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Effects of display types on collaborative processes

19.03.2010



Agenda

- 1** Types of display (environments)
- 2** Effects on collaborative processes
- 3** Choosing the right technology for specific learning scenarios
- 4** Designing a collaborative learning application for “Structured Academic Controversies”

Preparatory
lecture

Task for today’s
breakout session

Motivation: The „Digital Advantage“

- Well designed computer applications **can** be as easy to use as pen and paper (often they are not)
- Digital advantage:
 - Process of visualize large chunks of information
 - Simultaneously editable documents
 - Easy to make copies
 - Efficient search and history functions
 - Over-distance learning
 - ...
- If a computer application performs as good as pen and paper this is already a good result!

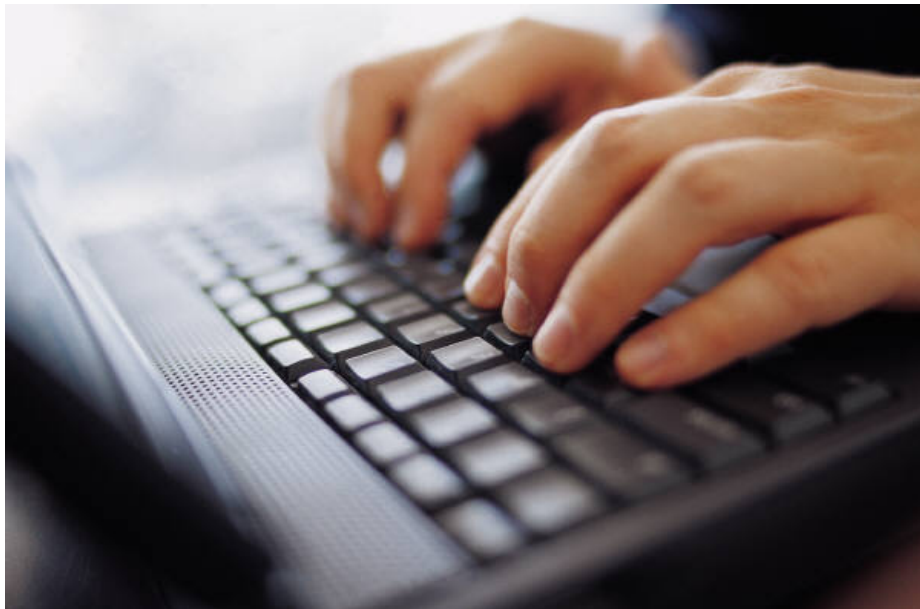
Personal vs. Shared Displays

Personal devices

- Brought in by participants
- E.g. laptops


Shared display

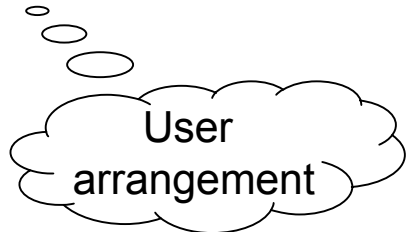
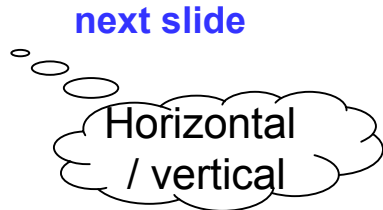
- Stationary
- E.g. smartboard, tabletop display, ...



Private vs. Personal vs. Shared Information

- Visibility

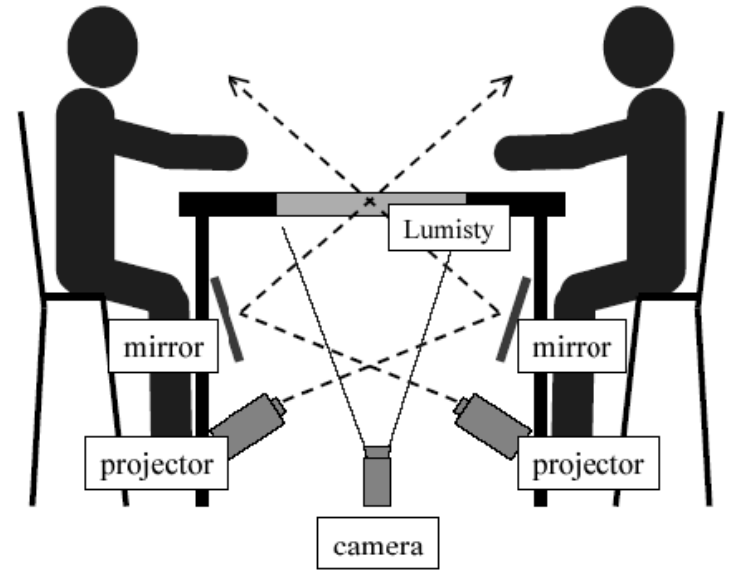
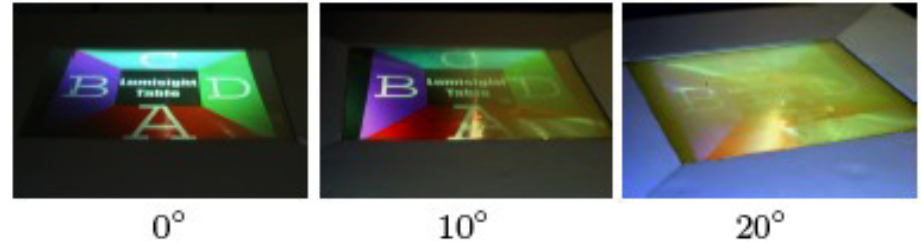
Information	Private	Personal	Shared
Personal display	Mobile phones	Laptops (sitting face-to-face / right angle)	TabletPC  Laptops (sitting side-by-side)
Shared display	Symbiotic displays LumiSight Table	Workspaces	Tabletop Wall display



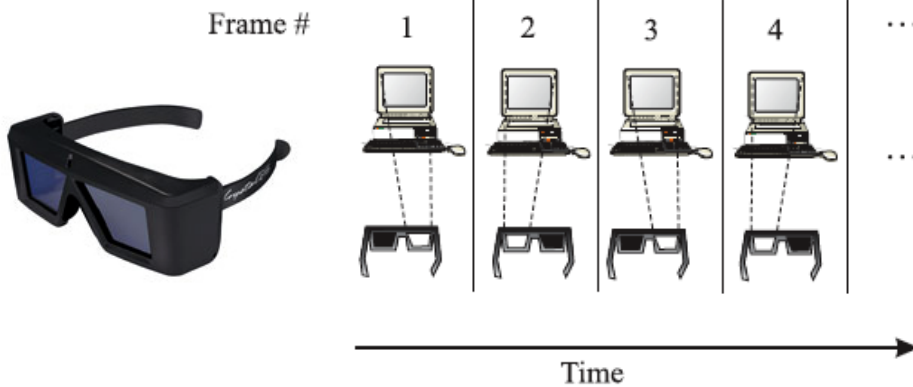
Private Information on Shared Displays



Symbiotic displays (Berger et al., 2005)



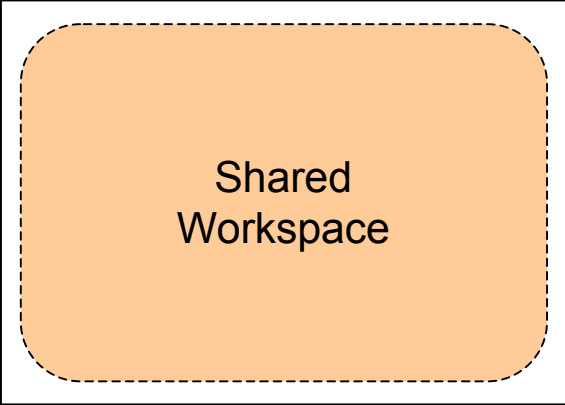
LumiSight (Matsushita et al., 2005)



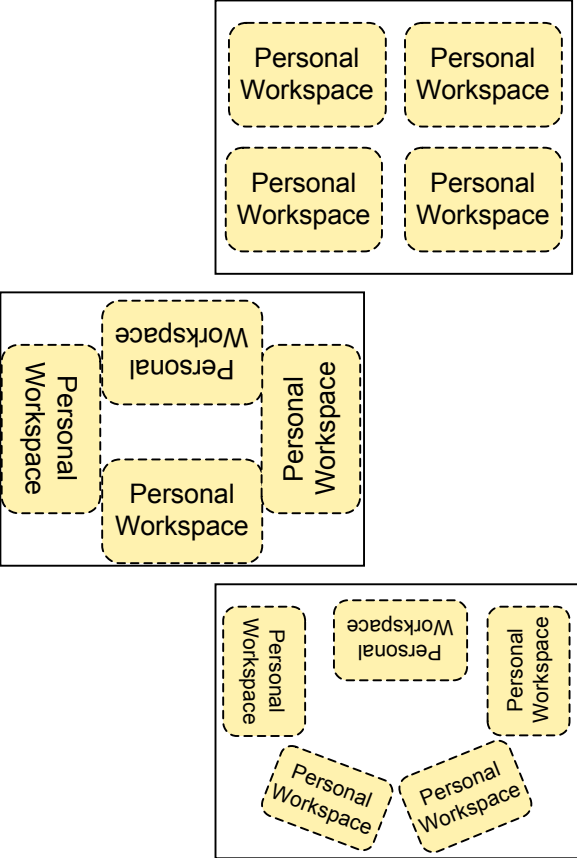
Using shutter glasses (Shoemaker & Inkpen, 2001)

Single Display Groupware (SDG)

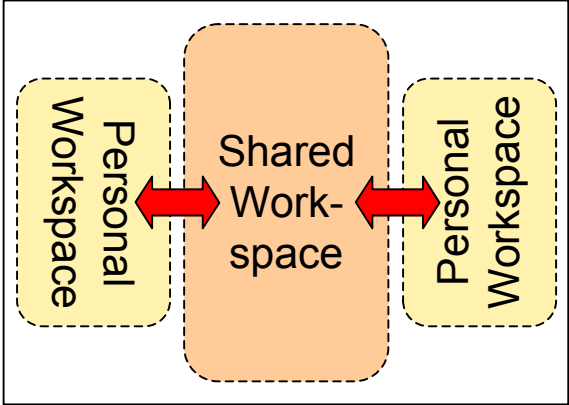
Shared Workspace



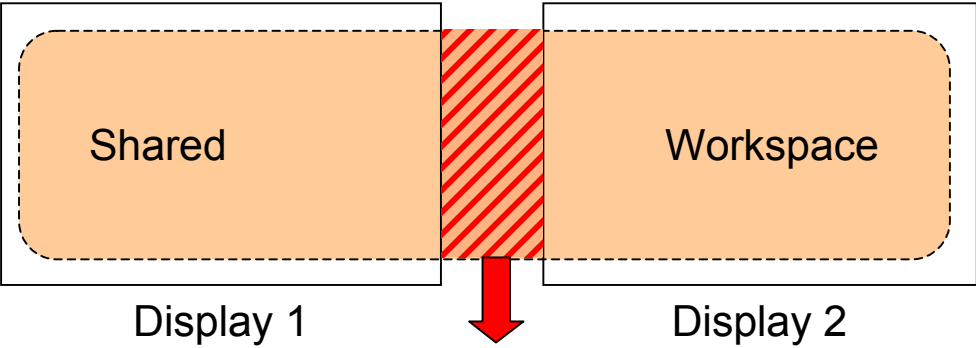
Personal Workspaces



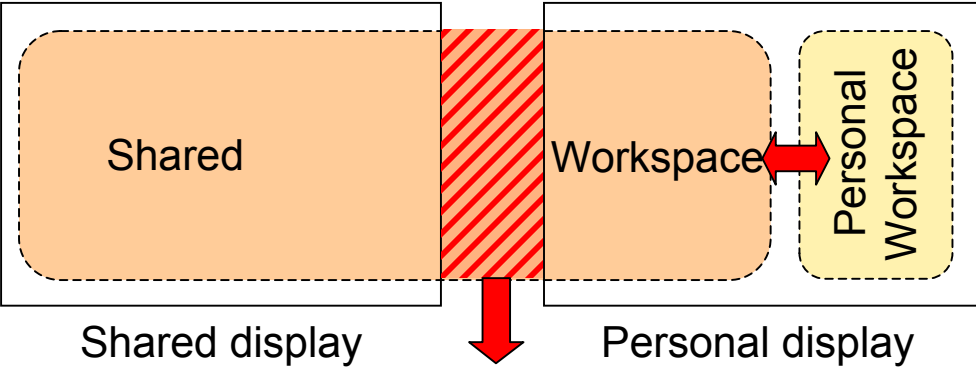
Hybrid



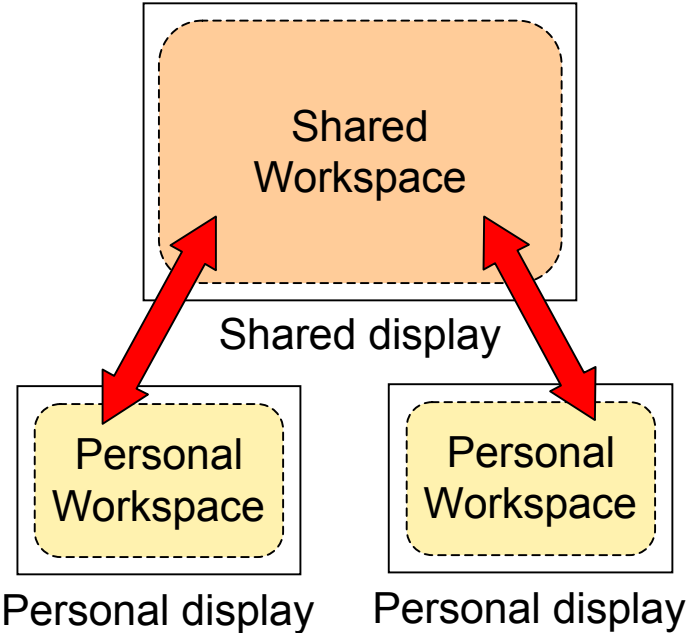
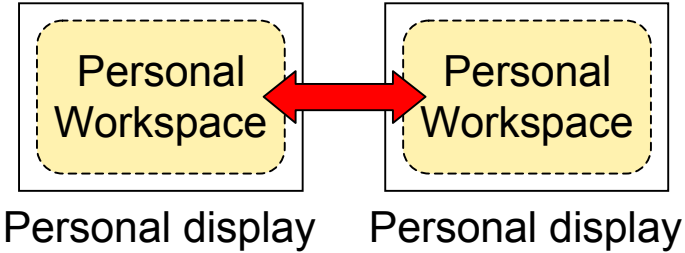
Multi-Display Environments and Distributed Applications



Multi-display interaction techniques



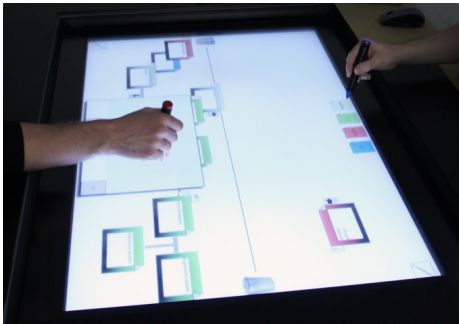
Multi-display interaction techniques



Single Display Groupware vs. Multi Display Environments

Single display groupware (SDG)

- One shared display
- Output is visible to all users
- Challenge:
 - What about personal data?
 - Conflicts caused by simultaneous actions
 - coordination policies



Multi Display Environments (MDE)

- Multiple connected displays
- Objects can be moved across displays
- Goal of MDEs: workspace spans over multiple displays
- Distributed applications: separate workspaces that interact with each other



Summary (Display Types)

- Personal vs. shared **displays**
 - Private, personal and shared **information**
- } any combination possible
- **Workspaces**
 - Personal workspaces on shared displays
 - Workspaces can stretch across multiple (physical displays)

Agenda

Preparatory
lecture

1

Types of display (environments)

2

Effects on collaborative processes

3

Choosing the right technology for specific learning scenarios

Task for today's
breakout session

4

Designing a collaborative learning application for "Structured Academic Controversies"

Display Angle: Vertical or horizontal interactive displays?

- Semi-experimental, semi-naturalistic study
- Groups of three
- Chairs were arranged next to each other
- Problem-solving task
- Horizontal condition:
 - More role switches
 - More ideas explored
 - Greater awareness



Condition	# role changes		# suggestions
	Interactor	Itinerary writer	
PC (Control)	1.4 (0.66)	0.4 (0.84)	44.3 (9.10)
Horizontal	4.8 (2.48)	0.1 (0.32)	69.7 (10.05)
Vertical	2.5 (2.12)	0	58.7 (11.07)

Rogers & Lindley, 2004

Display Angle, Size, Number and User Arrangement

- Set of coordinated, exploratory studies
- Problem solving task (sightseeing route)
- In each study a single display factor was varied:

Manipulation Display Factor	Display Angle	User Arrangement	Display Size	Number of Displays
Display Angle	Horizontal Vertical	Horizontal	Horizontal	Horizontal
User Arrangement	Side-by-side	Side-by-side Face-to-face Right angles	Side-by-side	Side-by-side
Display Size	Large (33")	Large (33")	Small (17") Large (33")	Large (33")
Number of Displays	Single shared	Single shared	Single shared	Single shared Multiple (one per user)

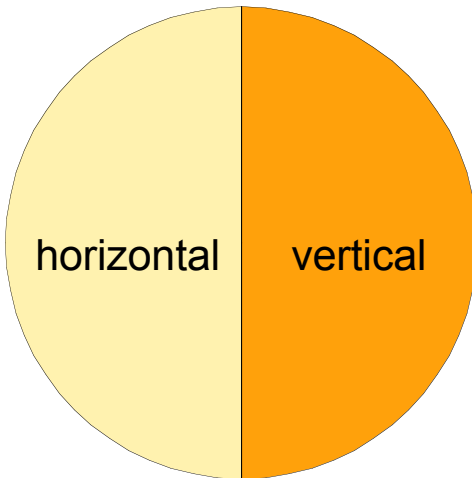
Effect of the Display Angle

Horizontal

- More natural
- More comfortable
- More pointing gestures

Vertical

- More ergonomic difficulties
 - Arm fatigue
 - Difficulty writing
 - Back stiffness
- Time efficient working
("more focused on getting the task done")
- Less preparatory comments



Users' preferences

Effect of the User Arrangement

Face-to-Face

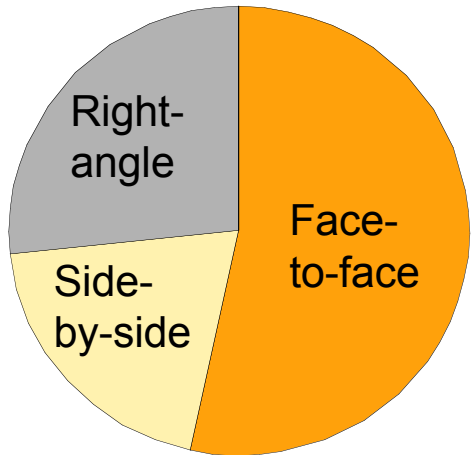
- More partner gaze
- Less ergonomic difficulties

Side-by-side

- Shared perspective
- Little space (e.g. for using the writing arm)
- More obstructed view
- Less equitable distribution of activity

Right angle

- Compromise



Users' preferences

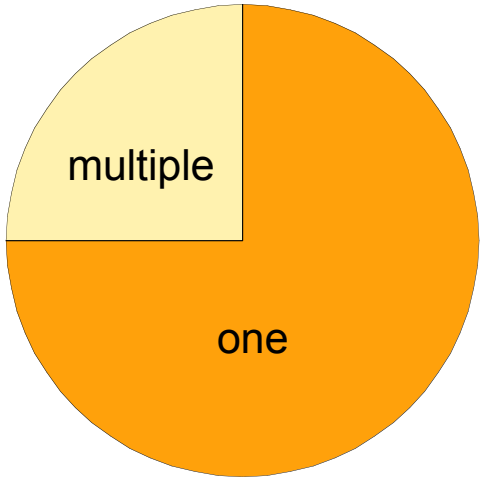
Effect of the Number of Displays

Sharing one display

- Sat closer together
- More on-task communication
- Participants felt they were more efficient
- Enables to discuss and share ideas

Multiple display

- Attention shifts between own and partner's display
- 1/3 of all pairs only used one of the displays
→ emulated the single display condition
- Supports the ability to work independent
- Accomodates different working styles
- Enjoyable to work in "one's own space"

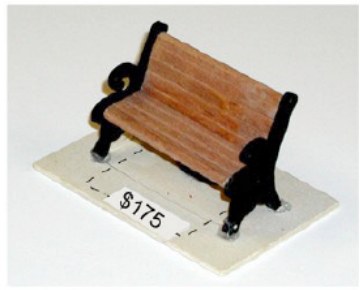
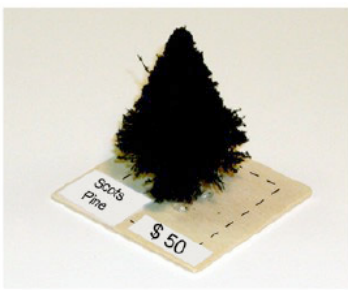
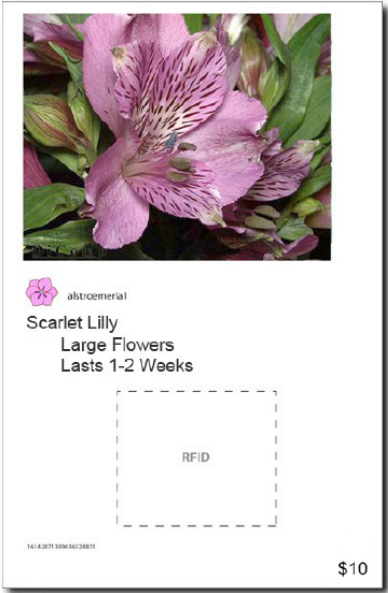


Users' preferences

Inkpen et al., 2005

Entry Points

- Entry points invite participation
- Experiment with 3 conditions
 1. Laptop (most constrained)
 2. Multi-touch tabletop
 3. Physical-digital setup with tangible entry points (least constrained)
- Collaborative design task (idea generation, planning, decision-making, ...)



Rogers et al., 2009

Results of Rogers et al.'s Study

Laptop

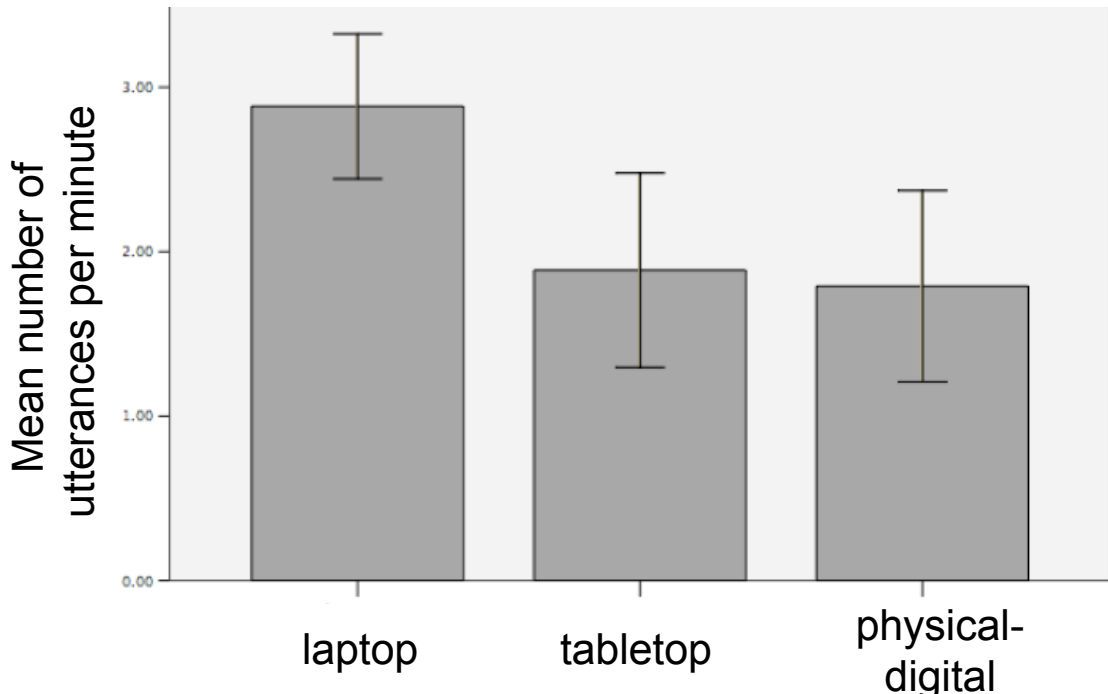
- More conversation (more verbalizing due to only one point of access)

Tabletop

- Faster completion

Physical-digital

- More equitable participation in terms of verbal utterances
- Participants who spoke the least
 - most physical actions
 - possible for more reticent members to utilize the tangible entry points



MultiSpace

- Multi-device environment
- Tabletop display as central hub
- Electronic content can be moved between tables and other devices.

- Focus group with teaching assistants (TAs)
- Frequent tasks:
 - Scheduling
 - Creating an exam
 - Grading



Everitt et al., 2006.

Informal Observations of the MultiSpace

- Tabletops
 - More democratic collaboration
 - On the wall group control rarely changed
- Different devices for different tasks
 - Tabletop for layout and organization tasks (e.g. sort exam questions)
 - Wall was used for comparison tasks: People often sent documents to the wall as a first step in collaboration...
- Task parallelism
 - Easy way to switch between parallel tasks and collaborative work
- Supportive collaboration
 - Trouble on wall or tabletop → colleagues helped immediately
 - Trouble on laptop or tabletPC → no help

Summary (Effects on Collaboration)

Different display types have different effects on collaborative processes

- Tabletops
 - Eye contact
 - Balanced participation
 - Orientation problem
- Wall displays
 - Same perspective
 - Used for presentations, discussions, comparisons, overviews
- Personal displays
 - People often appreciate “one’s own space”
 - Private information

Agenda

Preparatory
lecture

1 Types of display (environments)

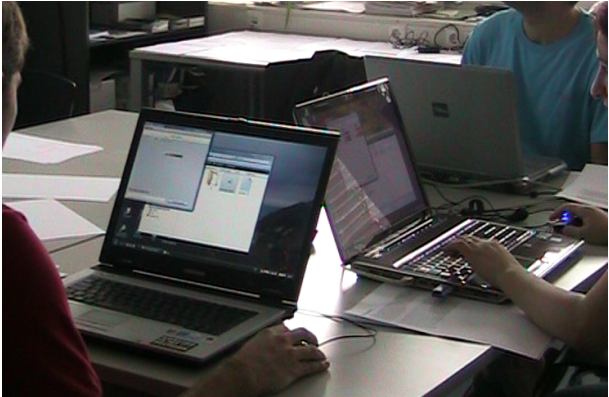
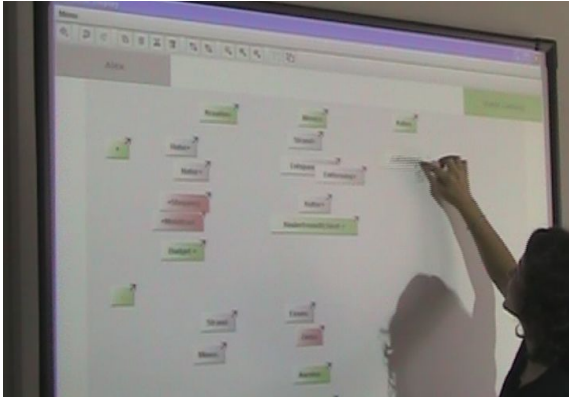
2 Effects on collaborative processes

3 Choosing the right technology for specific learning scenarios

Task for today's
breakout session

4 Designing a collaborative learning application for "Structured Academic Controversies"

Examples of Collaboration Scripts and Technological Solutions



↓ ArgueTable I



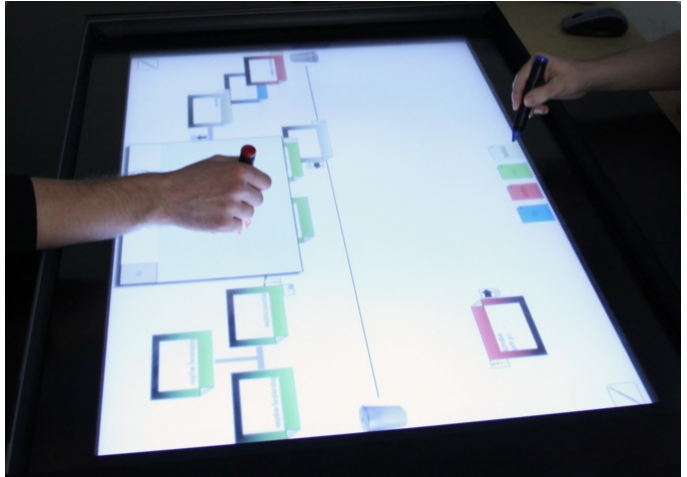
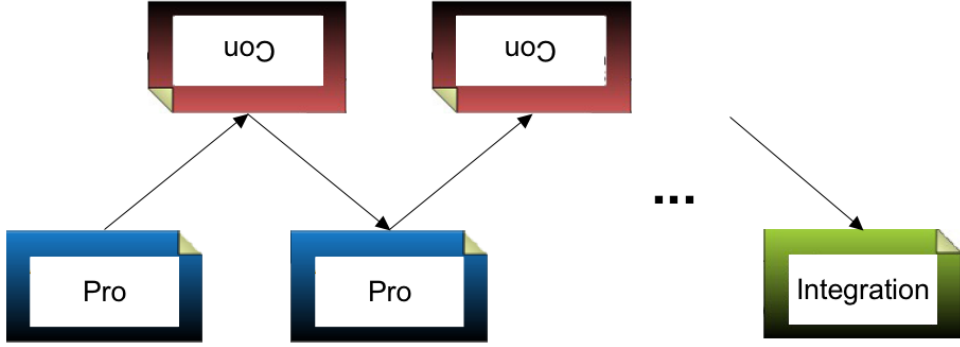
III ↑ Note&Share



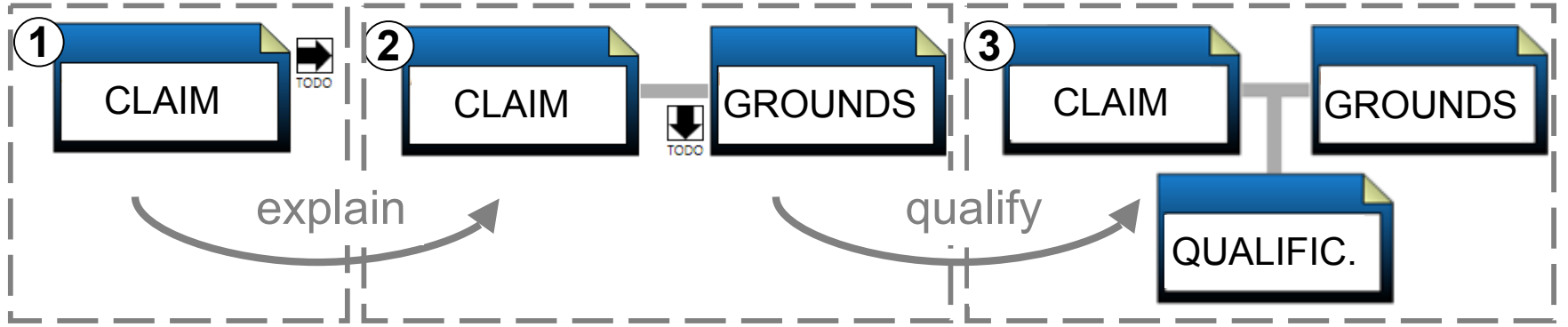
II ↑ Practicing text comprehension in pairs

Example I : ArgueTable

- Argumentation sequences:



- Constructing single arguments:



Why Did We Choose a Tabletop Display?

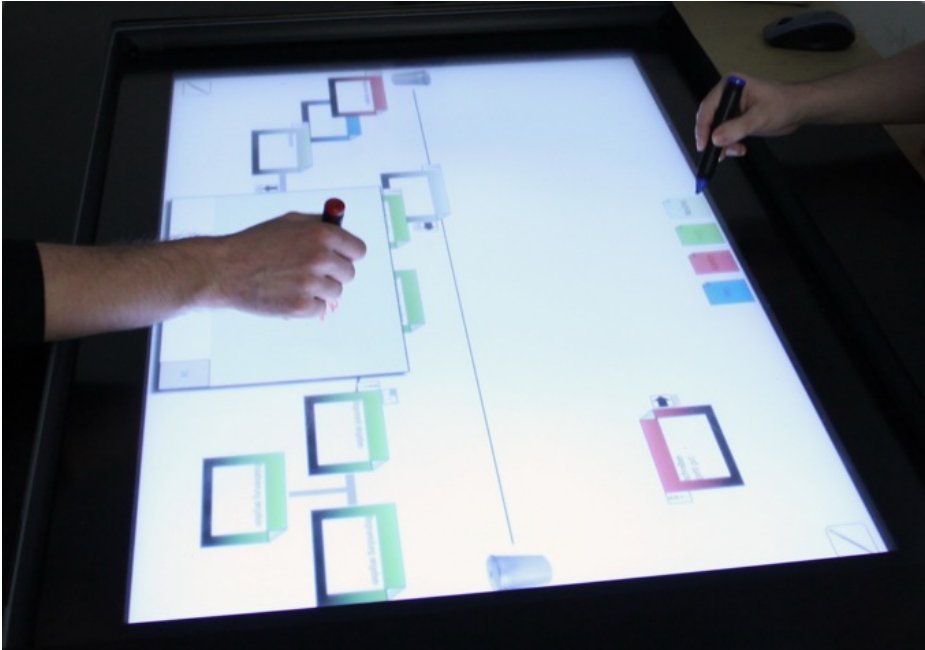
Because tabletop displays ...

- ... encourage eye contact → support natural face-to-face communication
- ... are ideal for small group collaboration with balanced participation



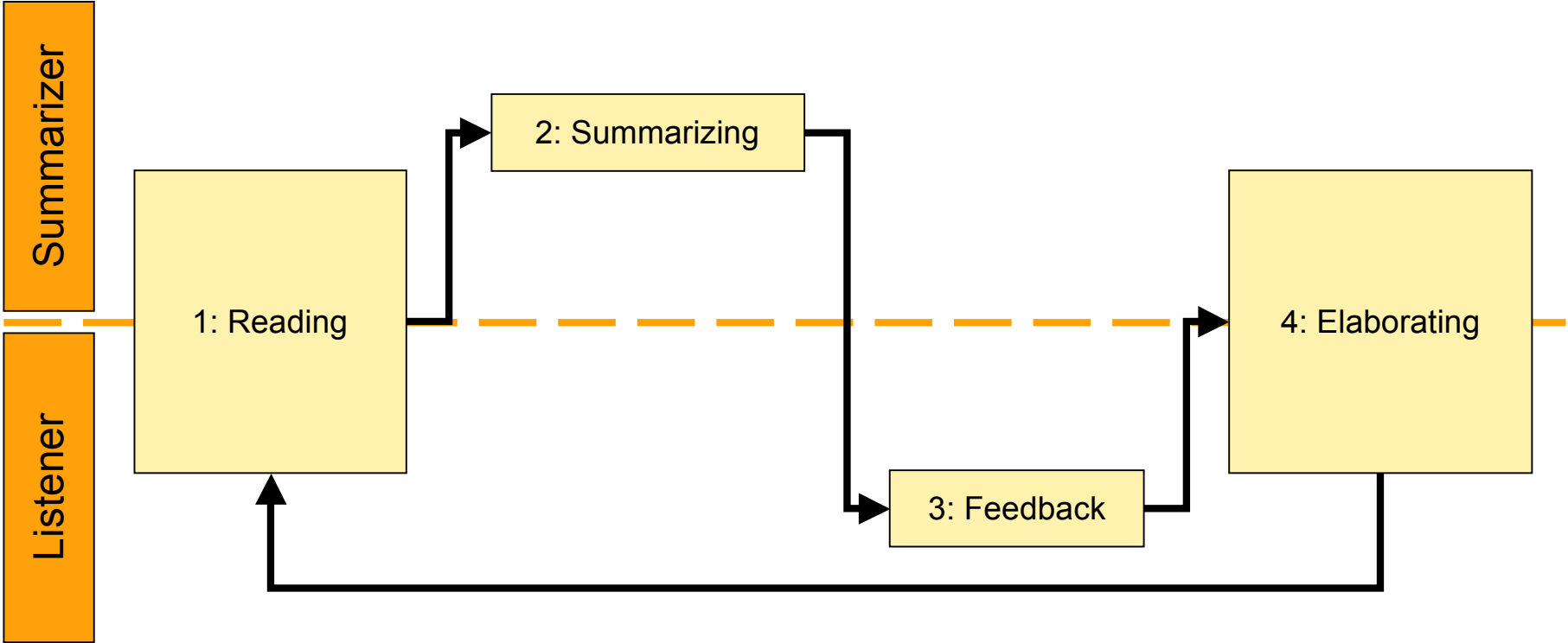
Problems:

- Orientation
- Text input



Example II : The MURDER Script

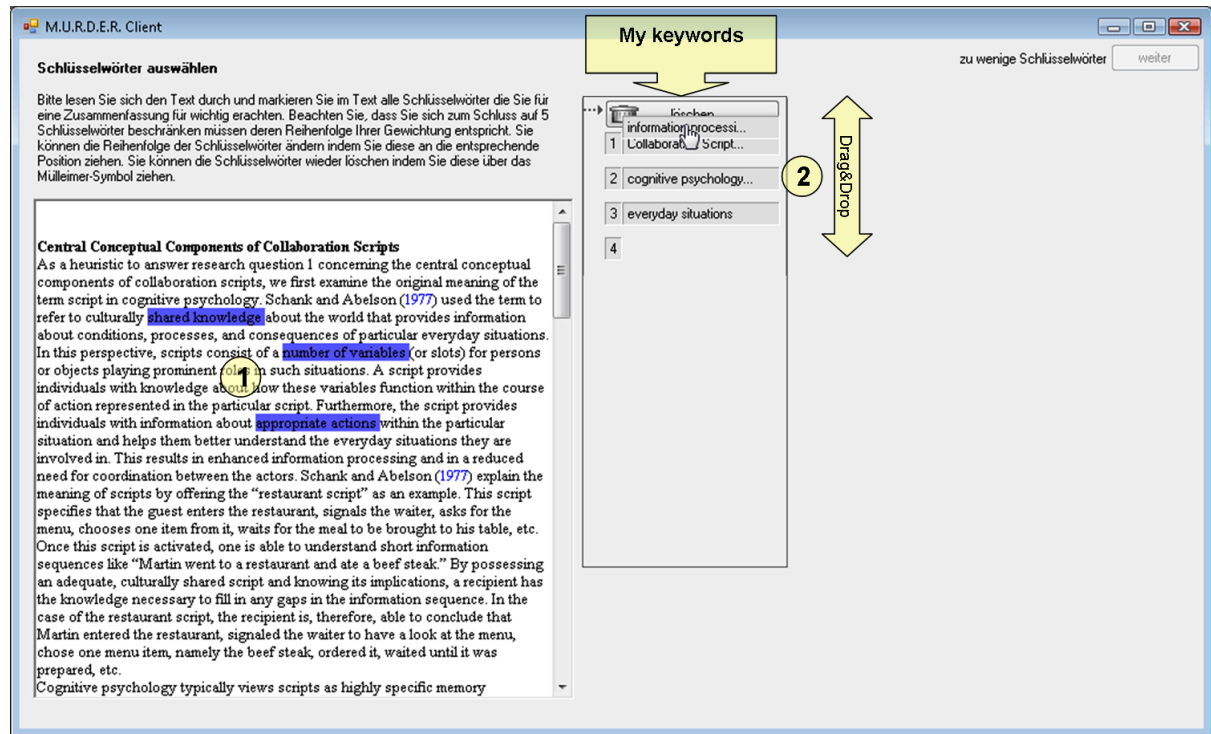
- Acronym for Mood, Understanding, Recall, Detection, Elaboration, Review
- Script for practicing text comprehension in pairs, originally developed for pen&paper [1]



[1] Dansereau et al., 1979

“Minimal” User Interface Design

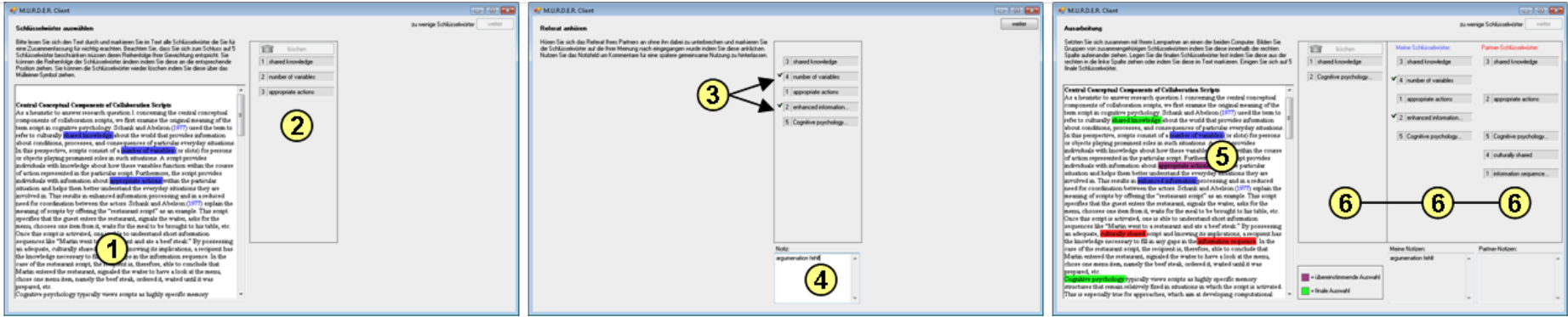
- Idea: Select few GUI elements carefully
 - Guide the learner’s activities
 - Minimize usability problems
- GUI elements:
 - Text (markings)
 - Keyword list
- Interaction techniques:
 1. Marking
 2. Drag&drop



Screenshot of MURDER application in phase 1 (for both listener and summarizer)

Step-by-Step Introduction of New GUI Elements

- GUI is gradually expanded
- Max. 2 new GUI elements per step:



Phase 1

Phase 2/3

Phase 4

New	① Text (markings)	③ Checkmarks	⑤ Multiple markings
	② Keyword list	④ Notes	⑥ Multiple keyword lists
Known		• Keyword list	• Text (markings)
			• Keyword lists
			• Notes

Why Did We Choose a Personal Displays (Laptops)?

- Summarizer and Listener are adversary roles
- In phases 1 – 3 the learners are acting as student vs. teacher
→ not supposed to see adversary's notes and keywords
- Only in phase 4 they act in concert
- Notebooks are frequently available in classrooms anyway
- Easy rearrangement between phases



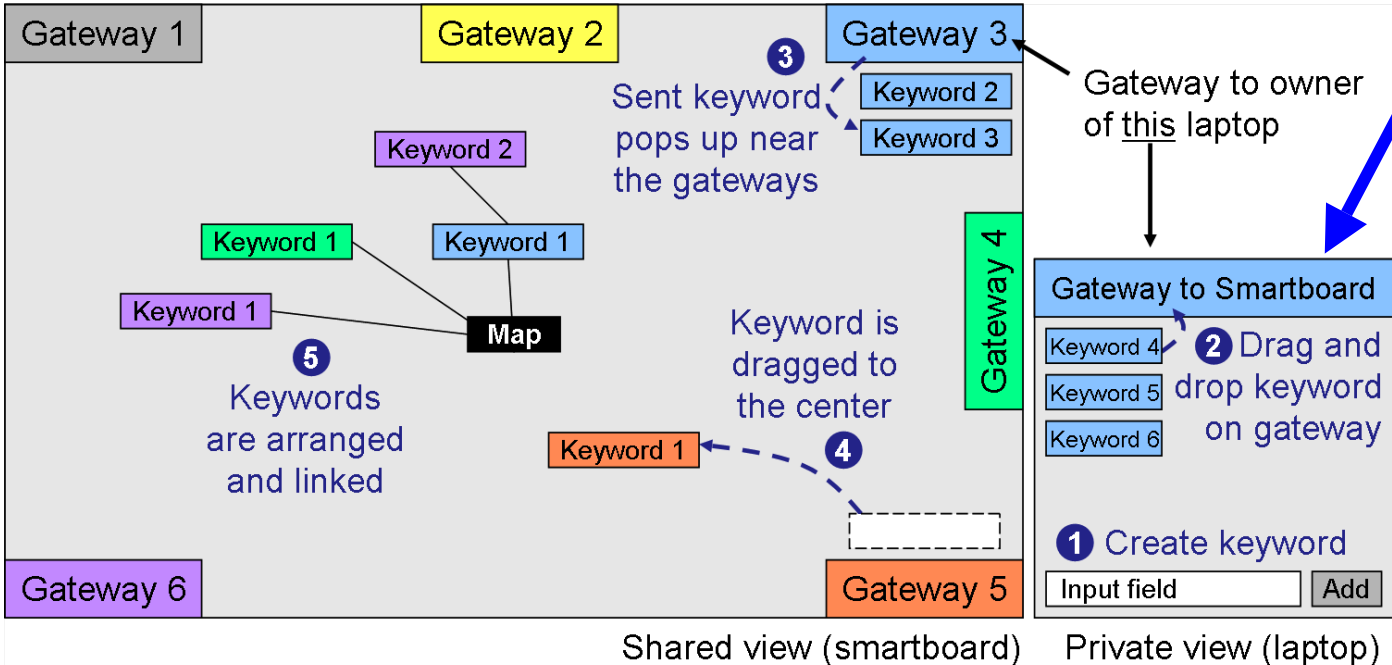
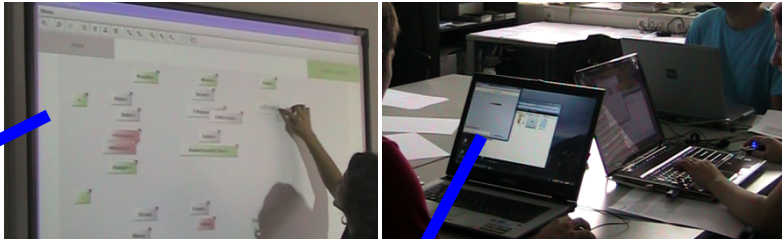
Problems:

- In phase 4 both learners need to share one laptop



Example III : Note&Share

- Facilitate knowledge sharing:
 - Note:** Individually create keywords (laptops)
 - Share:** Transfer keywords to smartboard (gateway interaction technique)



Why Did We Choose Both (Personal and Shared) Displays?

Laptops

- Individual phase
- Avoid production blocking



Shared display

- Visualization of the group knowledge

Interaction between laptops and shared display

- Interaction technique allows to move information between the displays very intuitively



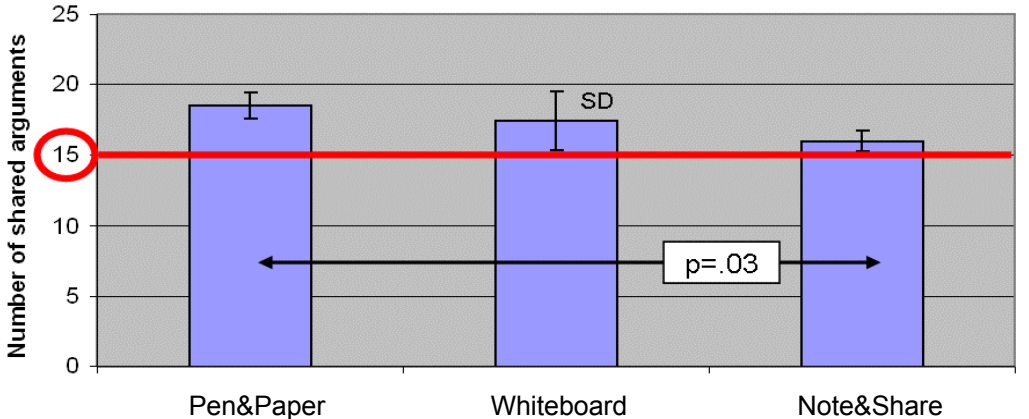
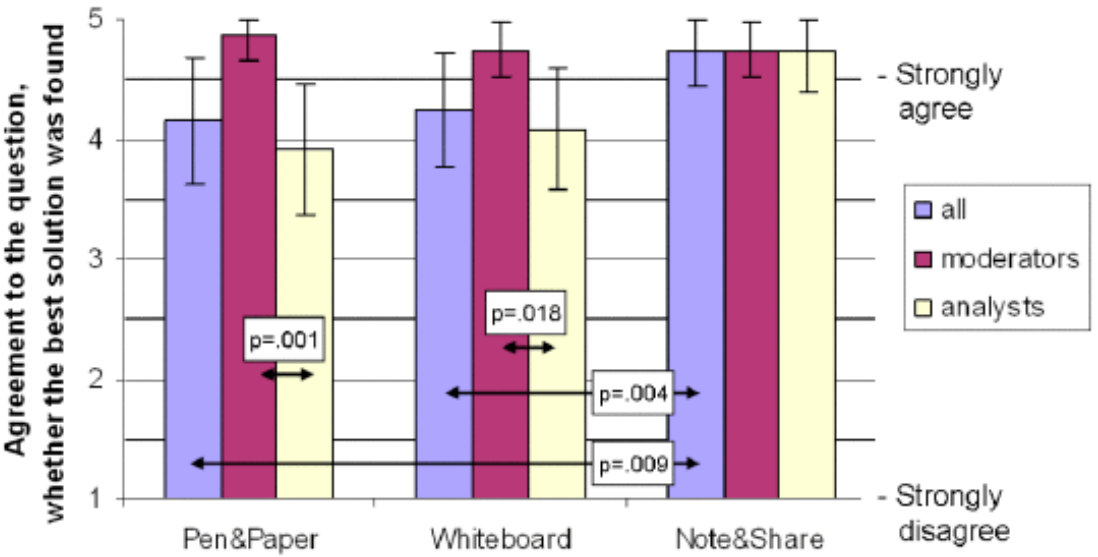
Problem

- Complex setup



Study Results and Observations (Note&Share)

- Hidden profile experiment
- 3 conditions:
 1. Note&Share
 2. Whiteboard
 3. Pen&paper
- Results:
 - More confidence in the solution
 - #shared arguments closest to the correct number
→ least “misunderstandings”



Summary – Things you should keep in mind for the following task

- Personal vs. shared displays
- Private, personal and shared workspaces

- Different display types have different effects on collaborative processes
 - Tabletops → eye contact, balanced participation (orientation problem)
 - Wall displays → same perspective, comparison/overview
 - Personal displays → “one’s own space”, private information

- Multi-display reaching techniques allow to easily move information across displays
 - ⇒ Switch displays between phases
 - ⇒ Use multiple displays simultaneously

Agenda

Preparatory
lecture

1

Types of display (environments)

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Designing a collaborative learning application for “Structured Academic Controversies” (SAC)

Task for today’s
breakout session

Design a collaborative learning application for the SAC Script

- Develop a concept, which describes how a “Structured Academic Controversy” (SAC) could be supported using technology.
- Create sketches or a paper prototype to describe your ideas.
- Your concept should answer the following questions:

Benefit of technology

- What are potential benefits of using technologies in this learning scenario?

Display environment

- Which display types are best suitable for this learning scenario?
- What are the factors that play a role in such a decision process?

User Interface

- How should the user interface look like in order to
 - support the collaborative processes described in this collaboration script?
 - guide the learners (make them stick to the script)?

Structured Academic Controversy Script

Collaboration script for 4 learners (2 dyads):

1	Pair building	<ul style="list-style-type: none"> ▪ Dyads are created and assigned to opposing positions on a specific topic ▪ Learning material is distributed between the two pairs ▪ Dyads are instructed to make any information in their own material available to the other dyad when it might support their position 	
2	Positions	Pairs develop their position	Pairs
3	Presentation & Discussion	<ul style="list-style-type: none"> ▪ Pairs present their arguments to the other dyad ▪ Exchange thoughts and information, possibly create counterarguments ▪ Discussion 	All four
4	Role switch	<ul style="list-style-type: none"> ▪ Positions are switched ▪ Iteration of steps 2 and 3 	-
5	Synthesis	Positions are dropped and all four learners are instructed to seek a synthesis of their discussion by writing a joint position statement	All four
6	In class	Position is to be presented to the class later on	

Which Types of Displays are Suitable in Which Phases?

- Do learners need a personal workspace (e.g. in an initial reading phase)?
- Wall or Table?
 - For pairs
 - For groups of four

▪ Tradeoff:

	Pros	Cons
Most suitable display per phase	+ Ideal for each step	- Overhead between phases
One display across phases	+ No handovers	- Unsuitable for some phases?

Literature

- Berger, S., Kjeldsen, R., Narayanaswami, C., Pinhanez, C., Podlaseck, M., Raghunath, M., 2005. Using symbiotic displays to view sensitive information in public. In: PERCOM '05: IEEE Computer Society, Washington, DC, USA, pp. 139–148.
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