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Virach SORNLERLAMVANICH, et al.

Co-Learning: Cognitive Load-Based Multilingual Learning Content Generation Model

Information Modelling and Knowledge Bases XXXVII, Marek Menšík and et al., Eds., Vol. 418,

Frontiers in Artificial Intelligence and Applications, IOS Press, 2026, pp. 161-176, <https://doi.org/10.3233/FAIA251723>

Cognitive Load-Based Multilingual **Co-Learning** Architecture for AI-Enhanced Education

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Outline of the Talk

- Issues in Learning Contents for Self-study
- Memory for Learning
- Working Memory in Learning Process
- **Co-Learning Algorithm**
- Implementation and Conclusion

Issues in Learning Contents for Self-study

Various tools and learning contents are available,
but skillful media creation is needed to create an attractive content for learning!!

Many learning contents are resulting in

- Excessive length
- Monotonous
- Redundant
- Messy
- Language problem

Effecting in
Learning process



- Improve concentration
- More interest
- Enhance engagement
- Easy to understand
- Learn in one's mother tongue

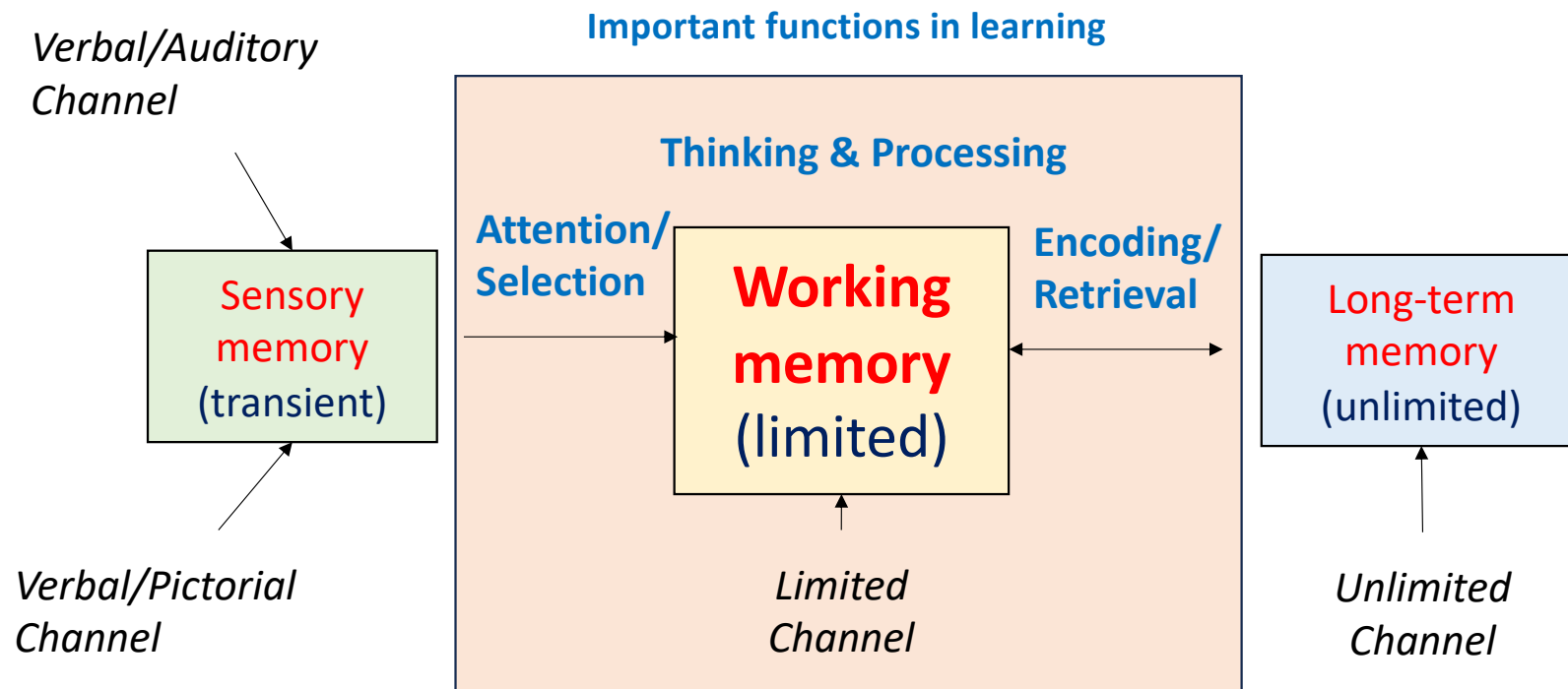
Characteristics of Classroom Lecture Recording

- Redundant Expressions
- Self-Corrections
- Hesitations and Disfluencies
- Error-Prone Speech
- Speaker Interruptions

Memory for Learning

Components in Human Memory in Learning

Mayer (2003), and Mayer and Moreno (2007)



Mayer, R. (2003). The Promising of Multimedia Learning: Using the Same Instructional Design Method across Different Media, *Learning and Instruction*, 12, 125-141.

Moreno, R., and Mayer, R. (2007). Interactive Multimodal Learning Environments. *Educational Psychology Review*, 19, 309-326.

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Cognitive Load Theory

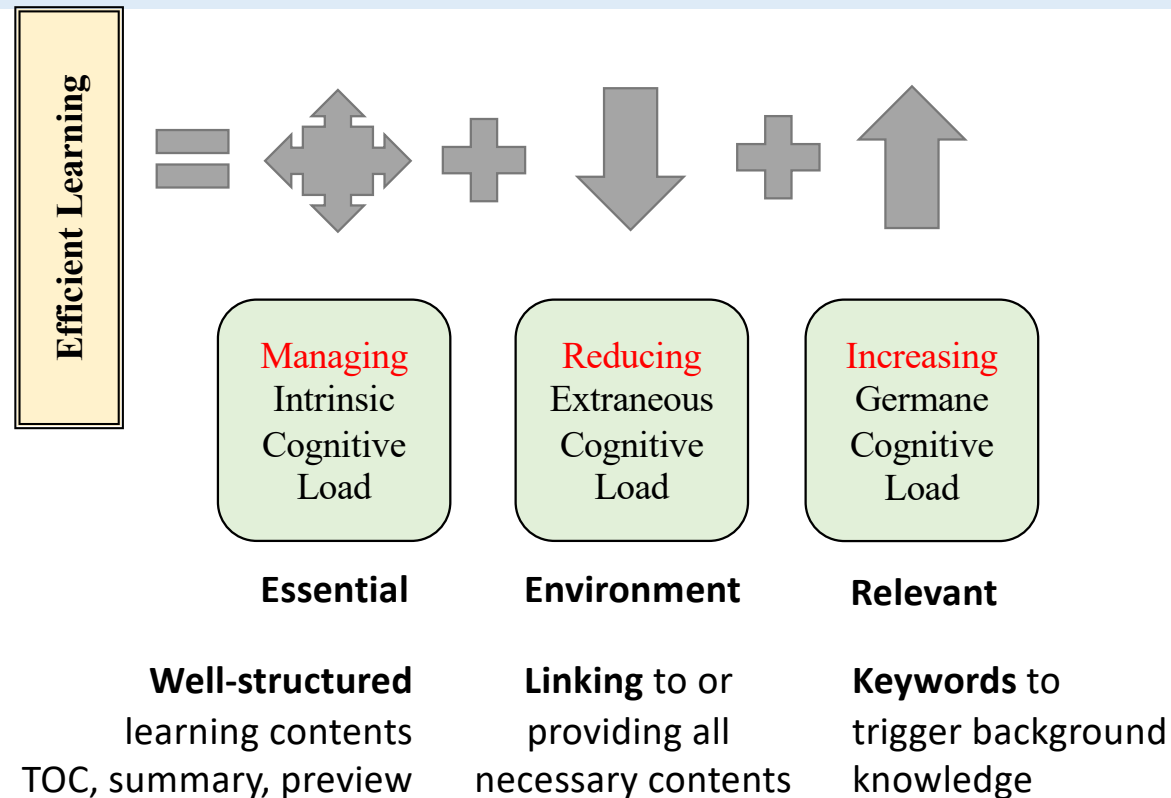
To enhance the Important functions in learning

- Attention/ Selection
- Thinking & Processing
- Encoding/ Retrieval

- Intrinsic Cognitive Load (Essential knowledge)
 - This is the load imposed by the task itself. This is effectively fixed, but we should try and reduce it by 'chunking' breaking the task down into smaller parts.
- Extraneous Cognitive Load (Peripheral information)
 - This is the environment and the way we present the information. We should try and minimize this.
- Germane Cognitive Load (Relevant to background knowledge)
 - This is the processing that takes place comparing the new information to what we already know and encoding new learning to the long-term memory as schema. The more we know about something the lower the Germane Cognitive Load will be as thoughts and processes are automated.

Working Memory in Learning Process

Sweller (2010)



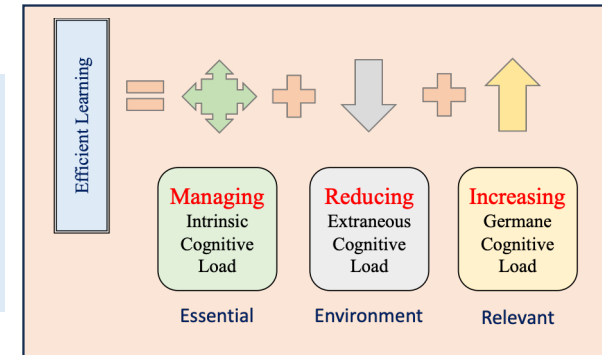
Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. *Educational Psychology Review*, 22, 123- 138.

Sweller, J., Ayres, P. and Kalyuga, S. (2011). *Cognitive load theory*. Springer. New York.

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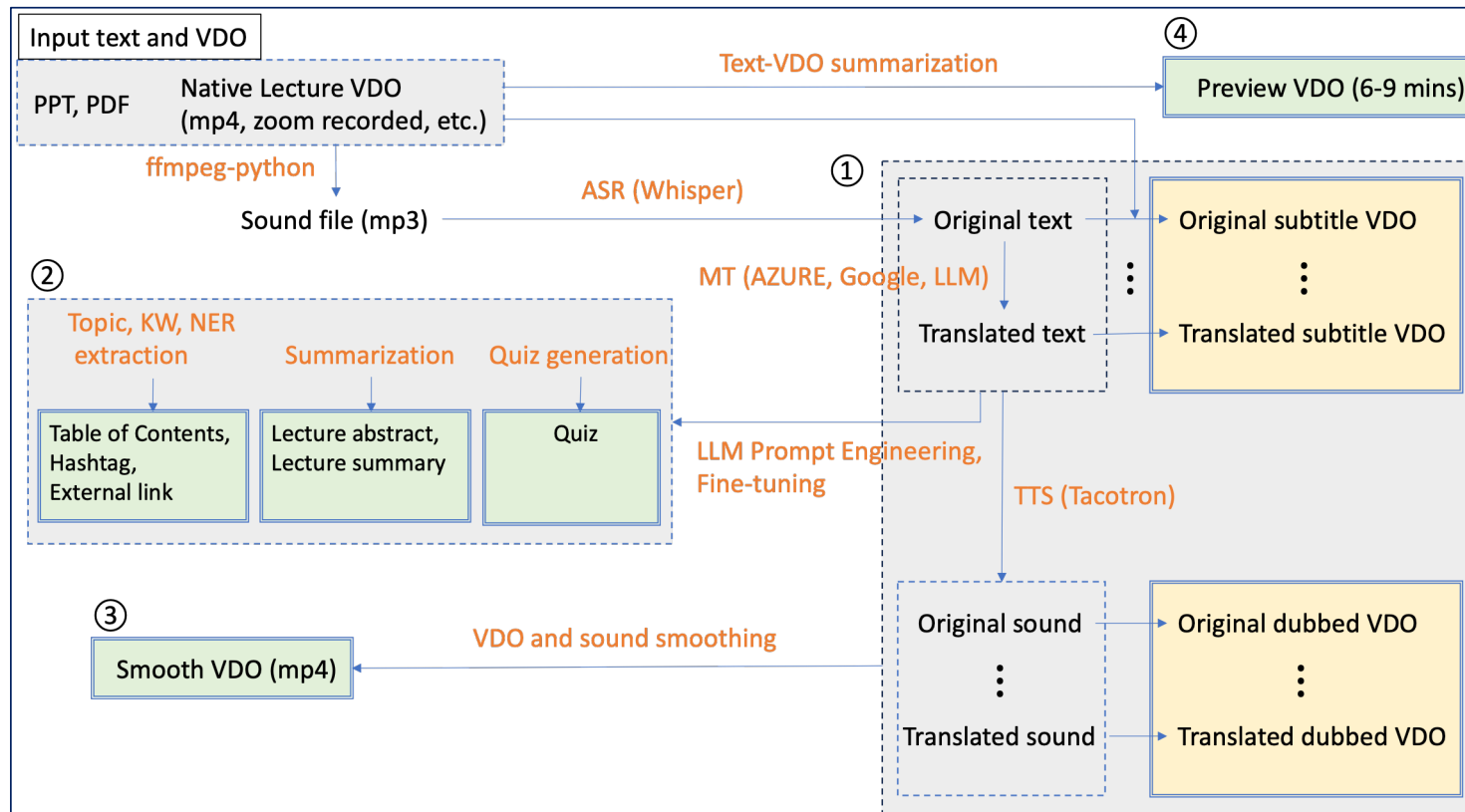
Co-Learning Algorithm

in Cognitive Load Theory



1. **Shortening the video** length not to exceed 6 minutes based on the Guo et al. (2014) survey that student median engagement time for videos less than 6 minutes long is close to 100%.
Manage intrinsic
2. **Providing TOC or video synopsis** to give content structure.
3. **Summarizing the content** for quick view of the contents.
4. **Indexing the content** for keyword search and scene search.
Reduce extraneous
5. **Linking to other related videos** for total understanding.
6. **Categorizing the videos** for better accessibility.
Increase germane
7. **Extracting keywords** for better representation of the content.

Co-Learning Model Architecture



- ① Transcribe, translate, and generate dubbed versions
- ② Generate summary, quizzes, and TOC
- ③ Remove noises, stuttering, and redundancy
- ④ Generate preview VDO

Co-Learning as an Education Partner

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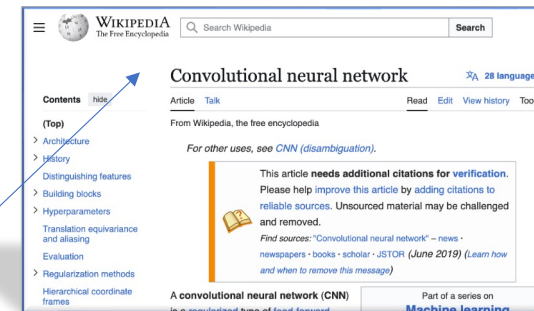
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Chapter

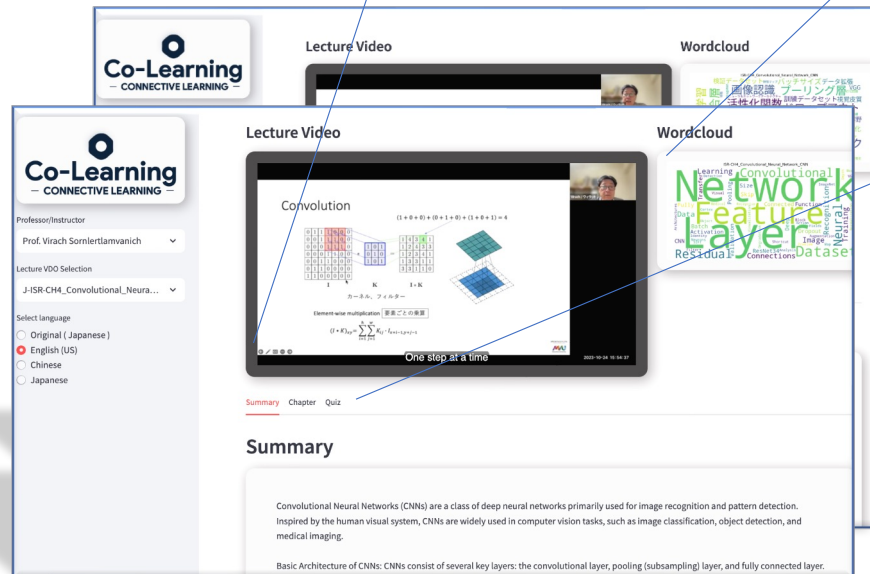
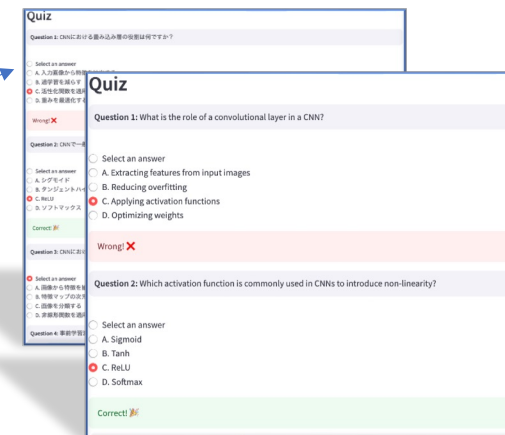
Chapter

Chapter	0:00 - 10:00 - Introduction to Acoustic Phonetics Main Idea: To provide an understanding of phonetics and its importance in speech processing. Details: Phonetics is the study of sounds in human speech. It includes articulatory phonetics (properties), and auditory phonetics (perception). The role of phonetics in automatic speech recognition (ASR) and how it helps in understanding speech.
Chapter	10:00 - 25:00 - Acoustic Analysis Techniques Main Idea: Explaining tools and methods for analyzing speech sounds. Details: Sound Spectrograms: Visual representation of sound intensity over time, showing different frequency components. Fourier Transform (FT) and Short-time Fourier Transform (STFT): Used to convert time-domain signals into frequency components. Mel-Frequency Cepstral Coefficients (MFCCs): Widely used features in ASR that mimic human hearing.

External link



Quiz



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	Video title 1	Video title 2	Video title 3	Video title 4
No. of students	79	80	83	72
No. of responses	79	77	82	68
Positive	71	47	30	63
Comments	Ability to prepare and review videos with a summary and a quiz	Improved quiz result display, making it easier to use than before	Enhanced word cloud functionality compared to the previous version	Organizing non-wordcloud information into three tabs creates a neater, more user-friendly interface
	Clear and easy-to-understand subtitles that facilitate learning	Improved word cloud displaying more relevant content	Better Chinese subtitles and audio quality than before	Wordcloud and other features have become much more user-friendly, making the tool feel highly effective
	Useful functions such as summaries, English subtitles, and voice narration	Conveniently locating the exact time to play corresponding videos while reviewing summary content	Effective learning through the quiz format, with summaries assigned to each topic for better comprehension	Implemented improvements enhance usability, with wordcloud showing significant improvements
	Instant quizzes effectively reinforce understanding			
Negative	8	30	52	5
Comments	Difficulty figuring out how to navigate to another page in the quiz	Subtitles disappearing from the screen after a certain period	White subtitles making them slightly difficult to read	Improved ease of viewing when items were separated, though overlapping subtitles sometimes reduced readability
	Wordcloud displaying different keywords for different languages	Difficulty reading slide content due to subtitle color and font	Picture quality issues and overlapping subtitles being slightly distracting	Video being easier to watch if the subtitle color were corrected
	Quiz selection resetting when changing a page	Irrelevant words being extracted in the wordcloud	Concerns about subtitle timing and readability, though reviewing them in the video remains convenient	
		Chinese pronunciation sounds unnatural	Poor image quality and difficulty reading text in the painting	

Evaluation result

Positive (70%):
Most of them are related to system contents

Negative (30%):
Most of them are related to UI

Conclusion

Learning is a fundamental part of human growth,

- **Connective learning:** a process learning from connecting to the background knowledge
- **Learning content refinement:** we connect the SOTA NLP techniques to refine and generate the content that leverage the learning efficiency according to the Cognitive Load Theory and Human Learning Process.
- **Model architecture:** we propose the architecture of Multi-lingual Co-Learning model that bridges the gap between the challenges faced by learners and lecturers in the current digital learning landscape.