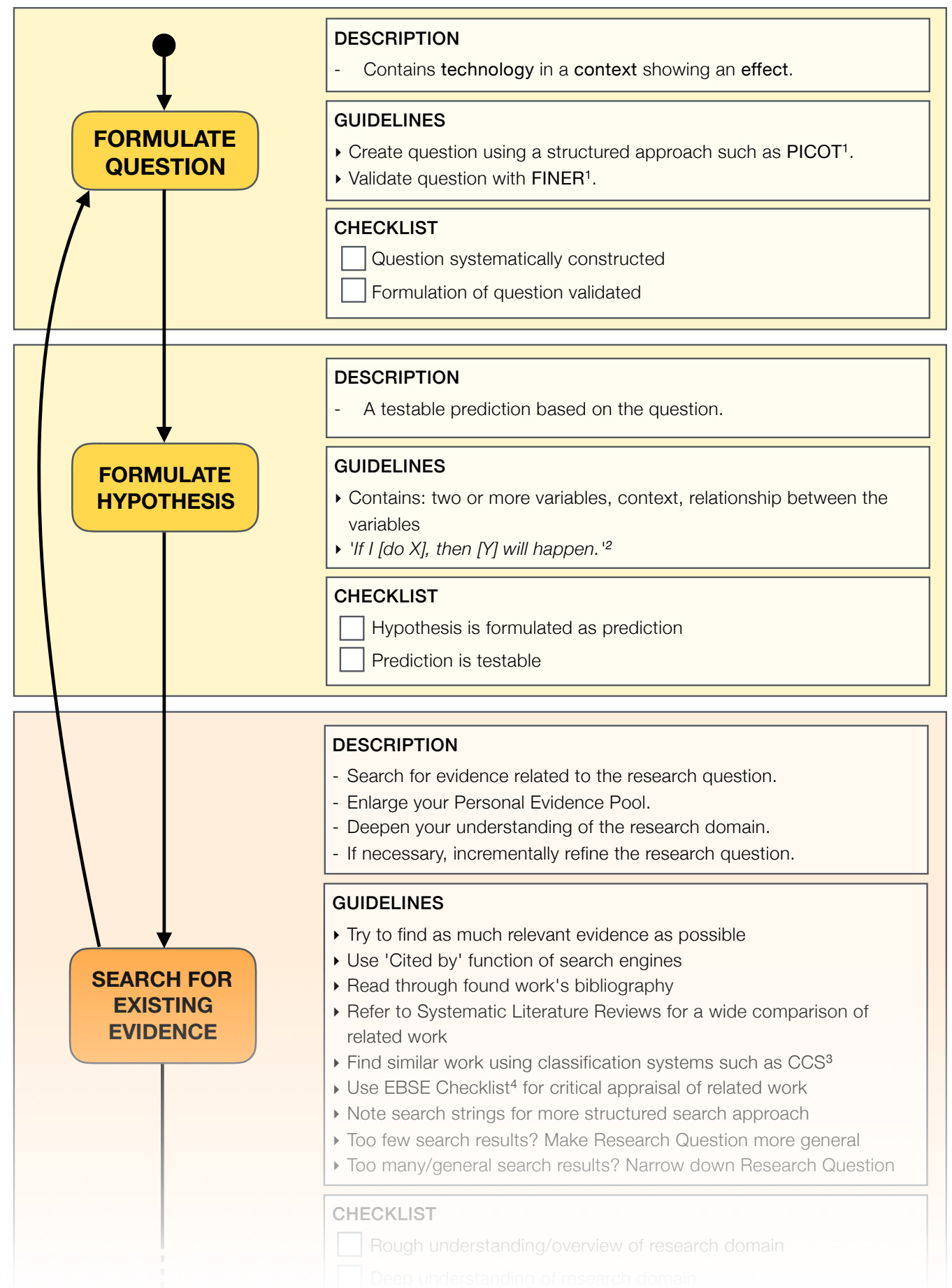
Mapping on Scientific Method



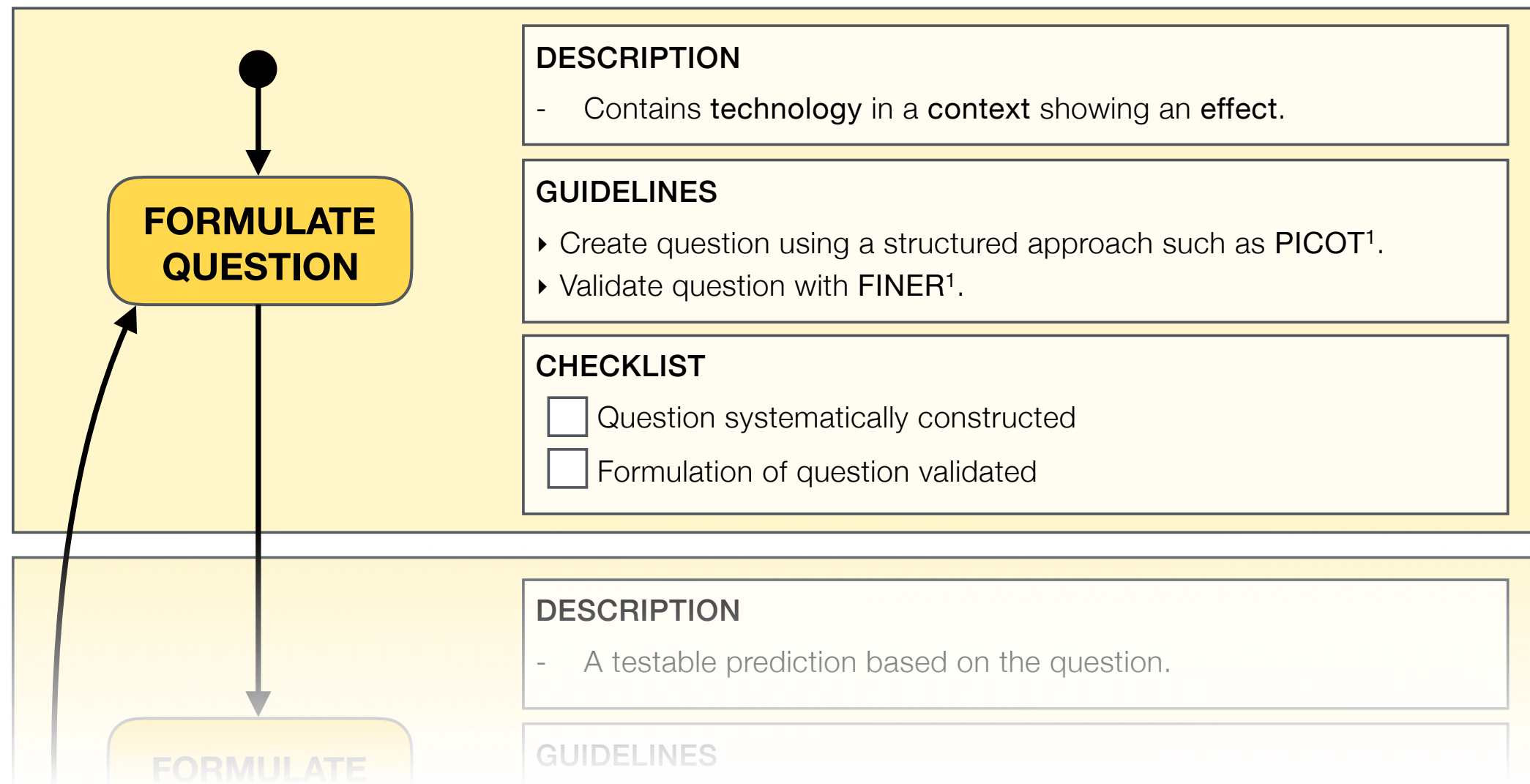
Mapping on Scientific Method



Checklist Overview



Checklist Details



Checklist Tools

P opulation	What specific population are you interested in?	F easible	<ul style="list-style-type: none"> ▸ Adequate number of subjects ▸ Adequate technical expertise ▸ Affordable in time and money ▸ Manageable in scope
I ntervention (Technology)	What is the investigational technology/ intervention?	I nteresting	<ul style="list-style-type: none"> ▸ Getting the answer intrigues investigator, peers and community
C omparison Group	What is the main alternative/ baseline to compare with the intervention	N ovel	<ul style="list-style-type: none"> ▸ Confirms, refutes or extends previous findings
O utcome	What do you intend to accomplish, measure, improve or affect?	E thical	<ul style="list-style-type: none"> ▸ Amendable to a study that institutional review board will approve
T ime	What is the appropriate follow-up time to assess outcome?	R elevant	<ul style="list-style-type: none"> ▸ To scientific knowledge ▸ To clinical and health policy ▸ To future research

After Action Review (AAR) <ul style="list-style-type: none"> ▸ What was supposed to happen? ▸ What actually happened? ▸ Why were there differences? ▸ What did we learn? 	Postmortem Analysis (PA) <ul style="list-style-type: none"> ▸ What went so well that we want to repeat it? ▸ What was useful but could have gone better? ▸ What were the mistakes that we want to avoid for the future? ▸ What were the reasons for the success or mistakes?
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REFERENCES

FINER, PICOT: Farrugia, P., Petrisor, B.A., Farrokhyar, F., Bhandari, M.: Practical tips for surgical research: Research questions, hypotheses and objectives. *Canadian journal of surgery. Journal canadien de chirurgie* 53(4), 278–281 (2009)

Checklist, AAR, PA: Dybå, T., Kitchenham, B.A., Jorgensen, M.: Evidence-based software engineering for practitioners. *IEEE Software* 22(1), 58–65 (2005)

Briefing Form

- Analog concept
- Template for paper summary
- Assistance for experiment design
- Easier to search existing work

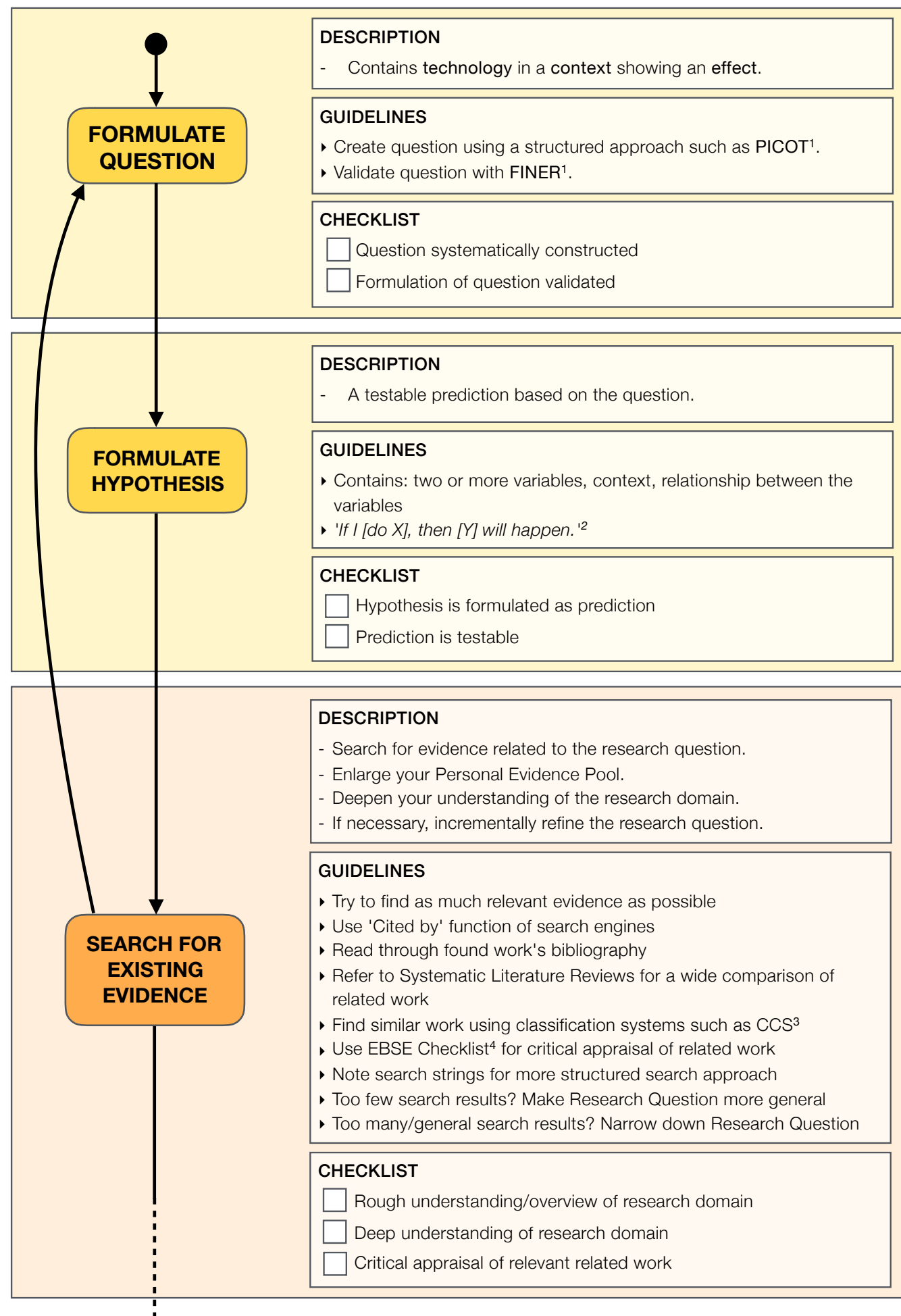
QUESTION
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HYPOTHESIS
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EXPERIMENT
VARIABLES
Dependent
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Independent
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Control
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Technique
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Statistical Results
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CONCLUSION
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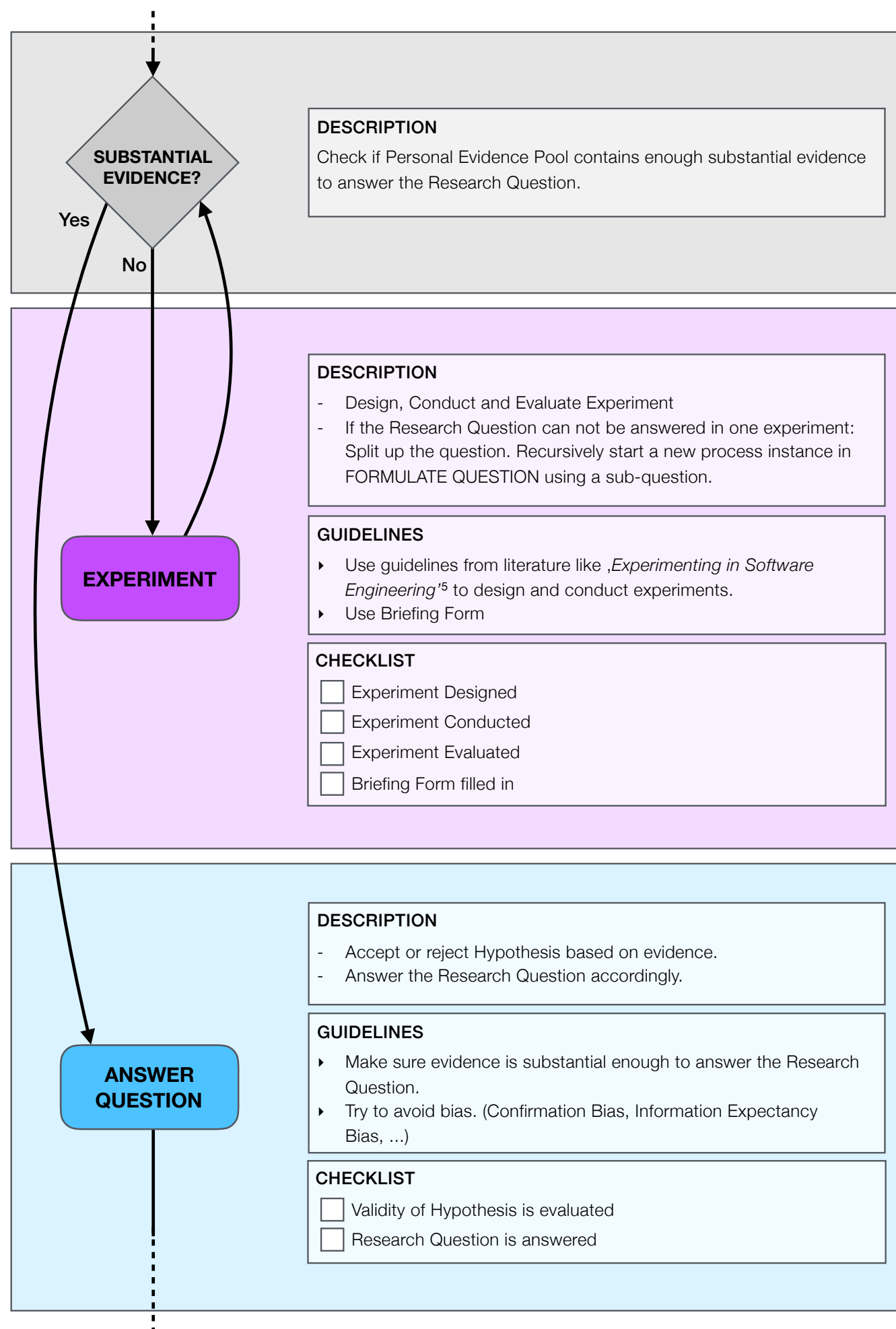
Discussion

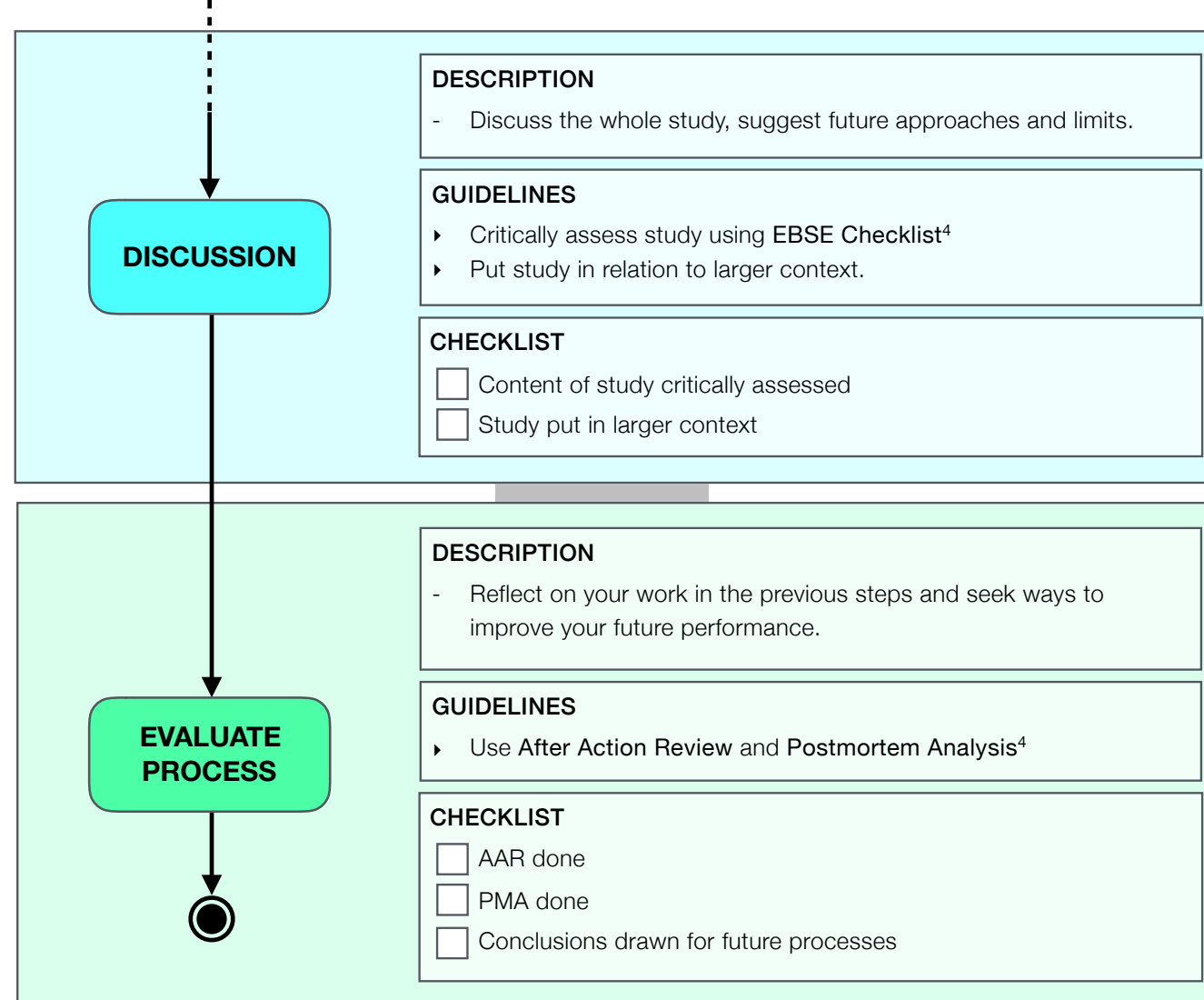
- Should be evaluated using students' thesis
 - Revise Checklist tools
 - Refine Briefing Form
- Digitalize Briefing Form

Sources

- Scientific Method: Garland, Jr., Theodore. "The Scientific Method as an Ongoing Process". U C Riverside. (http://idea.ucr.edu/documents/flash/scientific_method/story.htm)
- FINER, PICOT: Patricia Farrugia, Bradley A. Petrisor, Forough Farrokhyar, and Mohit Bhandari. Practical tips for surgical research: Research questions, hypotheses and objectives. Canadian journal of surgery. Journal canadien de chirurgie, 53(4):278–281, 2009.
- PMA, AAR: Tore Dybå, Barbara A. Kitchenham, and Magne Jorgensen. Evidence-based software engineering for practitioners. IEEE Software, 22(1): 58–65, 2005.
- [RHB06]: Austen Rainer, Tracy Hall, and Nathan Baddoo. A preliminary empirical investigation of the use of evidence based software engineering by under- graduate students. 10th International Conference on Evaluation and Assessment in Software Engineering (EASE 2006), 2006.







REFERENCES

- [1] Farrugia, P., Petrisor, B.A., Farrokhyar, F., Bhandari, M.: Practical tips for surgical research: Research questions, hypotheses and objectives. *Canadian journal of surgery. Journal canadien de chirurgie* 53(4), 278–281 (2009)
- [2] Buddies, S.: A Strong Hypothesis (2010), <http://www.sciencebuddies.org/blog/2010/02/a-strong-hypothesis.php>
- [3] <http://dl.acm.org/ccs/ccs.cfm>
- [4] Dybå, T., Kitchenham, B.A., Jorgensen, M.: Evidence-based software engineering for practitioners. *IEEE Software* 22(1), 58–65 (2005)
- [5] Wohlin, C., Runeson, P., Höst, M., Ohlsson, M. C., Regnell, B., & Wesslén, A. (2012). *Experimentation in software engineering*. Springer Science & Business Media.

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Study Appraisal Checklist

1. Is there any vested interest?
 - ▶ Who sponsored the study?
 - ▶ Do the researchers have any vested interest in the results?
2. Is the evidence valid?
 - ▶ Was the study's design appropriate to answer the question?
 - ▶ How were the tasks, subjects, and setting selected?
 - ▶ What data was collected, and what were the methods for collecting the data?
 - ▶ Which methods of data analysis were used, and were they appropriate?
3. Is the evidence important?
 - ▶ What were the study's results?
 - ▶ Are the results credible, and, if so, how accurate are they?
 - ▶ What conclusions were drawn, and are they justified by the results?
 - ▶ Are the results of practical and statistical significance?
4. Can the evidence be used in practice?
 - ▶ Are the study's findings transferable to other industrial settings?
 - ▶ Did the study evaluate all the important outcome measures?
 - ▶ Does the study provide guidelines for practice based on the results?
 - ▶ Are the guidelines well described and easy to use?
 - ▶ Will the benefits of using the guidelines outweigh the costs?
5. Is the evidence in this study consistent with the evidence in other available studies?
 - ▶ Are there good reasons for any apparent inconsistencies?
 - ▶ Have the reasons for any disagreements been investigated?

After Action Review (AAR)

- ▶ What was supposed to happen?
- ▶ What actually happened?
- ▶ Why were there differences?
- ▶ What did we learn?

Postmortem Analysis (PA)

- ▶ What went so well that we want to repeat it?
- ▶ What was useful but could have gone better?
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QUESTION
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HYPOTHESIS
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EXPERIMENT
<div>VARIABLES</div> <div><div>Dependent</div><div></div><div></div><div></div></div> <div><div>Independent</div><div></div><div></div><div></div></div> <div><div>Control</div><div></div><div></div><div></div></div>
<div>Technique</div> <div></div> <div></div> <div></div>
<div>Statistical Results</div> <div></div> <div></div> <div></div>

CONCLUSION
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