RESEARCH PRESENTATION

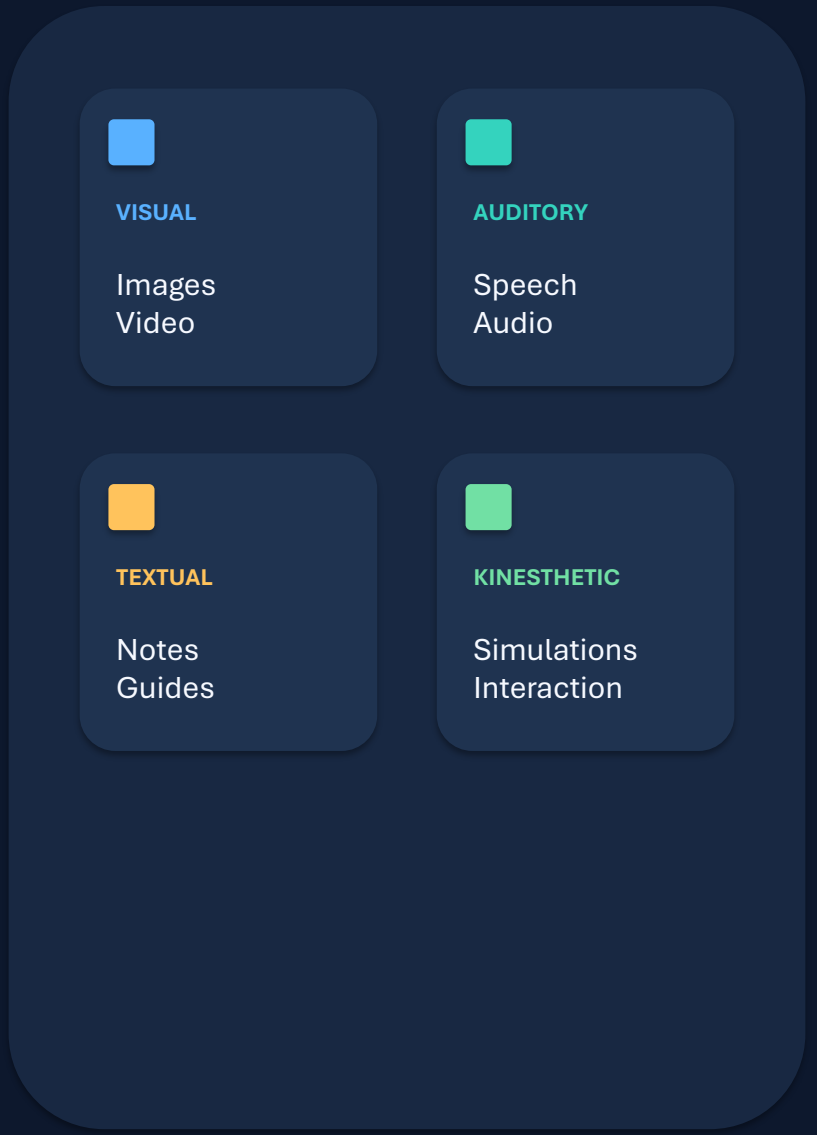
Multimedia Databases Customized to User Modality

A cognitive-aware approach to content retrieval, ranking, and learning personalization

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Core idea: match what learners need with how content is presented.



Why user modality matters

Conventional multimedia databases prioritize content relevance, but often ignore how users prefer to perceive information.

THE LIMITATION

One result list for everyone

- Search relies mainly on keywords, metadata, or semantic similarity.
- The same format is delivered to users with different preferences.
- Extra information and poor ranking can increase cognitive load.

RESEARCH AIM

Personalize at the data level

- Represent user preferences as a measurable modality profile.
- Describe multimedia objects in the same modality space.
- Rank and present content using both meaning and modality fit.

Research hypothesis: modality-aware adaptation improves retrieval quality and learning outcomes.

A shared four-dimensional modality space

Users and multimedia objects are represented with normalized vectors, enabling quantitative matching.

USER PROFILE

$$U = (w_v, w_a, w_t, w_k)$$

$$w_v + w_a + w_t + w_k = 1$$

- Visual
- Auditory
- Textual
- Kinesthetic / interactive

ADAPTIVE PIPELINE

1. **Collect signals** — Surveys + behavior
2. **Build vectors** — User + content
3. **Cluster profiles** — k-means
4. **Adapt** — Rank + format

COMBINED RELEVANCE

Final score = semantic relevance + modality compatibility

Examples: video + audio for process demonstrations; text for guides; simulations for hands-on practice.

Controlled pedagogical experiment

The model was evaluated in the course “Technologies of Printing Production.”

PARTICIPANTS

50

first-year students

Randomly assigned

CONTROL GROUP · n = 25

Standard database; no modality adaptation

EXPERIMENTAL GROUP · n = 25

Personalized ranking and content format

PROTOCOL & MEASURES

- Pre-test and modality profiling
- Learning tasks using multimedia resources
- Post-test and satisfaction survey (1–5)
- Independent-samples Student’s t-test; $p < 0.05$

Content covered printing technologies, materials, production processes, and printing equipment.

Modality-aware adaptation improved all reported metrics

Reported comparison of the control group and the experimental group.

METRIC	CONTROL	ADAPTIVE	CHANGE
Precision@10	0.63	**0.79**	**+25.4%**
NDCG@10	0.66	**0.84**	**+27.3%**
Knowledge gain	12.5	**18.9**	**+51.2%**
Task time (min)	18.2	**14.1**	**−22.5%**
CTR	0.43	**0.58**	**+34.9%**
Satisfaction / 5	3.9	**4.7**	**+20.5%**

STATISTICAL EVIDENCE

$p < 0.05$

- Precision@10: $p = 0.012$
- NDCG@10: $p = 0.009$
- Knowledge gain: $p = 0.004$

Conclusion

Better ranking, stronger learning outcomes, and higher user satisfaction.

Source: Hordyeyev, "Multimedia Databases with Customization for User Modality."