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# Metacognition and Self-Regulated Learning: Models and Measures

Psycholinguistics lab seminar - University of Geneva

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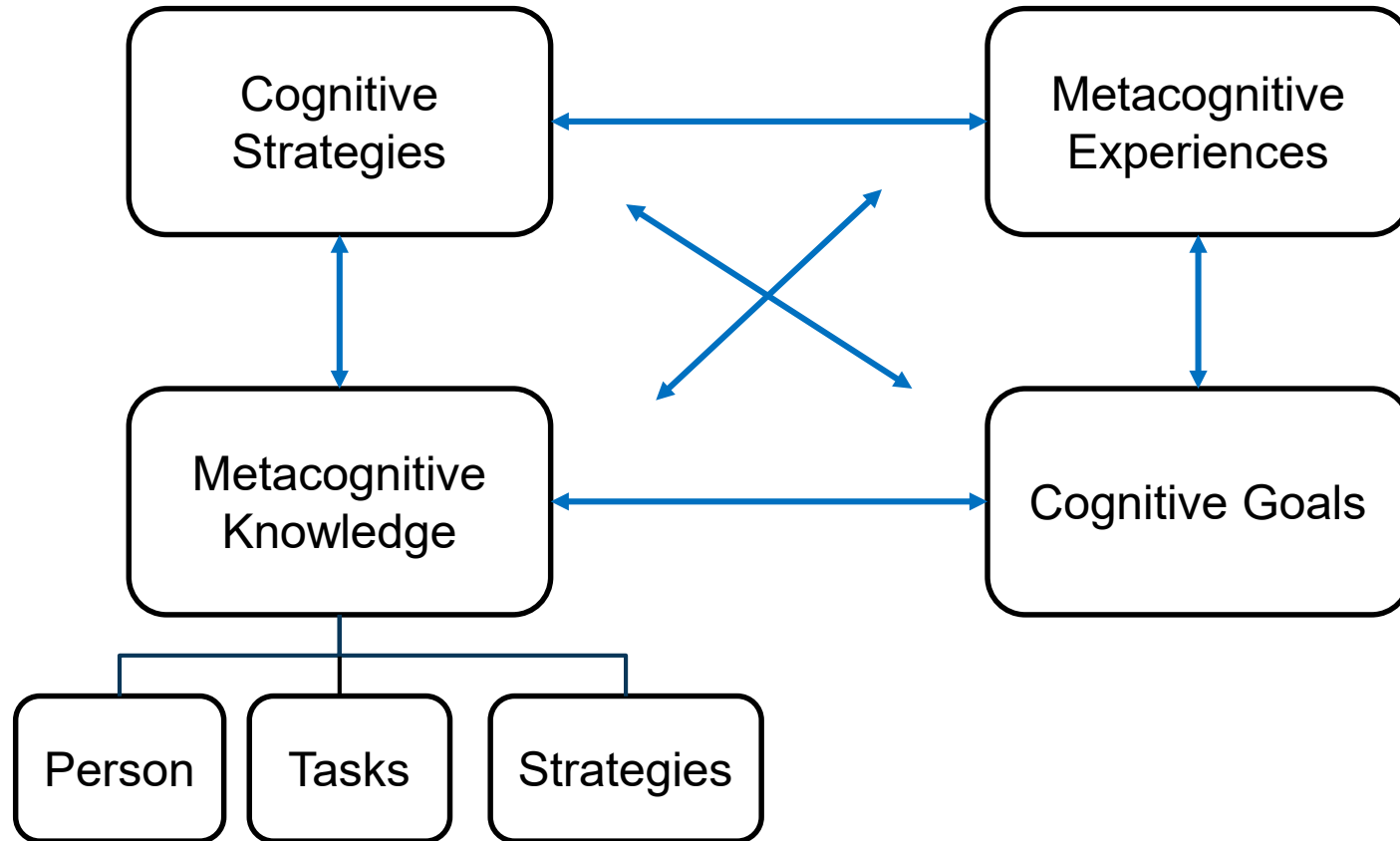
# A General Definition of Metacognition

Metacognition refers to thinking about thinking, or more generally, to using higher-level knowledge and strategies to regulate lower-level performance.

Schraw, Wise & Roos 2000, p. 223

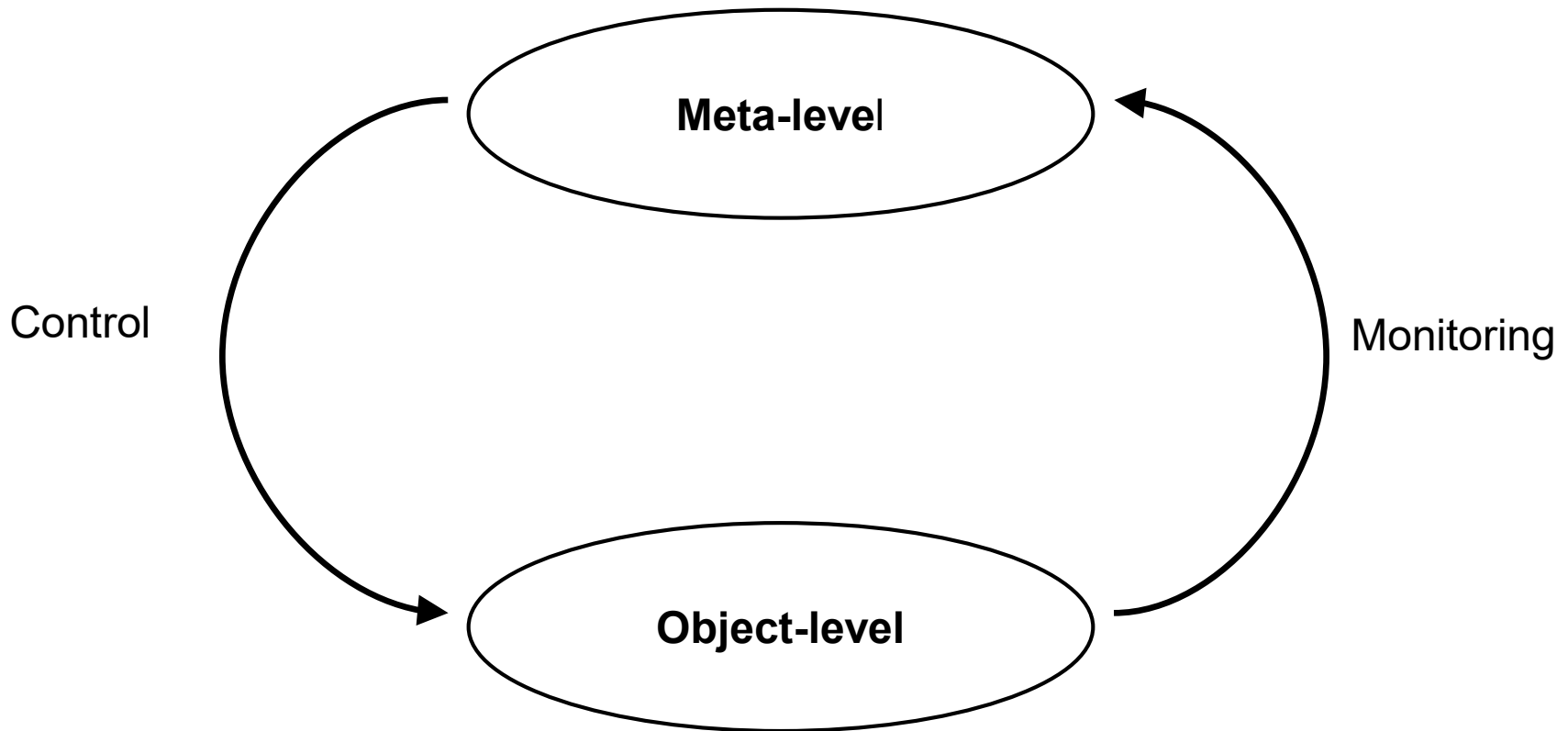
Schraw, G., Wise, S. L., & Roos, L. L. (2000). Metacognition and computer-based testing. In Schraw, G. & Impara, J.C., (Eds.), *Issues in the measurement of metacognition* (pp. 223-260). Buros Institute of Mental Measurements.  
<https://digitalcommons.unl.edu/burosmetacognition/6/>

# Flavell's Model of Metacognition



Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist*, 34, 906–911. <https://doi.org/10.1037/0003-066X.34.10.906>

# Nelson and Narens Model of Metacognition



Nelson, T. O. & Narens, L. (1990). Metamemory: A theoretical framework and new findings. In G. H. Bower (Ed.), *Psychology of learning and motivation* (Vol. 26; pp. 125-173). Academic Press. [https://doi.org/10.1016/S0079-7421\(08\)60053-5](https://doi.org/10.1016/S0079-7421(08)60053-5)

# How Metacognitive Knowledge and Strategies are Related: The Metacognitive Question

If I know the specifics of the task, the characteristics of my own cognitive functioning and a number of strategies, how can I anticipate, plan and control my learning process?

Büchel (1995)

Büchel, F. P. (Ed.), (1995). *L'éducation cognitive : Le développement de la capacité d'apprentissage et de son évaluation*. Delachaux et Niestlé.

# A General Definition of Self-Regulated Learning

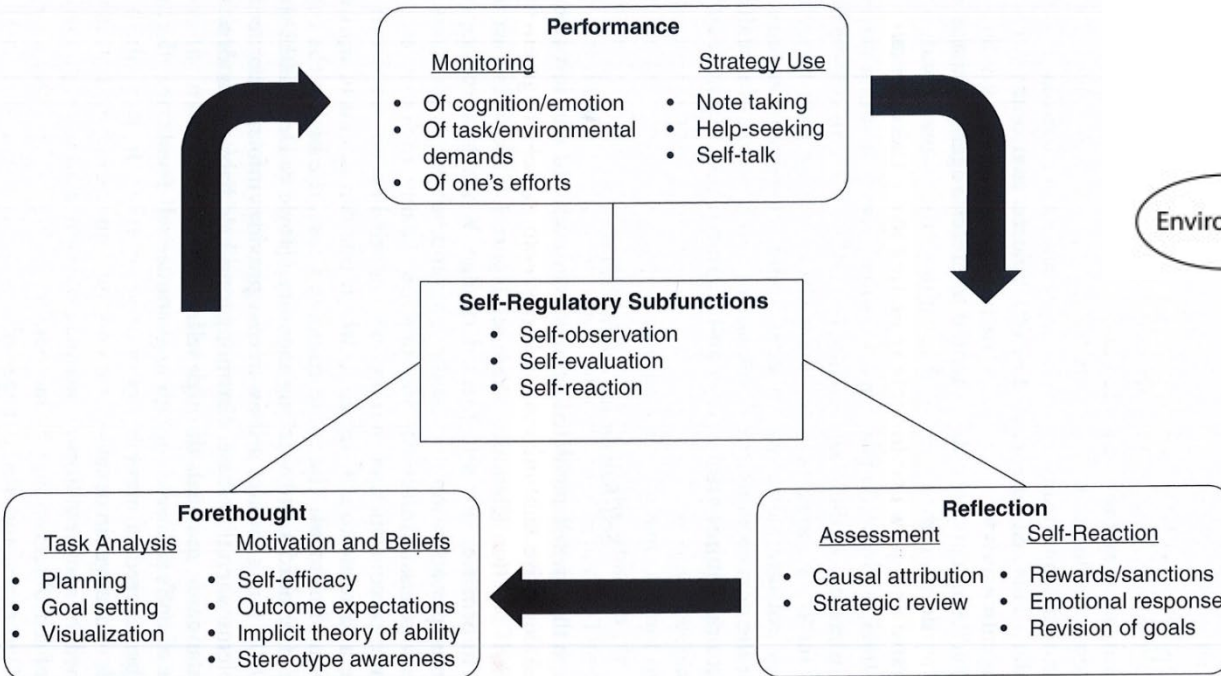
Self-regulation refers to the ways that learners systematically **activate** and **sustain** their **cognitions**, **motivations**, **behaviors**, and **affects**, toward the attainment of **their goals**.

Schunk & Greene 2018, p. 1

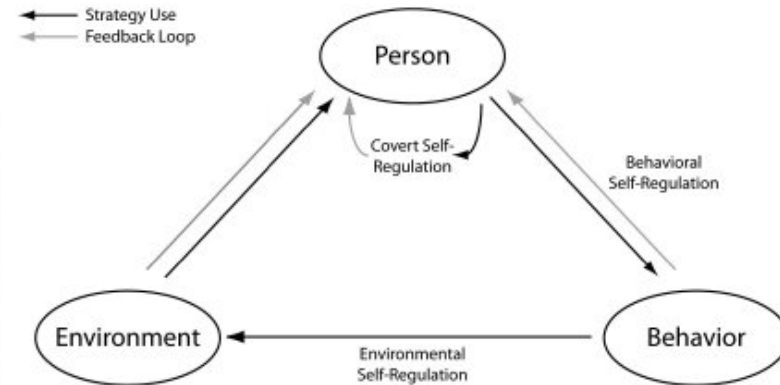
Schunk, D. H., & Greene, J. A. (2018). Historical, contemporary, and future perspectives on self-regulated learning and performance. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (pp. 1–15). Routledge/Taylor & Francis Group.

# Zimmerman Cyclical Model of Self-Regulated Learning

**Cyclical SRL Model**



**Triadic Reciprocal Causation**



Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall.

Usher, E. L., & Schunk, D. H. (2018). Social cognitive theoretical perspective of self-regulation. In D. H. Schunk & J. A. Greene (Eds.), *Handbook of self-regulation of learning and performance* (pp. 19–35). Routledge/Taylor & Francis Group.



# Phases and Areas of Self-Regulated Learning

Phases and relevant scales	Areas for regulation			
	Cognition	Motivation/Affect	Behavior	Context
<i>Phase 1</i> Forethought, planning, and activation	Target goal setting	Goal orientation adoption	Time and effort planning	Perceptions of task
	Prior content knowledge activation	Efficacy judgments	Planning for self-observations of behavior	Perceptions of context
	Metacognitive knowledge activation	Perceptions of task difficulty Task value activation Interest activation		
<i>Phase 2</i> Monitoring	Metacognitive awareness and monitoring of cognition	Awareness and monitoring of motivation and affect	Awareness and monitoring of effort, time use, need for help Self-observation of behavior	Monitoring changing task and context conditions
<i>Phase 3</i> Control	Selection and adaptation of cognitive strategies for learning, thinking	Selection and adaptation of strategies for managing, motivation, and affect	Increase/decrease effort	Change or renegotiate task
			Persist, give up Help-seeking behavior	Change or leave context
<i>Phase 4</i> Reaction and reflection	Cognitive judgments	Affective reactions	Choice behavior	Evaluation of task
	Attributions	Attributions		Evaluation of context

Pintrich, P. R. (2004). A Conceptual Framework for Assessing Motivation and Self-Regulated Learning in College Students. *Educational Psychology Review* 16, 385–407. <https://doi.org/10.1007/s10648-004-0006-x>

# The Need for *Strategy Motivation* (SM)

- a) The role of motivational beliefs is generally considered, in its influence on SRL, in relation to an outcome (learning, achievement).
- b) The source and strength of motivation in models, although positioned somewhat differently, are universally assumed to emanate from the outcomes that strategies are intended to accomplish.

→ *Outcome Motivation* (OM)

- c) Largely absent from major SRL models, are the motivational influence of strategies themselves

→ *Strategy Motivation* (SM)

Carver, C. S., Sutton, S. K., & Scheier, M.F. (2000). Action, emotion, and personality: Emerging conceptual integration. *Personality and Social Psychology Bulletin*, 26(6),741-751. <https://doi:10.1177/0146167200268008>

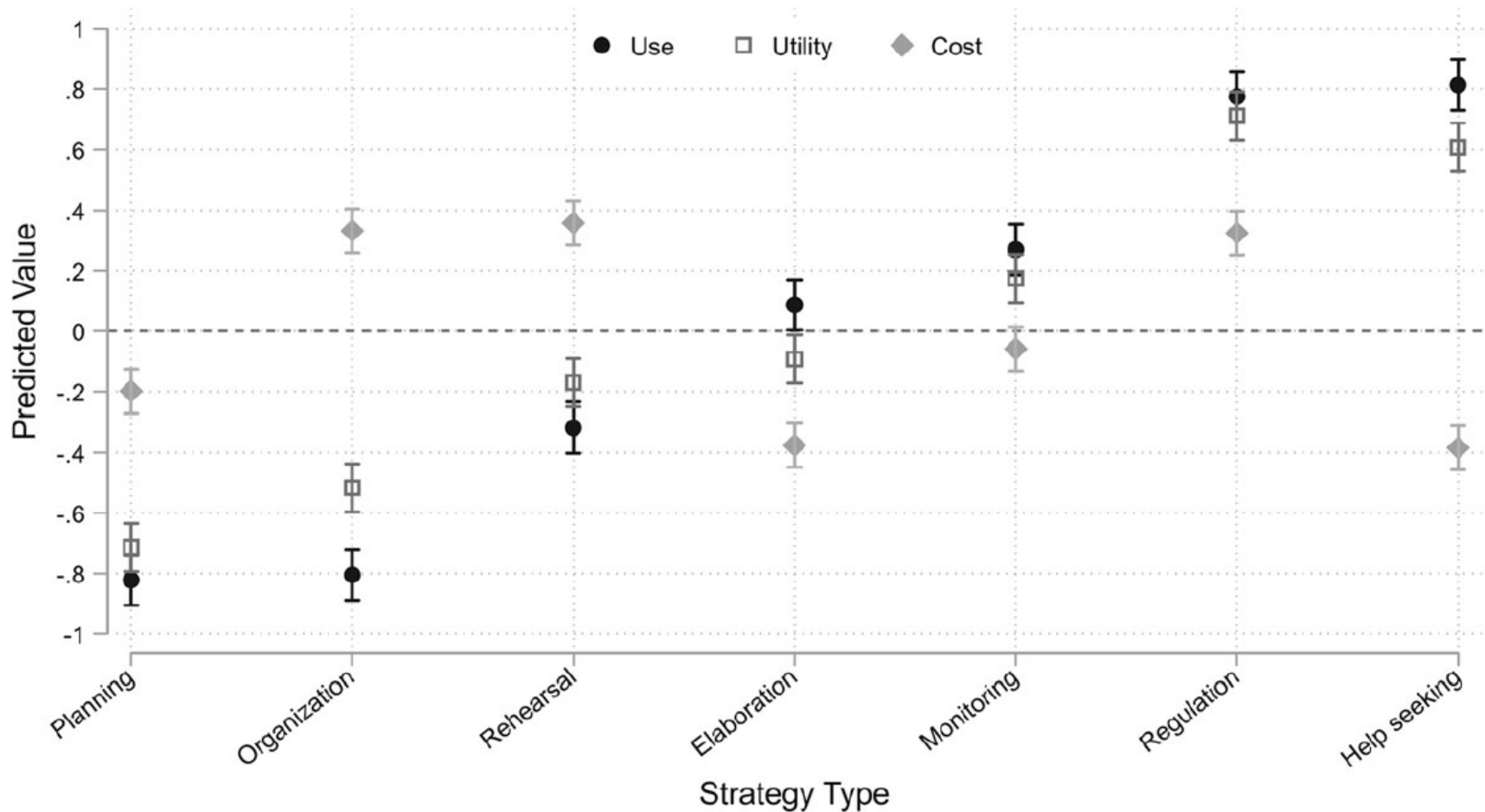
Karabenick, S. A. (2019). *Motivation and self-regulated learning: Introducing strategy motivation and information regulation*. Keynote address presented at the EARLI 2019 Conference, Aachen, Germany. <https://www.youtube.com/watch?v=IA55kxn3ssM>

Karabenick, S. A., Berger, J.-L., Ruzek, E., & Schenke, K. (2021). Strategy motivation and strategy use: Role of student appraisals of utility and cost. *Metacognition and Learning*. <https://doi.org/10.1007/s11409-020-09256-2>

Berger, J.-L., & Karabenick, S. A. (2021). *The relevance of strategic motivation in the choice of self-regulation strategies*. Document in preparation.

# Strategy Use: A Cost-Benefit Trade-Off?

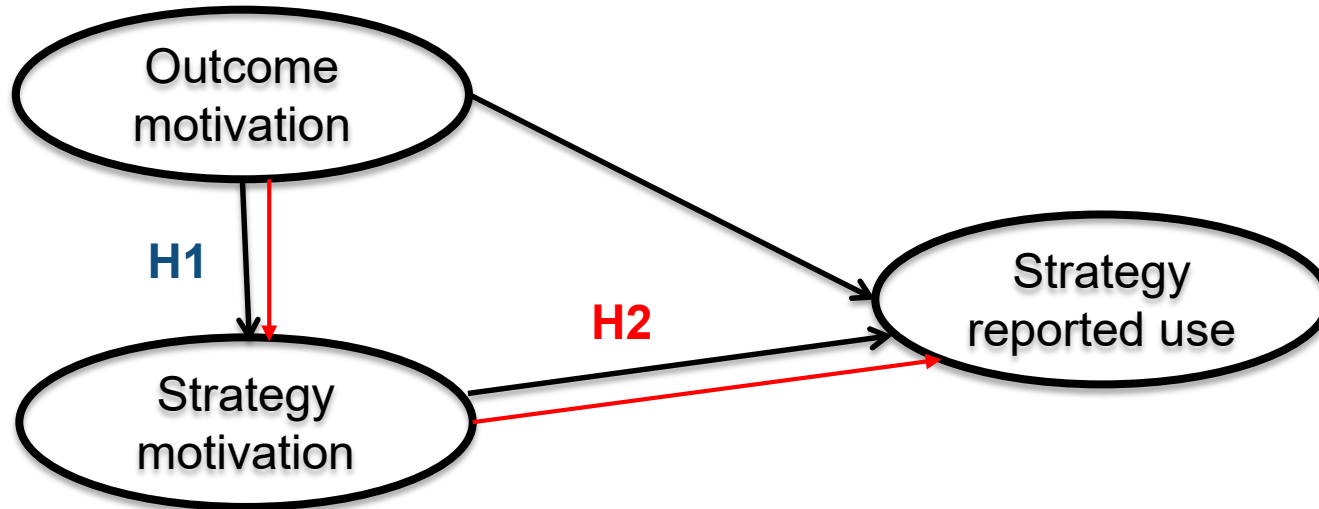
n = 305 9th grade high school students (U.S. Middle West)



*Predicted use, utility, and cost means across strategies (T1 and T2 merged)*

Karabenick, S. A., Berger, J.-L., Ruzek, E., & Schenke, K. (2021). Strategy motivation and strategy use: Role of student appraisals of utility and cost. *Metacognition and Learning*. <https://doi.org/10.1007/s11409-020-09256-2>

# Outcome Motivation, Strategy Motivation and Reported Use

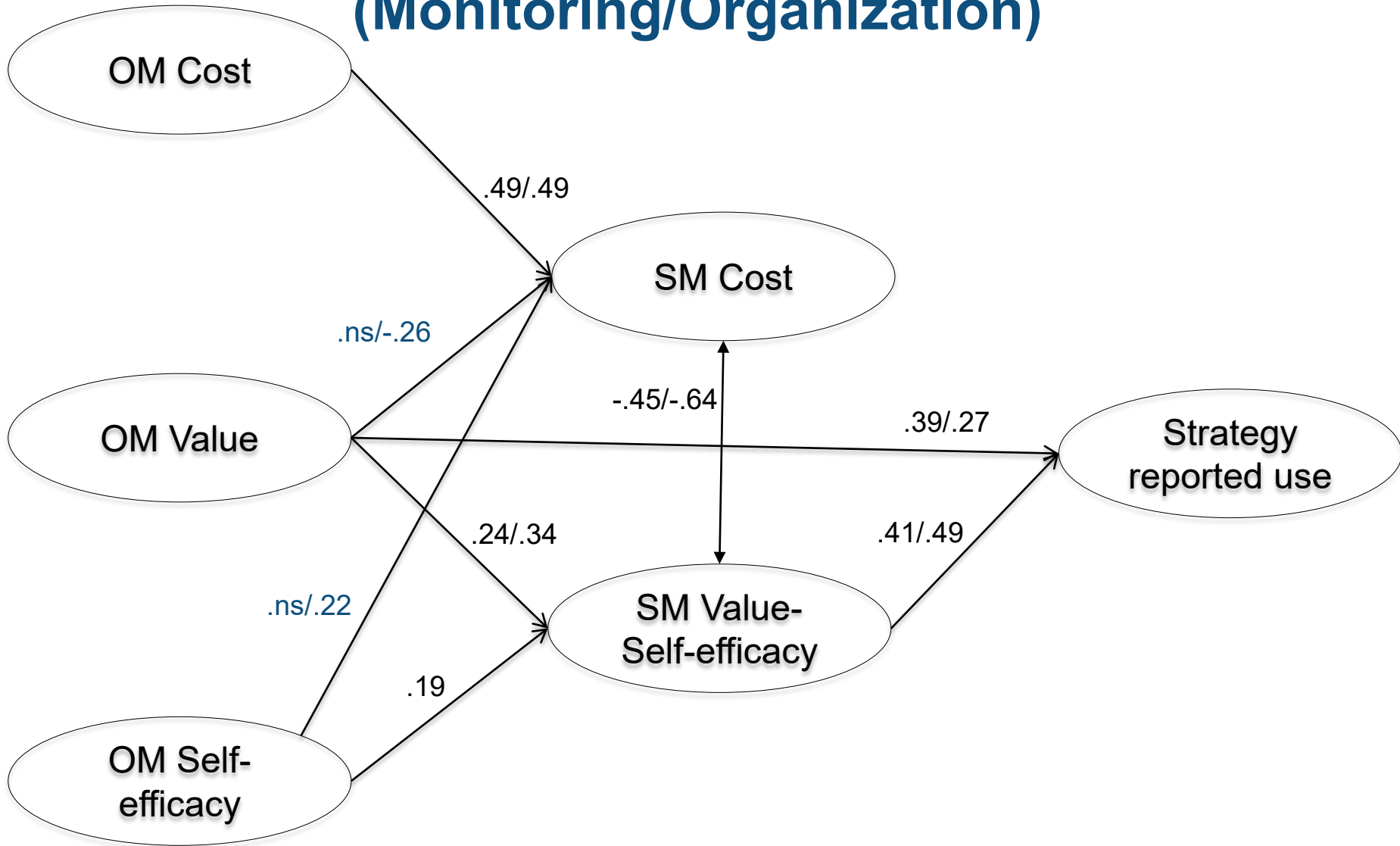


**H1** Outcome motivation explains Strategy motivation

**H2** Strategy motivation mediates the effect of Outcome motivation on Strategy reported use

Berger, J.-L., & Karabenick, S. A. (2021). The relevance of strategic motivation in the choice of self-regulation strategies. Document in preparation.

# The Key Role of Strategy Motivation (Monitoring/Organization)



OM = Outcome Motivation; SM = Strategy Motivation

# Basic Distinctions in the Measurement of Metacognition and SRL

## **Aptitude vs Event (Winne & Perry, 2000)**

Aptitude : “A relatively enduring attribute of a person that predicts future behavior” (p. 534)

Event: “A snapshot that freezes activity in motion, a transient state embedded in a larger, longer series of states unfolding over time” (p. 534)

## **On-line vs Off-line (Veenman & van Cleef, 2019)**

On-line: assessment during actual task performance → coding based on externally defined criteria

Off-line: assessment prior or retrospective to task performance → reliance on individual self-report.

## **Large vs specific grain-size**

Larger grain-size allows higher generalization

Specific grain-size allows higher proximity with performance (specificity-matching principle)

Winne, P. H., & Perry, N. E. (2000). Measuring self-regulated learning. In M. Boekaerts, P. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 531–566). Academic Press. <https://doi.org/10.1016/B978-012109890-2/50045-7>

Veenman, M. V. J. & van Cleef, D. (2019). Measuring metacognitive skills for mathematics: students' self-reports versus on-line assessment methods. *ZDM Mathematics Education* 51, 691–701. <https://doi.org/10.1007/s11858-018-1006-5>

# Popularity of Measurement Types in Metacognition and SRL

Measurement type	Construct					
	Metacognition		Self-regulation		Self-regulated learning	
	<i>f</i>	Percent	<i>f</i>	Percent	<i>f</i>	Percent
OFF Self-report (questionnaire)	29	24	37	73	44	59
ON Observation	24	20	10	20	12	16
ON Think-aloud	14	12	00	00	10	13
OFF Interviews	16	13	02	04	07	09
? Performance ratings	38	31	01	02	02	03
OFF Diaries	00	00	01	02	00	00

**Planning:** “Before I begin studying math I think about what and how I am going to learn.”

**Monitoring:** “When I study math, I ask myself questions to make sure I know what I have been learning.”

**Regulation:** “If I get confused with something I’m studying in math, I go back and try to figure it out.”

Dinsmore, D. L., Alexander, P. A., & Loughlin, S. M. (2008). Focusing the conceptual lens on metacognition, self-regulation, and self-regulated learning. *Educational Psychology Review*, 20, 391–409. <https://doi.org/10.1007/s10648-008-9083-6>

# Correlations Motivated Strategies for Learning Questionnaire - Grades & GPA

Subscale	Criterion	N	k	$r_{obs}$	$SD_{obs}$	$\rho$	$SD_{\rho}$	Lower 90%	Upper 90%	% Var	$r_{op}$
Intrinsic goal orientation	GPA	4702	10	.11	.08	.15	.11	.00	.29	23	.12
	Grade	10,325	40	.14	.09	.20	.12	.05	.35	35	.17
Extrinsic goal orientation	GPA	4420	8	.04	.12	.06	.16	-.15	.27	12	.05
	Grade	9433	33	.07	.11	.10	.16	-.10	.31	22	.08
Task value	GPA	2508	6	.12	.07	.14	.08	.04	.24	36	.13
	Grade	7658	34	.17	.11	.21	.14	.03	.39	26	.20
Control of learning beliefs	GPA	2354	5	.12	.05	.17	.07	.09	.26	49	.14
	Grade	6117	30	.14	.02	.20	.03	.16	.24	92	.16
Self-efficacy	GPA	3798	9	.18	.06	.21	.07	.12	.01	39	.20
	Grade	8123	39	.30	.15	.37	.18	.15	.60	16	.35
Test anxiety	GPA	1923	6	-.09	.15	-.11	.19	-.36	.13	12	-.10
	Grade	6993	30	-.14	.14	-.18	.19	-.42	.06	17	-.16
Rehearsal	GPA	2461	6	.05	.06	.07	.08	-.03	.18	40	.06
	Grade	5958	24	.08	.09	.12	.13	-.05	.29	31	.10
Elaboration	GPA	3735	8	.10	.02	.13	.03	.10	.17	81	.12
	Grade	6774	28	.13	.12	.17	.17	-.04	.39	21	.15
Organization	GPA	2721	5	.07	.03	.09	.04	.04	.14	71	.08
	Grade	5291	24	.08	.08	.11	.10	-.03	.24	44	.09
Critical thinking	GPA	1528	4	.06	.00	.08	.00	.08	.08	100	.07
	Grade	5245	26	.09	.14	.12	.19	-.12	.35	20	.10
Meta-cognitive Self-regulation	GPA	4390	13	.17	.16	.22	.20	-.03	.47	11	.19
	Grade	7155	32	.18	.13	.23	.17	.02	.45	21	.20
Time and study environment	GPA	2721	5	.17	.08	.23	.11	.09	.36	22	.19
	Grade	4892	24	.22	.10	.31	.13	.14	.48	33	.26
Effort regulation	GPA	2721	5	.16	.11	.23	.15	.04	.42	15	.18
	Grade	5180	24	.27	.13	.40	.19	.16	.64	23	.31
Peer learning	GPA	1528	4	-.06	.00	-.08	.00	-.08	-.08	100	-.07
	Grade	4347	20	.05	.10	.08	.13	-.10	.25	34	.06
Help seeking	GPA	1528	4	-.01	.00	-.02	.00	-.02	-.02	100	-.02
	Grade	4726	23	.04	.06	.06	.09	-.05	.17	61	.04

Credé, M., & Phillips, L. A. (2011). A meta-analytic review of the Motivated Strategies for Learning Questionnaire. *Learning and Individual Differences*, 21(4), 337–346. <https://doi.org/10.1016/j.lindif.2011.03.002>



# Multimethod SRL Assessment

Strategy knowledge test	MOT – COG	–0.19
	MOT – MCOG	0.28*
	COG – MCOG	0.34**
Questionnaire	MOT – COG	–0.08
	MOT – MCOG	0.54**
	COG – MCOG	–0.06
Microanalytic assessment—closed-ended	MOT – MCOG	0.26*
Microanalytic assessment—open-ended	MOT – MCOG	0.27*
Trace data	CLS – KW	0.10
	CLS – AW	0.07
	KW – AW	0.72**

*MOT* motivation; *MCOG* metacognition; *COG* cognition; *CLS* cognitive learning strategies; *KW* key words; *AW* auxiliary words

\* $p < 0.05$ , \*\* $p < 0.01$

Motivation	SKT – Q	0.09
	SKT – MI_C	0.05
	SKT – MI_O	–0.02
	Q – MI_C	0.29*
	Q – MI_O	0.00
	MI_C – MI_O	0.14
Metacognition	SKT – Q	0.22
	SKT – MI_C	0.17
	SKT – MI_O	0.03
	Q – MI_C	0.21
	Q – MI_O	0.10
	MI_C – MI_O	0.16
Cognition	SKT – Q	0.05
	SKT – TD_CLS	0.12
	SKT – TD_KW	–0.04
	SKT – TD_AW	–0.13
	Q – TD_CLS	0.15
	Q – TD_KW	–0.05
	Q – TD_AW	–0.06

*SKT* strategy knowledge test; *Q* questionnaire; *MI\_C* microanalysis closed-ended questions; *MI\_O* microanalysis open-ended questions; *TD\_CLS* trace data\_cognitive learning strategies; *TD\_KW* trace data\_key words; *TD\_AW* trace data\_auxiliary words

\* $n < 0.05$  \*\* $n < 0.01$

Measure	GPA
Strategy knowledge test—motivation	0.00
Strategy knowledge test—cognition	–0.33**
Strategy knowledge test—metacognition	–0.15
Questionnaire—motivation	–0.24*
Questionnaire—cognition	–0.02
Questionnaire—metacognition	–0.20
Microanalysis—motivation—closed-ended questions	–0.19
Microanalysis—metacognition—closed-ended questions	–0.07
Microanalysis—motivation—open-ended questions	–0.10
Microanalysis metacognition—open-ended questions	–0.26*
Trace data—cognitive learning strategies	–0.08
Trace data—key words	–0.08
Trace data—auxiliary words	0.29*

\* $p < 0.05$ , \*\* $p < 0.01$

Dörrenbächer-Ulrich, L., Weißenfels, M., Russer, L., & Perels, F. (2021). Multimethod assessment of self-regulated learning in college students: different methods for different components? *Instructional Science* 49, 137–163.

<https://doi.org/10.1007/s11251-020-09533-2>

# The Debate about the Validity of Self-reported Metacognitive Strategies

Measuring SRL and metacognitive strategies by means of self-report questionnaire cannot provide valid information:

- The cognitive limits of the respondent (e.g., memory failure)
- Lack of understanding of the items
- The grain-size of assessment
- ...

## Versus

Self-report questionnaire provides valid information:

- Strong theoretical foundations
- Adequate predictive validity with regard to learning, motivation, and achievement
- Reliable scales' scores

→ No study on the cognitive processing of self-reported items measuring SRL.

Berger, J.-L., & Karabenick, S. A. (2016). Construct validity of self-reported metacognitive learning strategies. *Educational Assessment*, 21(1), 19–33. <https://doi.org/10.1080/10627197.2015.1127751>

# What is Cognitive Pretesting?

A systematic and consistent interview methodology for pretesting the validity of items during the development of self-report instruments ... or the validity of already “validated” scales

Cognitive Pretesting can be used to:

- a) assess how respondents interpret an item;
- b) determine what respondents think about while cognitively processing the item;
- c) identify the rationale respondents use to choose an answer option;
- d) indicate how items might be modified to enhance their validity.

Karabenick, S. A., Woolley, M. E., Friedel, J. M., Ammon, B. V., Blazeovski, J., Bonney, C. R., ... Kelly, K. L. (2007). Cognitive processing of self-report items in educational research: Do they think what we mean? *Educational Psychologist*, 42, 139–151. <https://doi:10.1080/00461520701416231>

# Information Provided by the Cognitive Pretesting Procedure

What percentage of students:

- a) Give a coherent interpretation of the item meaning?
- b) Elaborate correctly in terms of the strategy timing (e.g. before studying)?
- c) Elaborate correctly in terms of the type of strategy (activity)?
- d) Select an answer choice which is congruent with regard to the memories they recalled?

# The Cognitive Pretesting Interview Procedure

1. “Please read that question out loud for me.”

2. “What is that question trying to find out from you?”

→ *Criterion: Interpretation*

3. “These numbers (1 = “not at all true of me” to 5 = “very true of me”) describe how different people feel about this question. Which number would you choose as your answer?”

4. “Please explain to me why you chose that answer. What were you thinking about?”

→ *Criteria: Elaboration & Answer Choice*

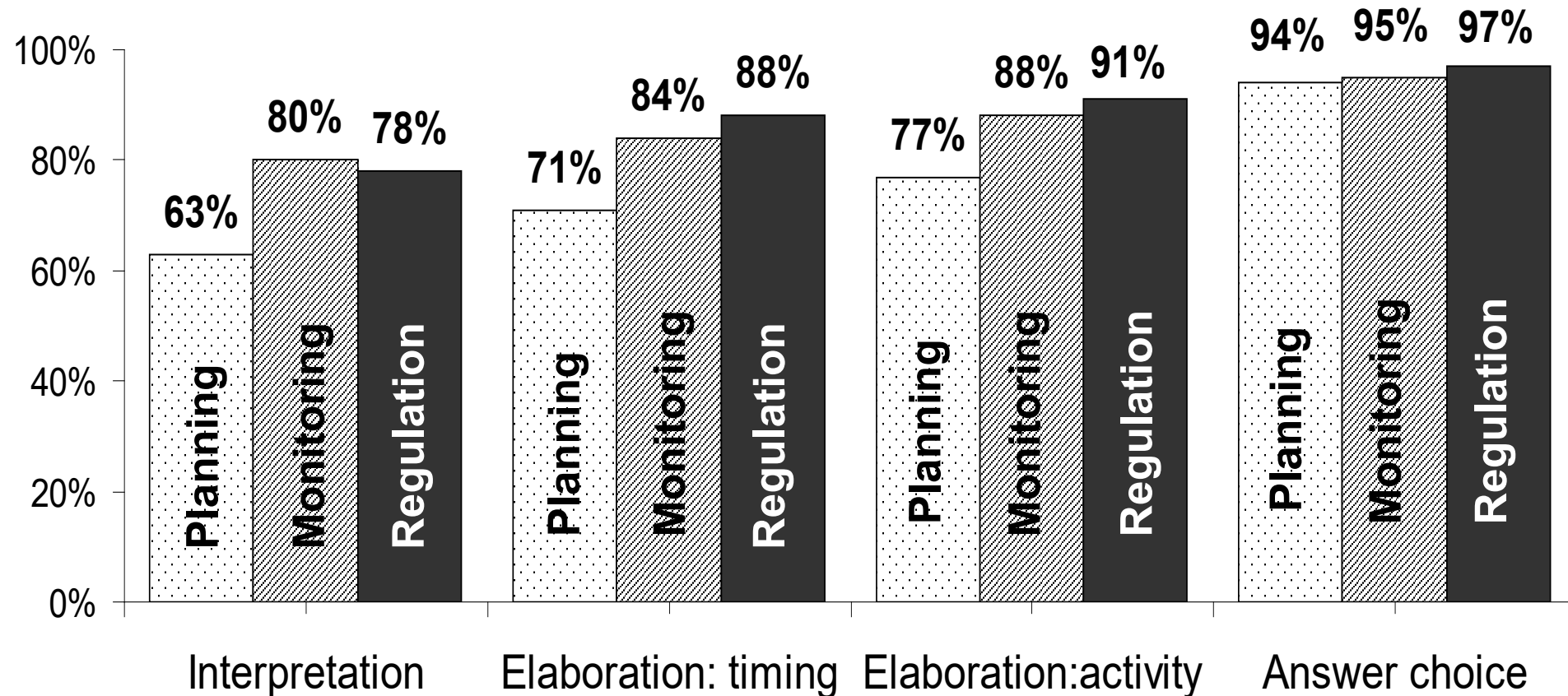
(+ *Follow-up prompts if needed*)

5. “Now let’s do the next question.”

Karabenick, S. A., Woolley, M. E., Friedel, J. M., Ammon, B. V., Blazeovski, J., Bonney, C. R., ... Kelly, K. L. (2007). Cognitive processing of self-report items in educational research: Do they think what we mean? *Educational Psychologist*, 42, 139–151. <https://doi:10.1080/00461520701416231>

# MSLQ Metacognitive Self-Regulation Scale: Cognitive Validity by Criteria

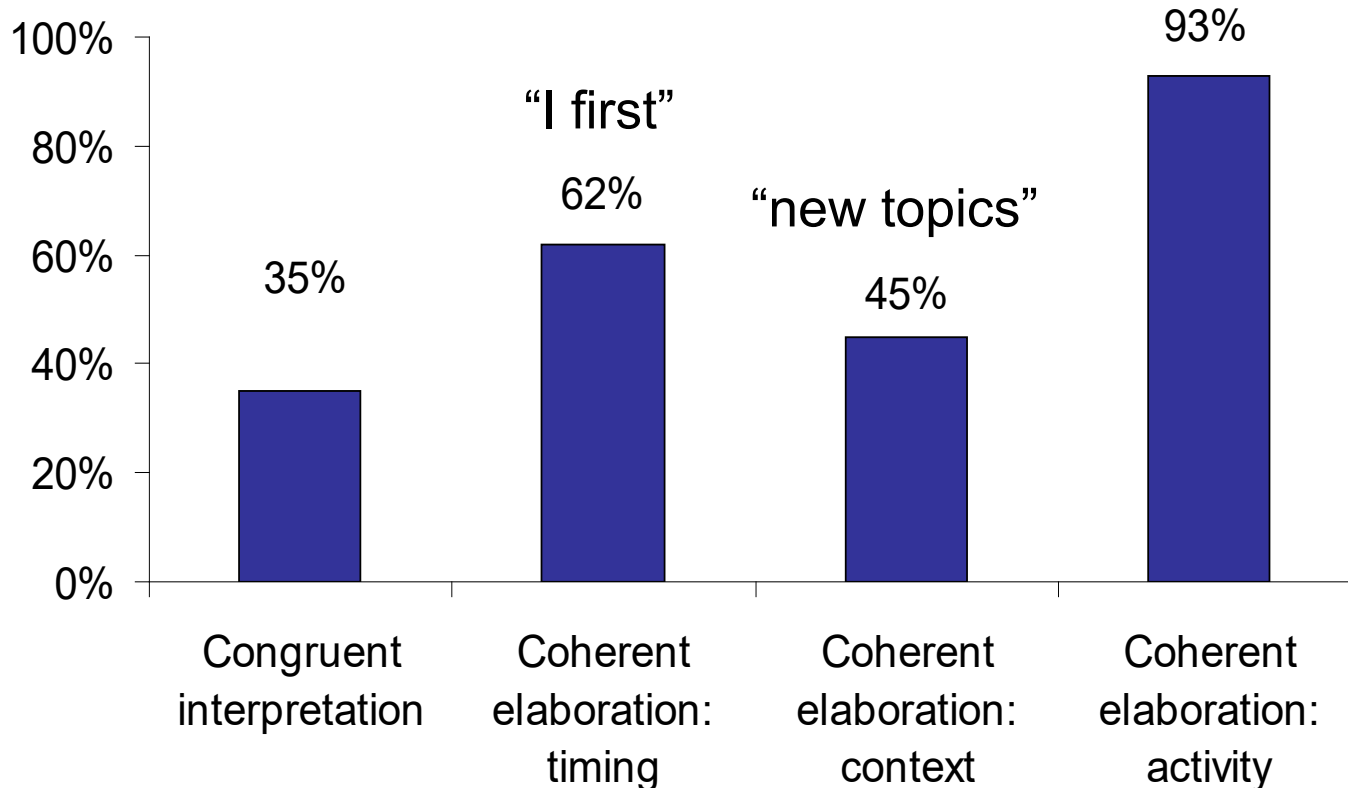
n = 29 9th grade high school students (U.S. Middle West)



# Planning Items: Cognitive Validity

% of students giving congruent interpretation of the item meaning and coherent elaboration of their answers

## 4. "When I learn new topics in math, I first figure out the best way to study."



# “4. When I learn new topics in math, I first figure out the best way to study.”

*Girl, planning score = 5/25, end of the term grade: C+*

S: I don't really understand that one...um, the best way to study? I don't really get what it's saying, different ways to study maybe like sitting down at somewhere quiet or I don't study that much and I don't know different ways to study.

*I: These numbers describe how different people feel about this strategy. Which number would be the best for you?*

S: I guess it would be number 1 again (NB. not at all true of me).

*I: Can you tell me a little bit more about why you picked your answer?*

S: Because I don't really know other ways to study other than just study, I'm...I don't know much about it.



# “4. When I learn new topics in math, I first figure out the best way to study.”

Boy, planning score = 16/25, algebra I 2/3, end of the term grade: B-

S: Um...it's asking me if I ask questions after learning a new topic or if I don't get something if I ask questions.

*I: These numbers describe how different people feel about this strategy. Which number would be the best for you?*

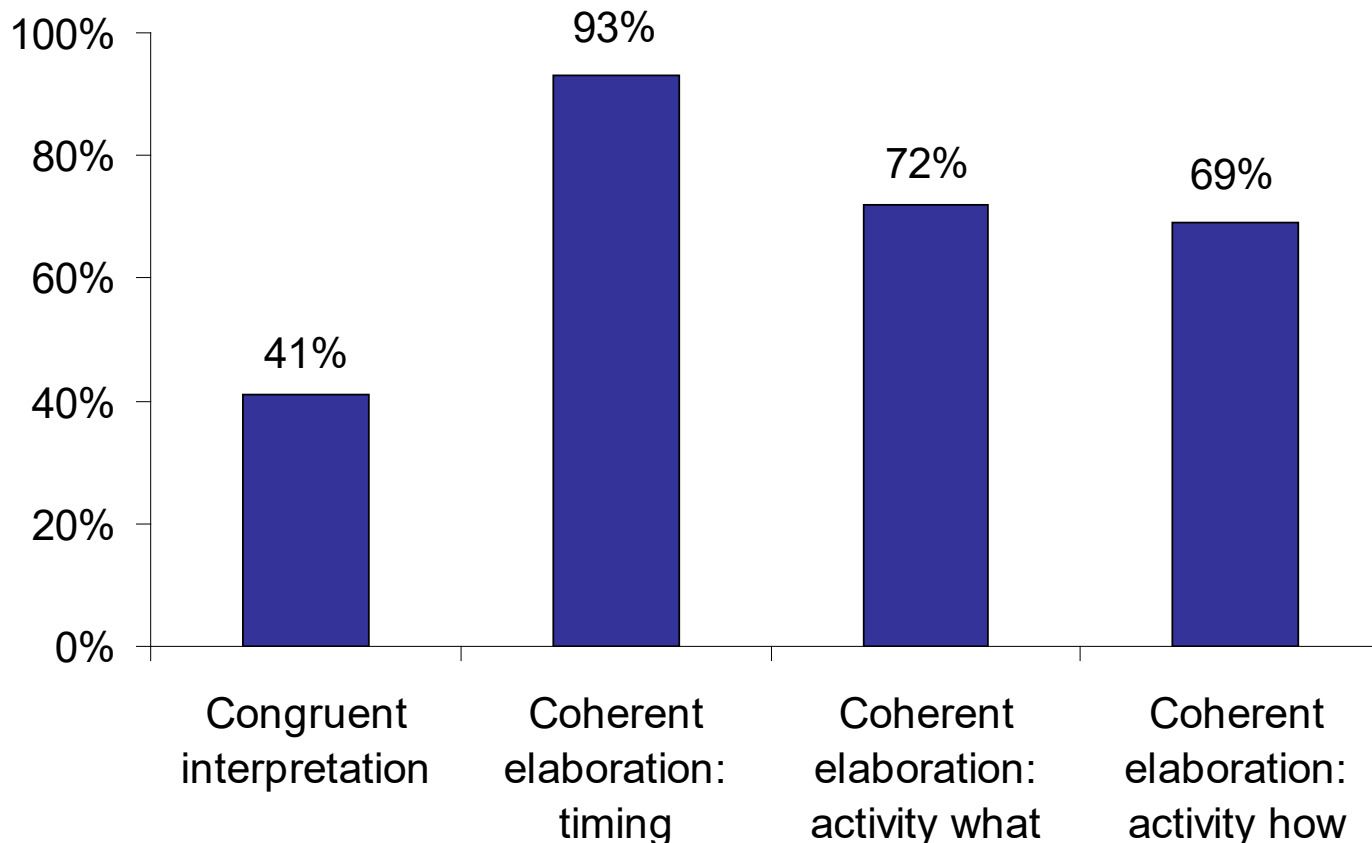
S: And I would pick 4 because I do this whenever we learn a new topic, I ask the teacher questions about it.

(...)

# Planning Items: Cognitive Validity

% of students (n = 29) giving congruent interpretation of the item meaning and coherent elaboration of their answers

## 2. Before I begin studying math I think about what and how I am going to learn.



## “2. Before I begin studying math I think about what and how I am going to learn.”

*Girl, planning score = 9/25, end of the term grade: A*

S: This is asking you um...find a way or a plan that works for you about how you are going to study math before you start to begin doing it.

*I: These numbers describes how different people feel about this strategy. Which number would be the best for you?*

S: I think this is a 2 for me because usually I don't plan how I am going to...how I'm going to learn or study it I just do what I usually do and just study it the way I think it should be studied.

# Perspectives

## Strategy Motivation

- Why do students differ in their SM?
- How does SM change over time?
- What person and situation variables moderate the SM-reported use association?

## Longitudinal perspective

- How does SRL in areas such as motivation and context change from primary school to higher education?

## Switch from quantity to quality

- To which degree are the SRL or metacognitive processes adapted to the learning setting?
- Frequency of strategies might matter less than adequacy

## Multi-method approach

- Method-dependence in the field calls for triangulation
- How eye-tracking and physiological indicators might add to understanding metacognitive and SRL processes? Convergence or complementarity?

Berger, J.-L. (submitted). Motivational beliefs, metacognition and self-regulated learning: Investigating the learning triumvirate with Stuart Karabenick. In T. C. Urdan & E. Gonida (Eds.), *Advances in achievement motivation* (vol. 22). Emerald Publishing Limited.

**Thank you for your attention**