



Off-Task Thoughts and Self-Regulated Learning in Video-Based Learning

Daniel Ebbert

Shane Dawson

Negin Mirriahi

Srecko Joksimovic

Natasha Wilson

The Challenge of Online Learning

- Video-based learning is increasingly prevalent in higher education
- Students face challenges in maintaining focus and engagement
- Mind wandering occurs ~30% of the time during learning activities (Wong et al., 2022)
- Mind wandering negatively impacts learning outcomes (Wong et al., 2022)

Research Significance

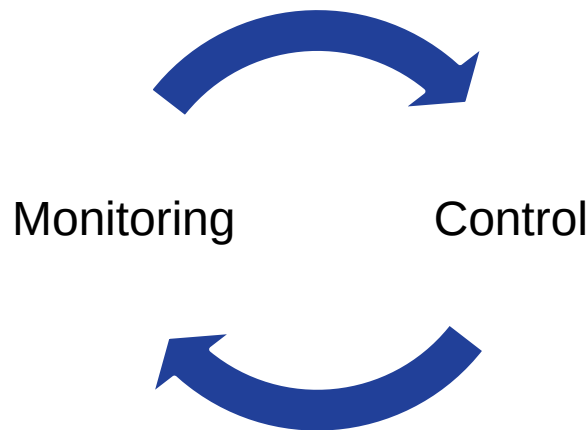
- Understanding mind wandering is important for improving online learning
- Self-regulated learning strategies may help mitigate negative effects
- Limited research on how learners react to their mind wandering
- Potential to inform instructional design and learner support strategies

- Background
- Part I: Theory Development & Meta-Analysis
- Part II: Empirical Work during Video-based Learning
- Future Work

Background

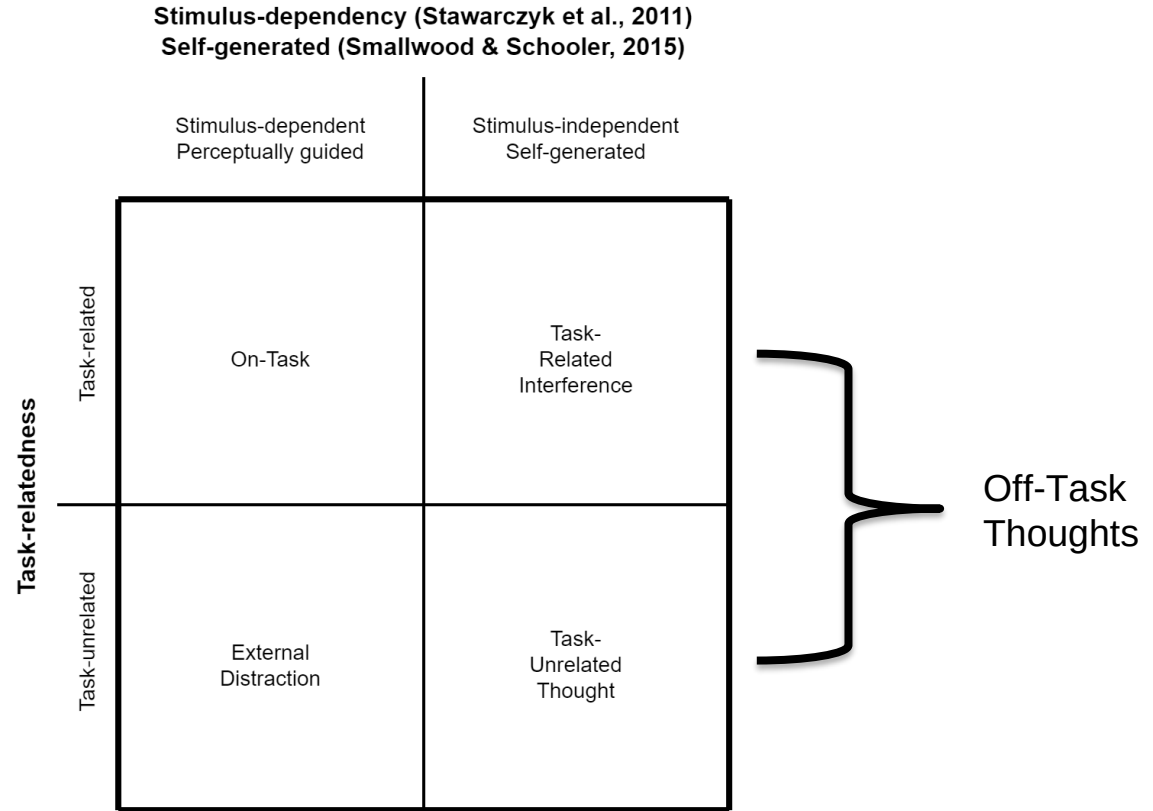
Metacognition

- Meta = About
- Cognition = Thinking
- Metacognition = Thinking about one's thinking (Flavell, 1979; Schooler & Smallwood, 2009)



Cycle of metacognitive monitoring and control (Nelson, 1990, 1996; Nelson & Narens, 1994)

Mind Wandering Conceptualisation



Off-task thoughts while learning

- Occur frequently during educational activities
 - Task-Unrelated Thoughts (TUT): ~30% of the time (Wong et al., 2022)
 - Task-Related Interference (TRI): ~23% of the time
- Impact on learning:
 - TUT: Negatively correlated with learning outcomes (Wong et al., 2022)
 - TRI: No significant correlation with learning outcomes

Meta-Awareness

- Meta-awareness means the conscious recognition of one's current thoughts (Schooler et al., 2011)
- Someone who is meta-aware might be aware of their off-task thoughts
- Meta-awareness is a part of metacognitive monitoring (Schooler & Smallwood, 2009)

Self-regulated Learning

- Learners actively manage their own learning process through planning, monitoring, and reflection (Panadero, 2017)
- COPES model chosen as theoretical framework due to its strong grounding in metacognition (Winne, 1997; Winne & Hadwin, 1998)
- Model describes how learners adapt to tasks through iterative metacognitive monitoring and control (Winne & Azevedo, 2022)

Research Question

How do off-task thoughts interact with self-regulated learning processes in video-based learning environments, and how can learners effectively manage these thoughts to improve learning outcomes?

Part I

Theory Development & Meta-Analysis

Part I Outline

- Theory Development
- Meta-Analysis

Theory Development

Ebbert, D., Mills, C., Winne, P., Mirriahi, N., & Joksimovic, S. (2024). *The (un)conscious learner: How meta-awareness influences self-regulated learning and mitigates off-task thought*. Manuscript submitted for publication.

- Develop a model linking meta-awareness and self-regulated learning
- Explore how metacognitive processes influence off-task thought experiences
- Examine potential pathways for learners to adapt to off-task thoughts

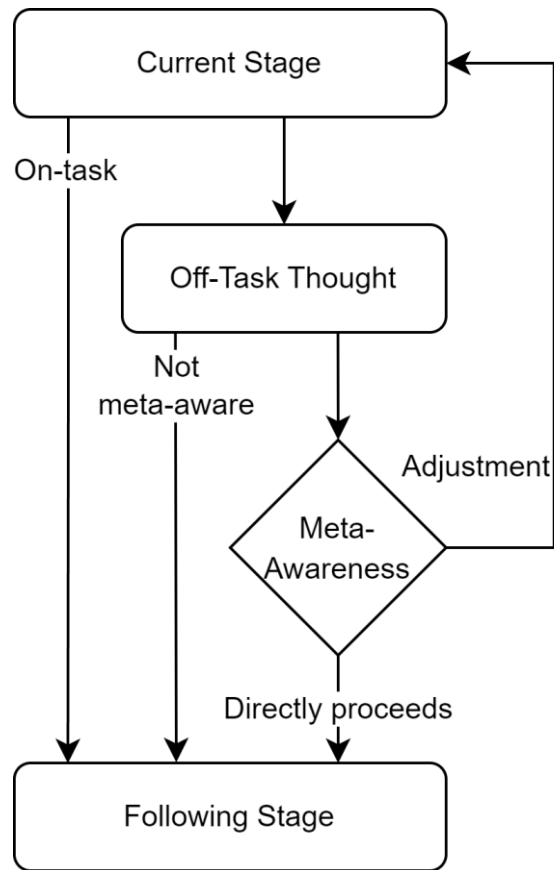
Why COPES?

- Emphasizes metacognition as core component of self-regulated learning (Winne & Azevedo, 2022)
- Describes how learners adapt to tasks through metacognitive monitoring and control
- Provides framework for understanding how off-task thoughts may influence each stage of learning

COPES Stages

- Stage 1: Task Definition
- Stage 2: Goal Setting and Planning
- Stage 3: Enacting Study Tactics and Strategies
- Stage 4: Metacognitively adaptive studying

Pathways between stages



Stage 1: Task Definition

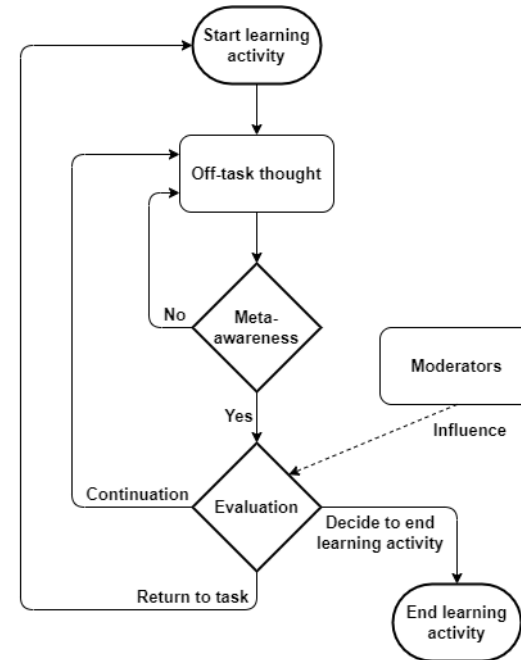
- Learners analyse the task
- TUTs could result in misinterpretation of the task

Stage 2: Goal Setting and Planning

- Learners set goals and plan how to achieve these goals
- Plan could include monitoring for TUTs
- TUTs could result in suboptimal plan

Stage 3: Enacting Study Tactics and Strategies

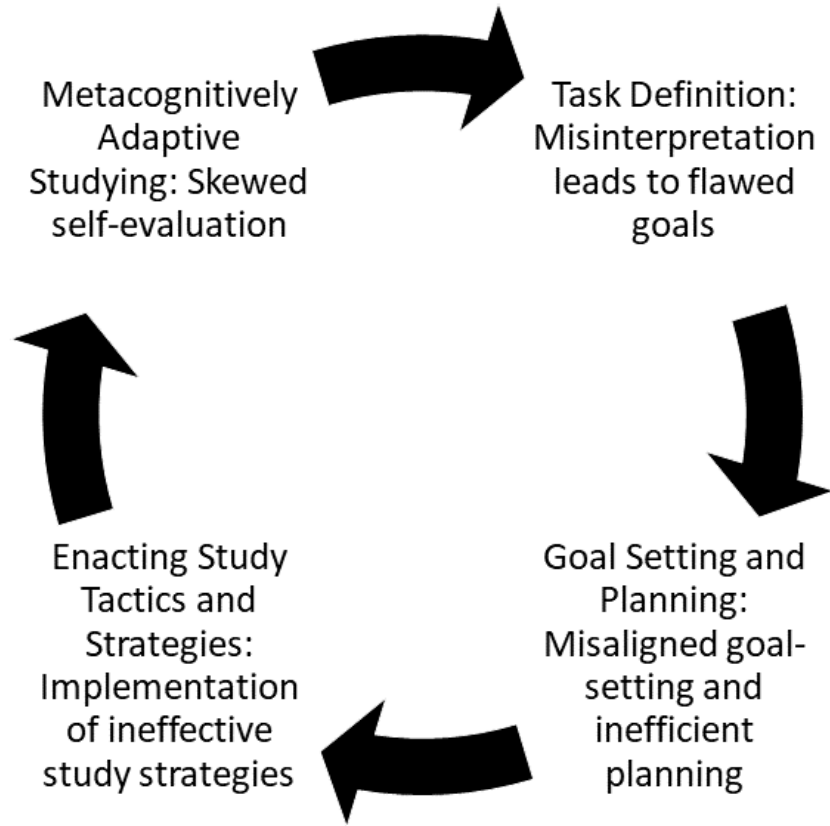
- Learners enact the study plan
- TUTs most likely during this stage



Stage 4: Metacognitively adaptive studying

- Learners reflect on the learning experience
- TUTs during this stage might lead to misalignment between actual learning experience and subsequent evaluation

Cascading Effect of TUTs



Potential Moderators

Moderating Factor	Relevance
Thought Content	• TUT or TRI • Comprehension-congruent or comprehension-incongruent
Goal Orientation	• Whether the thought was goal-oriented
Time on Task	• Number of previous TUTs
Motivation	• Higher motivation balances out the negative effects of TUTs • Higher motivation leads to increased meta-awareness
Interest	• Interest in the topic correlates with less TUTs
Mood	• Negative mood increases TUTs

Key Takeaways

- TUTs can occur at any stage during the learning process and may have a cascading effect
- Metacognitive monitoring, especially meta-awareness, is essential in mitigating the negative effects of TUTs
- Learners can adapt their learning strategies in response to TUTs

Meta-Analysis

Ebbert, D., Zamecnik, A., Wilson, N., Joksimovic, S., Mirriahi, N., & Dawson, S. (2024). *The mind's wanderlust: A meta-analysis of mind wandering, task-related interference, and learning*. Manuscript submitted for publication.

- TUTs occur ~30% of the time while learning (Wong et al., 2022)
- TUTs negatively influence learning outcomes (Wong et al., 2022)

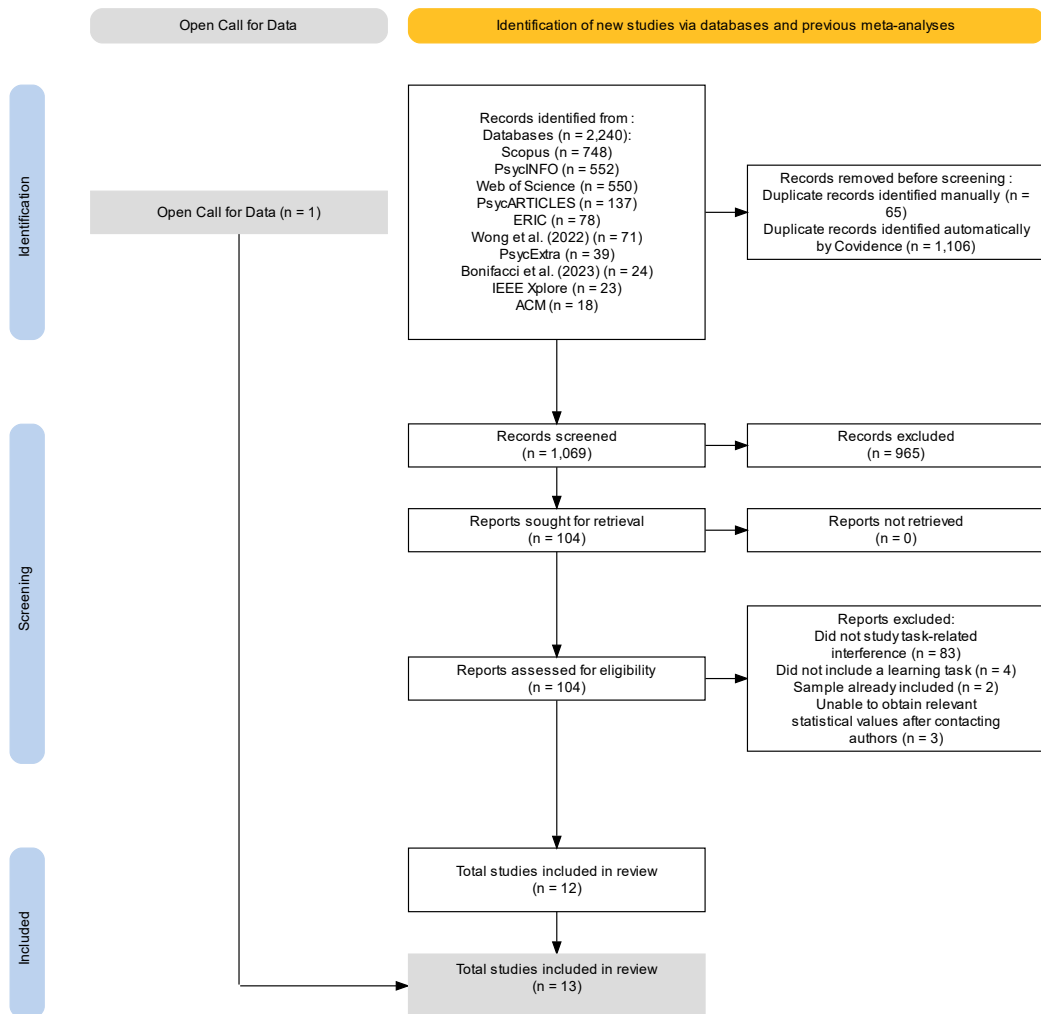
What about TRI?

Estimated to occur 20-25% and no correlation with learning outcomes (Welhaf et al., 2020)

Research Question

What is the frequency of task-related interference, and how are these thoughts associated with learning outcomes?

PRISMA Flow diagram



Synthesis Result

- TRI occurs 23.18% of the time
- No significant correlation between TRI and learning outcomes ($\beta = .025$, $p = .432$)

- TRI should be considered when studying off-task thoughts
- Learners are engaged in an internal stream of thought about half of the time while learning

Part I

Summary

- Off-task thoughts are a distraction from self-regulated learning
- Learners can become aware of their off-task thoughts
- Learners might want to react to off-task thoughts
- TUT occurs about 30% of the time
- TRI occurs about 23% of the time

Part II

Exploring Self-Regulated Learning and
Off-Task Thoughts During Video Learning

- Videos are a common learning resource
- Commonly learned from when alone
- Requirement of self-regulated learning to succeed

Part II Outline

- Experiment
- Case Study

Reactive v Proactive

Two approaches to directing off-task thoughts (Szpunar, 2017)

Proactive

- Interpolated testing
- Pretesting
- Notetaking



Experiment

Reactive

- Automated detection
- Meta-awareness



Case Study

- Current work aimed at conferences
 - EC-TEL 2024
 - LAK 2025
- Planned expansion into journal papers

Experiment

Ebbert, D., Claassen, A., Wilson, N., Joksimovic, S., Mirriahi, N., & Dawson, S. (2024). *Addressing mind wandering in video-based learning: A comparative study on the impact of interpolated testing and self-explanation*. In *Proceedings of the Nineteenth European Conference on Technology Enhanced Learning (EC-TEL 2024)*.

- Interpolated testing has been shown to reduce TUTs and increase learning outcomes (Jing et al., 2016; Szpunar et al., 2013; Welhaf et al., 2022)
- Writing self-explanations requires metacognitive monitoring (Fiorella & Mayer, 2015)
- Self-regulated learners might engage in metacognitive monitoring in expectation having to write a self-explanation

Research Questions

RQ1: Does writing self-explanations at pauses during video learning sessions more effectively reduce task-unrelated thoughts and enhance learning outcomes compared to interpolated testing or no intervention?

RQ2: Does the number of thought reports, in total and by thought type, correlate with learning outcomes?

- Experiment with three groups
 - Control
 - Interpolated testing
 - Self-explanation
- Intervention: Learning activity at pauses while learning from a video (Why is blue rare in nature? – 8 min)
- Self-caught thought reports & probes combined with the learning activities
- Pre- and post-test

Results – Group Comparison

- No difference between the groups on:
 - Knowledge gain
 - Number of thought reports
 - Number of TUT thought reports
 - Number of TRI thought reports

Results – Correlational Analysis

- No correlation with knowledge gain for:
 - Number of TUT thought reports
 - Number of TRI thought reports
- Significant correlation for total number of thought reports and knowledge gain
 - $\tau = .1527$, $H(1) = 2.33$, $p = .009$

Conclusion

- Meta-awareness appears beneficial
- Interpolated testing is of limited utility
- Self-caught vs probe-caught measurement will affect outcomes

Case Study

Ebbert, D., Caldwell, D., Farndale, A., Betteridge, A., Fewster-Young, N., Korolkiewicz, M., Lloyd, A., McNicholas, P., Costabile, M., Wilson, N., Joksimovic, S., Mirriahi, N., & Dawson, S. (in preparation). *Mind wandering and learner responses in online video-based learning.*

- All previous work on off-task thoughts during video-based learning limited interaction with the video player
- Pause, Play, Rewind, and Seek were not possible
- Learners could not react to their off-task thoughts
- Rewinding the video after off-task thoughts would be an act of self-regulated learning

Research Questions

RQ1: Is self-regulated learning associated with meta-awareness?

RQ2: Do self-regulated learners rewind the video they are learning from after they realize they were off task?

Procedure

- Cooperation with lecturers in 8 courses across 2 semesters at an Australian university
- Requested students to report their off-task thoughts while learning from course videos

Data gathered (n = 53)

- SRL questionnaire
- Self-caught thought reports
- Video player tracking data

Results Correlational Analysis

Correlation of SRL-O subscales with thought reports per minute

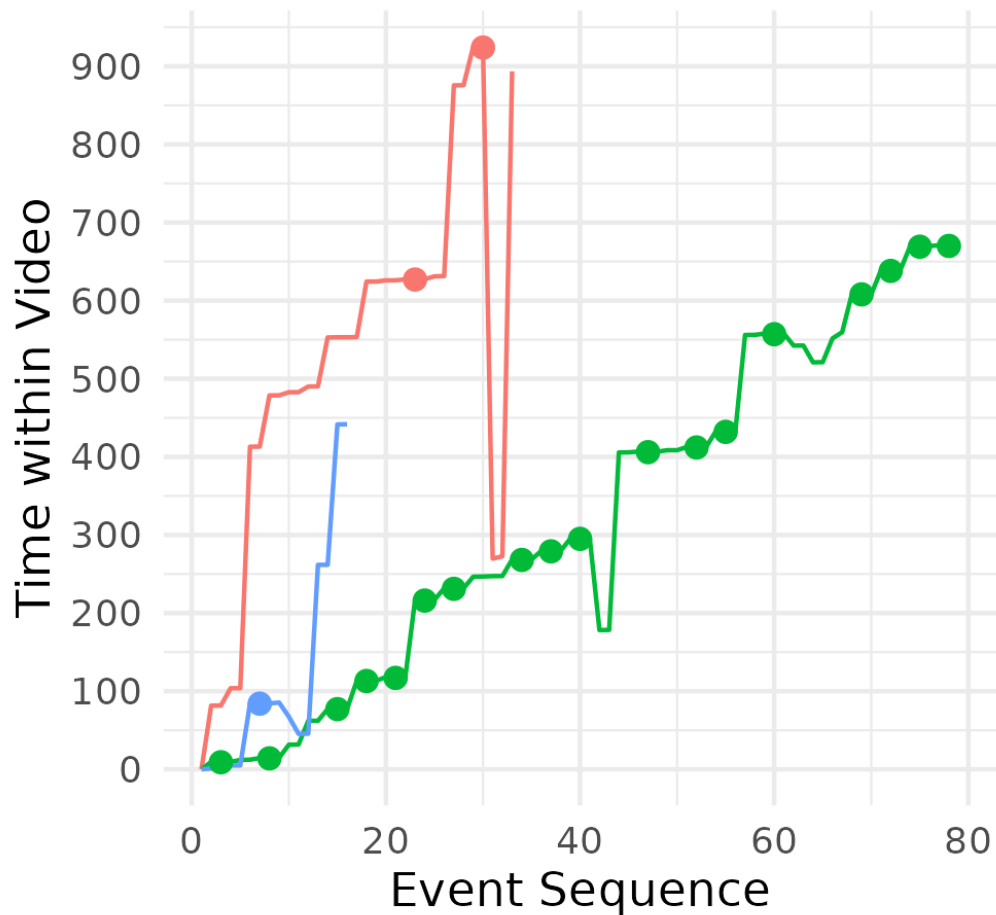
SRL-O Subscale	τ	p
Metacognition	-.098	.370
Online Effort Regulation	-.074	.494
Online Task Strategies	-.222	.041
Study Environment	-.082	.486
Planning and Time Management	-.033	.782

Results Video Rewinding

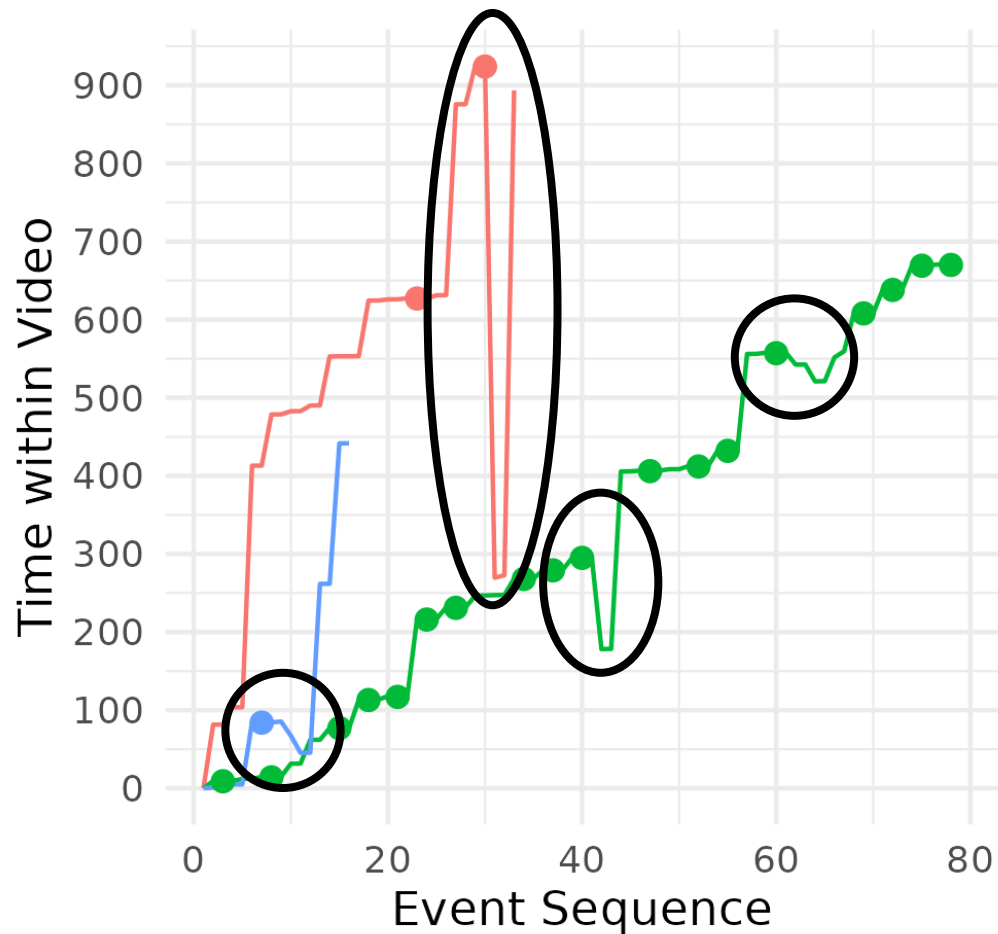
Participant	Video	Sec in Video	Thought Type	Rewind duration in sec
1	1	295	TRI	117
1	1	557	TRI	15
2	2	84	TUT	39
3	3	924	TRI	654

All participants who rewound their videos were pre-service teachers.

Results Video Rewinding



Results Video Rewinding



Results Video Rewinding

Intent to Rewind

- Two cases with intent to rewind
- No rewinding occurred
- Both cases were TUT

- Correlations between self-regulated learning and number of thought reports written
 - Task strategies and number of thought reports
 $\tau = -.222, p = .041$
- Only 4 reactions to off-task thoughts

- Limited evidence of self-regulated learning adaptation to off-task thoughts
- Reacting to off-task thoughts needs to be taught

Main Conclusions

- **Experiment**
 - No significant differences between groups.
 - Positive correlation between total thought reports and knowledge gain.
- **Case Study**
 - Limited evidence of self-regulated learning adaptation to off-task thoughts.
 - Only a small proportion of participants rewind the video in response to off-task thoughts.
 - Reacting to off-task thoughts may need to be explicitly taught to learners.

Future Work

Future Work Outline

- Measurement of meta-awareness
- Eye-tracking
- Rewinding study
- Trajectory

Measures of Meta-Awareness

Current Measure

- Meta-awareness = Number of thought reports

Limitations

- Does not account for off-task thoughts that participants were unaware of (Chu et al., 2023)

Proposed Measure

- Meta-awareness = Proportion of off-task thoughts a participant is aware of
- Accounts for both self-reported off-task thoughts and those detected through objective measures (e.g., eye-tracking)

Using Eye-Tracking for TUT Detection

- Combine eye-tracking data with self-caught thought reports
- Train machine learning models to detect TUT episodes based on gaze patterns preceeding thought reports
- Use the model in detecting TUT episodes that participants were unaware of

New Meta-Awareness Measure

Procedure

- Use gaze data and thought reports to train a machine learning model for TUT detection
- Apply the trained model to identify instances of off-task thoughts that participants were unaware of
- Meta-awareness = $\text{Number of self-reported off-task thoughts} / \text{Total number of off-task thoughts (self-reported + model-detected)}$

Rewinding Study

- Learners might want to react after realising their off-task thoughts (Varao-Sousa et al., 2017)
- Effect of rewinding a video after off-task thoughts on learning outcomes unknown

Research Question

Does rewinding a video after mind wandering offset the negative effect of mind wandering on learning outcomes?

- Experiment with 3 conditions
 - No rewind (control)
 - Optional rewind
 - Mandatory rewind

Procedure

- Participants recruited through Prolific
- Complete self-regulated learning questionnaire
- Pre-Test
- Watch a video and report off-task thoughts
 - Gaze data gathered while watching the video
- Depending on condition participants rewind the video
- Post-Test

Trajectory

- Explore other strategies learners use following their off-task thoughts
- Make recommendations to learners on how to react following their off-task thoughts

Thank you!

References

- Fiorella, L., & Mayer, R. E. (2015). Introduction to Learning as a Generative Activity. In *Learning as a Generative Activity: Eight Learning Strategies that Promote Understanding* (1st ed., pp. 1–19). Cambridge University Press. <https://doi.org/10.1017/CBO9781107707085>
- Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist*, 34(10), 906–911. <https://doi.org/10.1037/0003-066X.34.10.906>
- Jing, H. G., Szpunar, K. K., & Schacter, D. L. (2016). Interpolated testing influences focused attention and improves integration of information during a video-recorded lecture. *Journal of Experimental Psychology: Applied*, 22(3), 305–318. <https://doi.org/10.1037/xap0000087>
- Nelson, T. O. (1990). Metamemory: A Theoretical Framework and New Findings. *Psychology of Learning and Motivation*, 26, 125–173. [https://doi.org/10.1016/S0079-7421\(08\)60053-5](https://doi.org/10.1016/S0079-7421(08)60053-5)
- Nelson, T. O. (1996). Consciousness and Metacognition. *American Psychologist*, 51(2), 102–116. <https://doi.org/10.1037/0003-066X.51.2.102>
- Nelson, T. O., & Narens, L. (1994). Why Investigate Metacognition? In J. Metcalfe & A. P. Shimamura (Eds.), *Metacognition: Knowing about Knowing* (pp. 1–25). The MIT Press. <https://doi.org/10.7551/mitpress/4561.003.0003>
- Panadero, E. (2017). A Review of Self-regulated Learning: Six Models and Four Directions for Research. *Frontiers in Psychology*, 8. <https://doi.org/10.3389/fpsyg.2017.00422>
- Schooler, J. W., & Smallwood, J. (2009). Metacognition. In T. Bayne, A. Cleeremans, & P. Wilken (Eds.), *The Oxford Companion to Consciousness* (1st ed., pp. 438–442). Oxford University Press.
- Schooler, J. W., Smallwood, J., Christoff, K., Handy, T. C., Reichle, E. D., & Sayette, M. A. (2011). Meta-awareness, perceptual decoupling and the wandering mind. *Trends in Cognitive Sciences*, 15(7), 319–326. <https://doi.org/10.1016/j.tics.2011.05.006>
- Smallwood, J., & Schooler, J. W. (2015). The Science of Mind Wandering: Empirically Navigating the Stream of Consciousness. *Annual Review of Psychology*, 66(1), 487–518. <https://doi.org/10.1146/annurev-psych-010814-015331>
- Stawarczyk, D., Majerus, S., Maj, M., Van der Linden, M., & D'Argembeau, A. (2011). Mind-wandering: Phenomenology and function as assessed with a novel experience sampling method. *Acta Psychologica*, 136(3), 370–381. <https://doi.org/10.1016/j.actpsy.2011.01.002>
- Szpunar, K. K., Khan, N. Y., & Schacter, D. L. (2013). Interpolated memory tests reduce mind wandering and improve learning of online lectures. *Proceedings of the National Academy of Sciences*, 110(16), 6313–6317. <https://doi.org/10.1073/pnas.1221764110>
- Varao-Sousa, T. L., Solman, G. J. F., & Kingstone, A. (2017). Re-reading after mind wandering. *Canadian Journal of Experimental Psychology / Revue Canadienne de Psychologie Expérimentale*, 71(3), 203–211. <https://doi.org/10.1037/cep0000123>
- Welhaf, M. S., Phillips, M. E., Smeekens, B. A., Miyake, A., & Kane, M. J. (2022). Interpolated testing and content pretesting as interventions to reduce task-unrelated thoughts during a video lecture. *Cognitive Research: Principles and Implications*, 7(1), 26. <https://doi.org/10.1186/s41235-022-00372-y>
- Welhaf, M. S., Smeekens, B. A., Gazzia, N. C., Perkins, J. B., Silvia, P. J., Meier, M. E., Kwapil, T. R., & Kane, M. J. (2020). An exploratory analysis of individual differences in mind wandering content and consistency. *Psychology of Consciousness: Theory, Research, and Practice*, 7(2), 103–125. <https://doi.org/10.1037/cns0000180>
- Winne, P. H. (1997). Experimenting to bootstrap self-regulated learning. *Journal of Educational Psychology*, 89(3), 397–410. <https://doi.org/10.1037/0022-0663.89.3.397>
- Winne, P. H., & Azevedo, R. (2022). Metacognition and Self-Regulated Learning. In R. K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences* (3rd ed., pp. 93–113). Cambridge University Press. <https://doi.org/10.1017/9781108888295.007>
- Winne, P. H., & Hadwin, A. F. (1998). Studying as Self-Regulated Learning. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Metacognition in Educational Theory and Practice* (1st ed., pp. 277–304). Routledge.
- Wong, A. Y., Smith, S. L., McGrath, C. A., Flynn, L. E., & Mills, C. (2022). Task-unrelated thought during educational activities: A meta-analysis of its occurrence and relationship with learning. *Contemporary Educational Psychology*, 71, 102098. <https://doi.org/10.1016/j.cedpsych.2022.102098>