空間與學習：教育空間的科技設計

--從教學實踐計畫到科技部資訊教育學門計畫

劉晨鐘

國立中央大學

資訊工程學習系

從教學實踐計畫到科技部資訊教育學門計畫

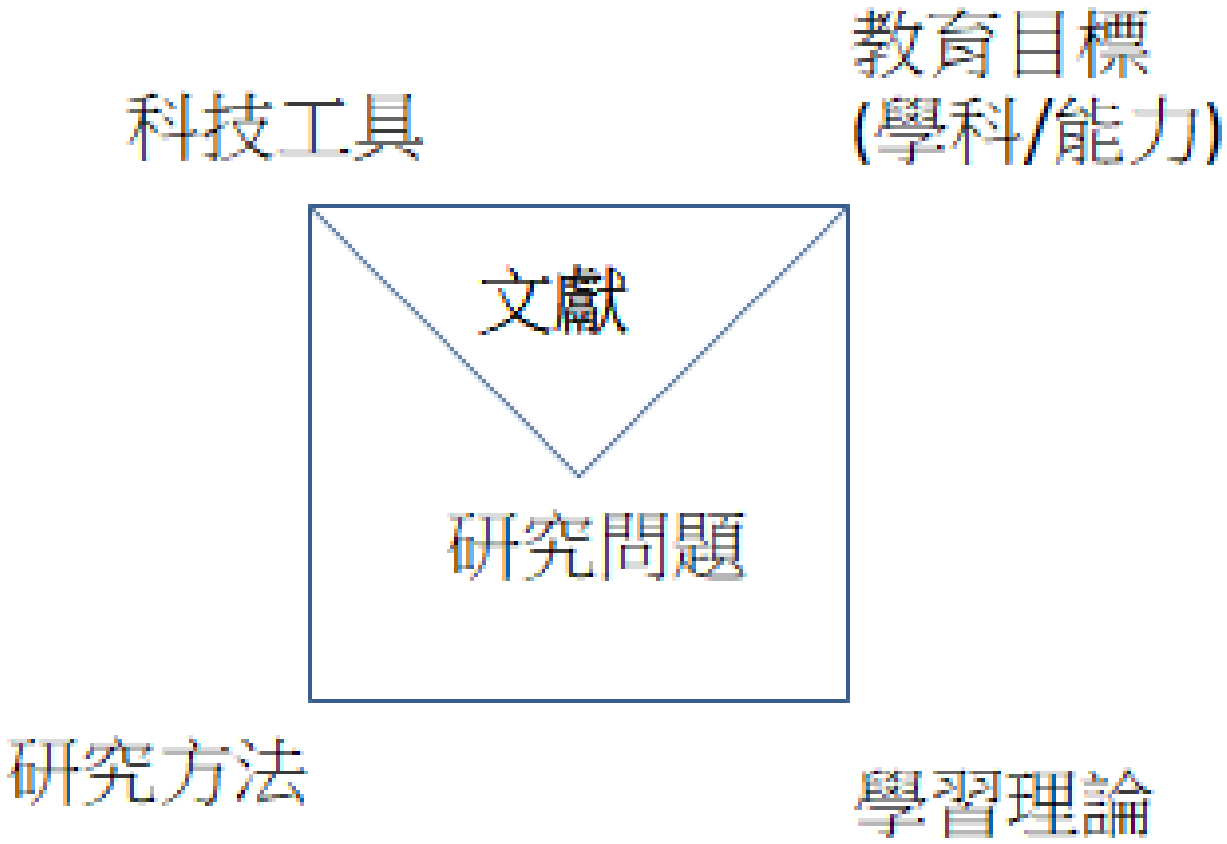
劉晨鐘 資訊工程學系

誰可以申請?

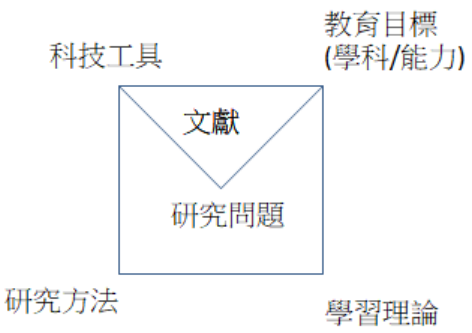
- 資訊相關科系(資工系、資管、資傳等)
- 數位學習相關系所(數位內容、遊戲)
- 教育相關系所
- 領域科系: 資訊科學 (程式、AI等)、語言、科學、工程等

計畫的主題

- 電腦輔助學習或數位學習(不限學科)
  - 能力培養: 創造力、 合作、問題解決、批判等
  - 學科能力: 語文、科學…等
- 資訊教育
  - ”資訊科學”的教育研究
  - **Computational thinking (or programming)**
  - 資訊素養
  - **AI**教育
- 新媒體的研究
  - 網路霸凌
  - 網路成癮、網路不適當使用
  - 網路倫理
  - 數位落差


教育目標
(學科/能力)
科技工具
文獻
研究問題
研究方法
學習理論

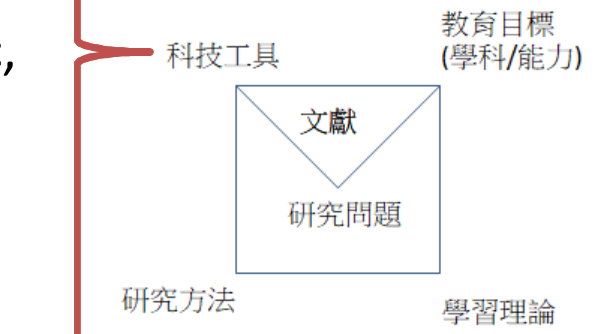
教育目標



- 學科知識: 語文、數學、科學、程式設計能力、 AI知識等
- 情意: 感受、動機、投入狀態(心流)、學習概念、自我效能等。
- 後設認知: 規劃、監控、自我調節能力
- 素養: 合作、問題解決、創造力、批判思考等

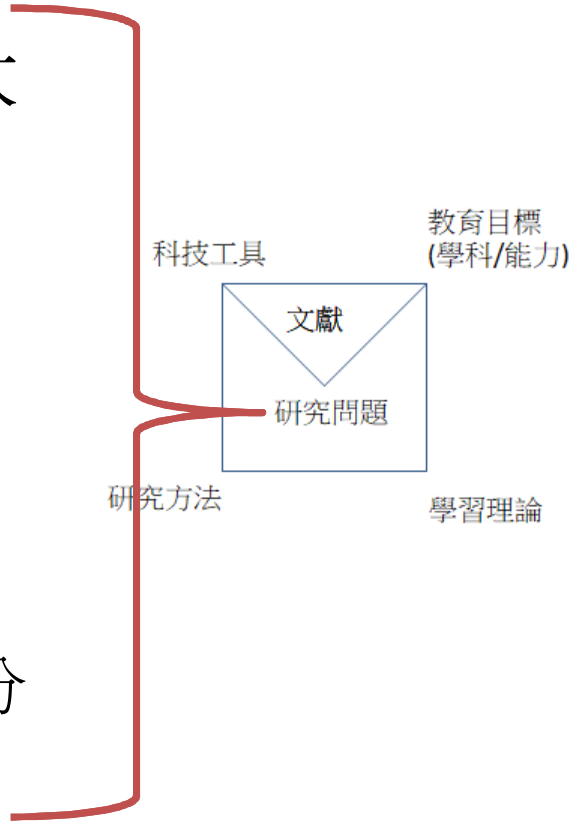
科技工具

- AI相關技術: 機器學習、資料探勘工具、視覺化工具、 深度學習。
- 認知工具: 概念圖軟體、知識地圖、模擬軟體
- 社會/合作平台: 社群媒體、Google Doc, Wiki
- 新媒體: VR/VR、說故事軟體、 行動載具軟體(eg. APP Inventor)、遊戲
- 自行開發
- 等等



研究問題

- 與教育部教學實踐計畫最大的差異: Gap analysis
  - 文獻中已經確定什麼?
  - Gap 1: 文獻中的衝突就是最好的研究問題
  - Gap 2: 文獻中不知道的是什麼? (在….方面的文獻卻是付之闕如?)，應有清楚的列舉分析



研究問題

- 國際與國內研究趨勢與疆土: 學術創新與時代意義!
  - 這個計畫/研究屬於哪一個子領域?
  - 文獻分析很重要
  - 國內學者(有哪一些重要研究者)的研究成果現況分析
  - 關於人的知識有很重要!

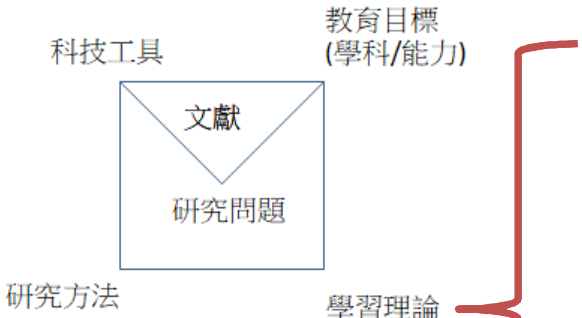
研究問題

- 如何文獻回顧
  - 避免過時與老舊的議題 (翻轉? 雲端?)，必須有時代意義 (檢查一下文獻是否為最近的論文)
  - 避免過於窄化的研究問題(例如: 使用VR是否能夠幫助學生學習牛頓第二運動定律?)
  - 避免雜亂無章的瑣碎描述(一篇一篇的單一研究)
  - 避免只是陳述事實 ，而無評述

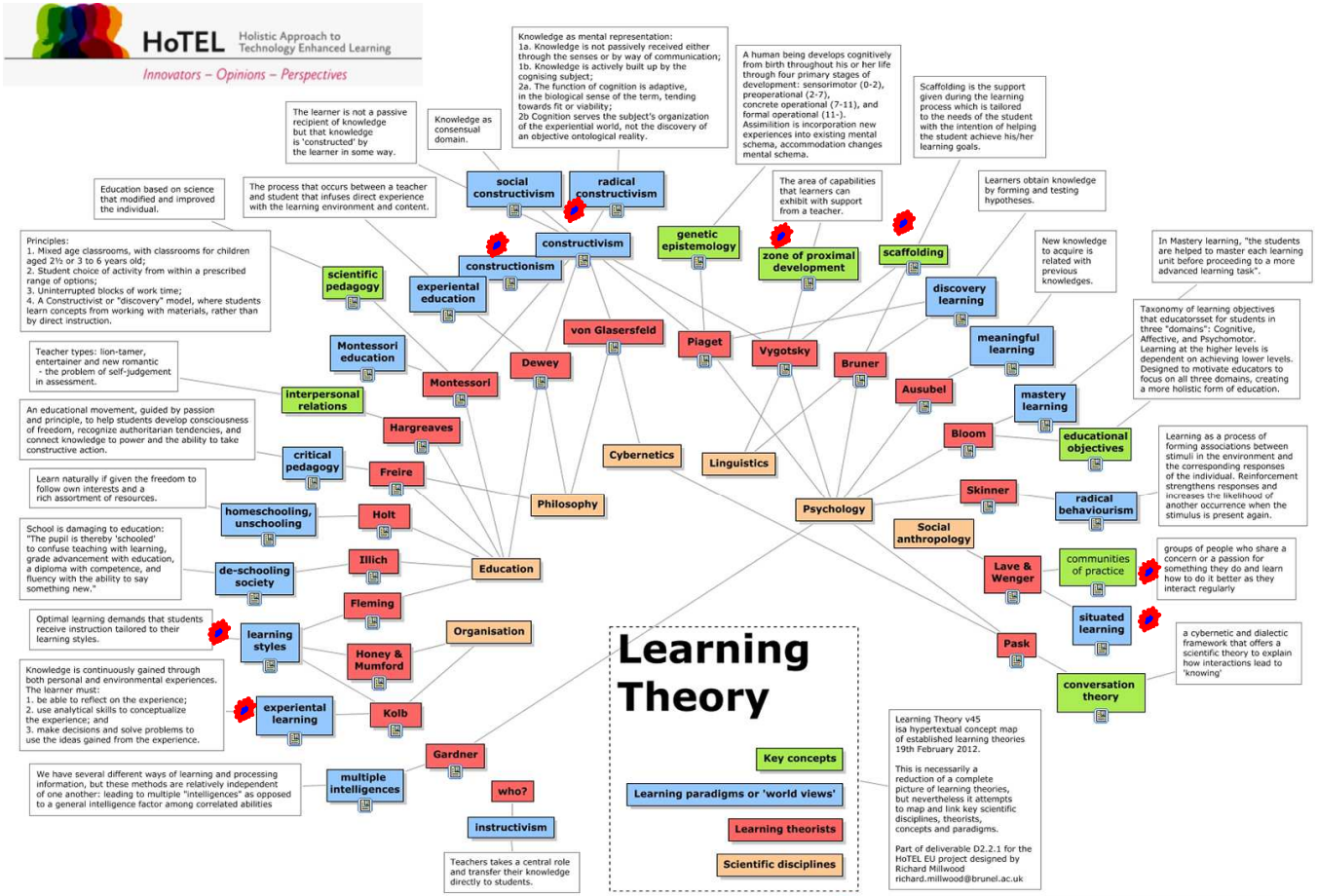
及時(up-to-date)
可一般化(generalized)
架構化(Framework)
評述式 (critical)

文獻回顧四原則

學習理論/教學方法



- 將研究價值凸顯出來的基礎
- 兩種用途:
  - 指引學習/教學活動設計
  - 指引研究方法



by Richard Millwood

teachthought

https://www.teachthought.com/learning/a-visual-summary-the-most-important-learning-theories/

學習理論/教學方法

- 常用的學習理論/教學方法
  - 合作學習(collaborative learning)
    - Pair programming
    - Team Game tournament (分組對抗)
    - Jigsaw (拼圖法)
  - 鷹架理論(scaffolding)/近測發展區理論(ZPD)
    - 摹寫
  - 實務社群理論(community of practice)
    - 合法周邊參與/角色階梯
  - 社會認知理論(social cognitive theory)
    - 知識分享(信任、期待、與環境)

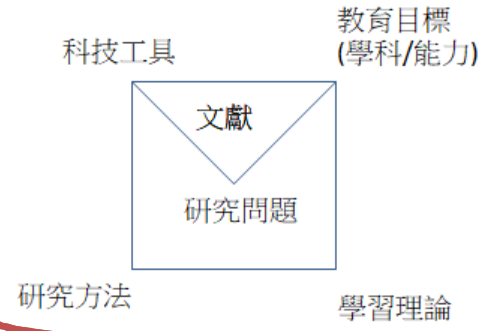
學習理論/教學方法

- 心流(flow theory)
  - 遊戲學習
- 建造主義(constructionism)
  - 機器人
  - Maker
- 體驗學習(experiential learning)
  - 真實體驗➔ 反思觀察➔建立抽象概念➔主動試驗

研究方法

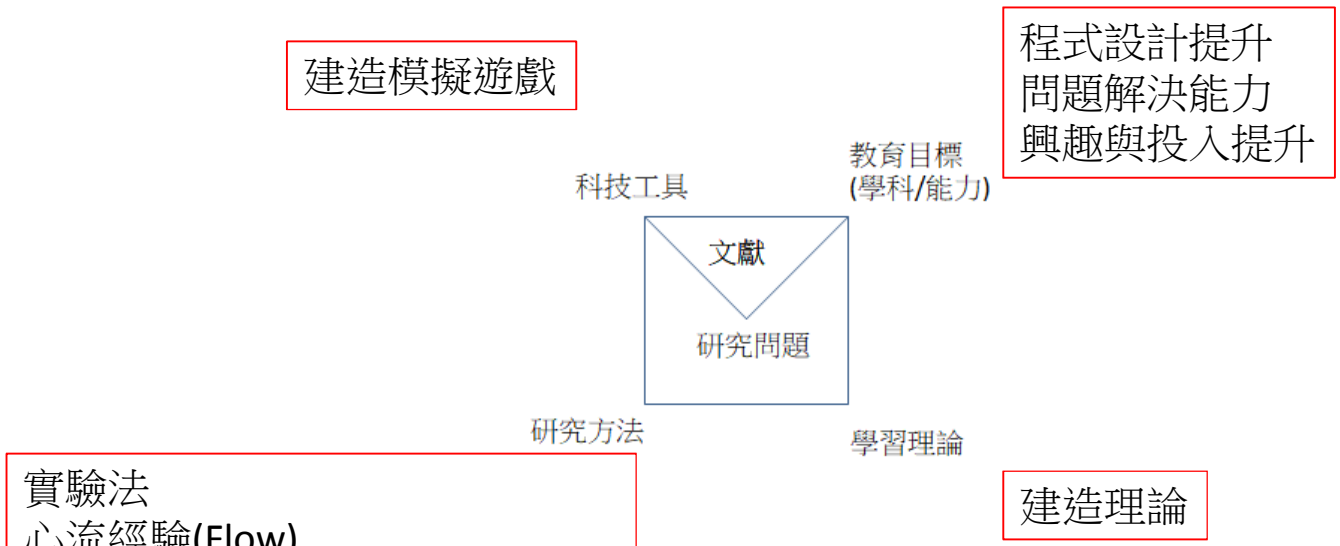
- 質化或是量化研究
- 實驗法
- 單一組觀察與關聯分析

- 針對研究問題，一定要先規劃好
  - 受試者與場域(腹案)
  - 變項的控制與量測(觀察)
  - 資料蒐集、工具的選用(測驗、量表、分析架構)
  - 資料分析: 選用何種統計或是AI分析方法



案例分享

The effect of simulation games on the learning of computational problem solving (2011)



Liu, C.-C., Cheng, Y.-B. & Huang, C.-W. (2011). The effect of simulation games on the learning of computational problem solving. *Computers & Education, 57*(3), 1907-1918.

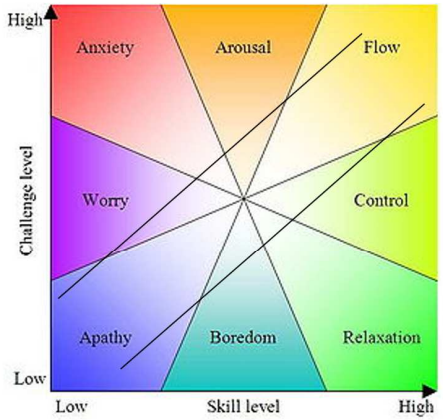
教育目標

- 程式設計提升
- 問題解決能力提升
- 興趣提升
- 投入感提升

學習理論

Constructionism

心流理論



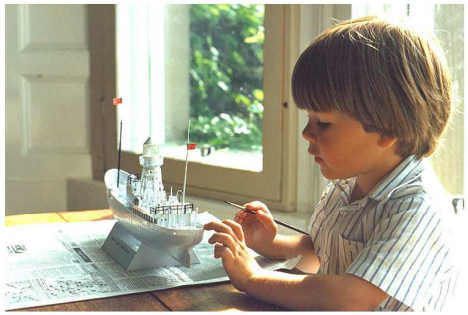


圖1. 基於建造主義的Train B&P建造遊戲

科技工具設計(選用)- 基於建造主義

```
begin
int count=0;
while(true)
{
  if(TrainPassMe()){
count++;
print (count);
}
 if(count==3){
train0.Break(30);
print "Train0 Break[30]";
print("Train is
stopping");
}
}
end
```

The program governs the behavior of the track in (3)

文獻分析與研究問題

- **Framework**
  - 以電腦模擬**(computer simulation)**輔助問題解決學習
  - 於遊戲中的學習問題解決
  - 支援運算問題解決的模擬遊戲

文獻分析與研究問題

- Gap Analysis
  - 正: 這裡些系統一方面顯示電腦模擬可以有助於提高學生對複雜的概念的理解 (Holzinger, Kickmeier-Rust, Wassertheurer, & Hessinger, 2009 ; Kumar & Sherwood, 2007)，另一方面，他們可以提升查詢策略和自學能力 (Rendas et al., 1999)，因為他們可以讓學生直接運用自己的學習成果了解複雜的系統 (Holzinger et al., 2009)。經由這樣的模擬，學生可以獲得知識和提升他們的自信、批判性思維和問題解決的能力 (Jeffries, 2005 ; Rivers & Vockell, 1987; Woodward et al., 1988)，學生也會因此更可能將電腦模擬中獲得的知識轉移應用到其他情境 (Kumar & Sherwood, 2007)。

  - 反: “有一些研究顯示學生往往只是在表面和玩樂的層次上進行與模擬系統的互動 (Mayer, 2004; Swaak & de Jong, 2001)。這種表面互動部分是由於大部分學生還不能在沒有教學支援的情形下來獨立解決問題 (Leutner, 1993 ; Yamen, Nerdel, & Bayrhuber, 2008)。換句話說，學生需要進一步的援助，以獲取知識和減少模擬的複雜性。這種說法和Holzinger等人的研究一致 (Holzinger et al. 2009)，他們的研究發現，雖然模擬可以幫助增強對於複雜概念的理解，但學生可能不知道如何與複雜的模擬互動以解決一個問題。”

→ 所以，我們想建立一套遊戲軟體與學習活動設計幫助學生習得計算問題解決能力，並提升他們的學習動機與投入。

研究設計

- 單一組前後測、關聯分析

- To investigate the influence of the game on motivation and flow perceptions.

- 117 first-year students in a university in northern Taiwan

- traditional(1.5months)-> flow survey -> construction game (two weeks)-> flow survey

研究設計(資料蒐集)

- 程式能力: 自編測驗
- 活動紀錄: 系統log
- 投入: 心流問卷
- 動機: 學習動機策略問卷 (Motivated Strategies for Learning Questionnaire ; MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1991)

研究設計(分析)

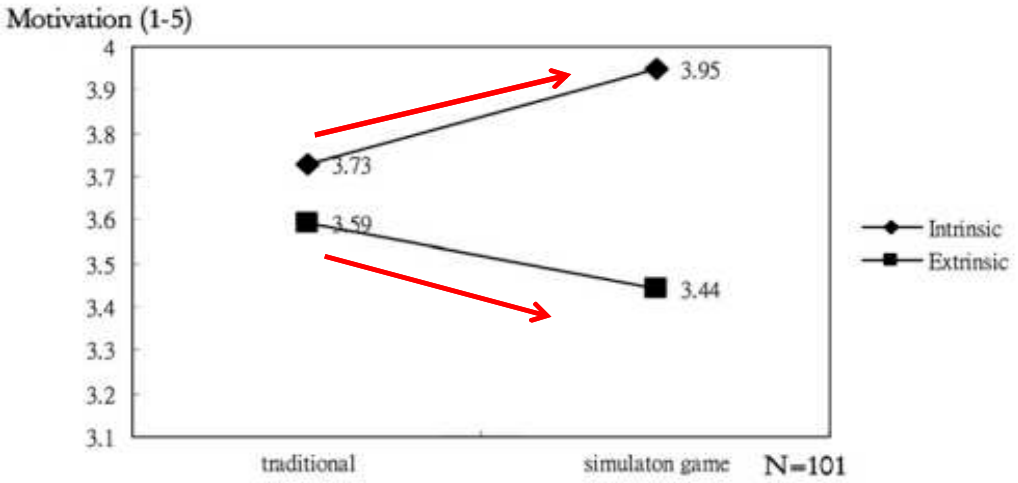


Fig. 4. The students' motivation in the traditional and simulation game setting.

- Students in the game setting reported higher level of intrinsic motivation but lower level of extrinsic motivation.
- The game transformed the learning experience from an extrinsic motivation into a intrinsic motivation.

歡迎投件

人文司 > 科教領域 > 資訊教學門

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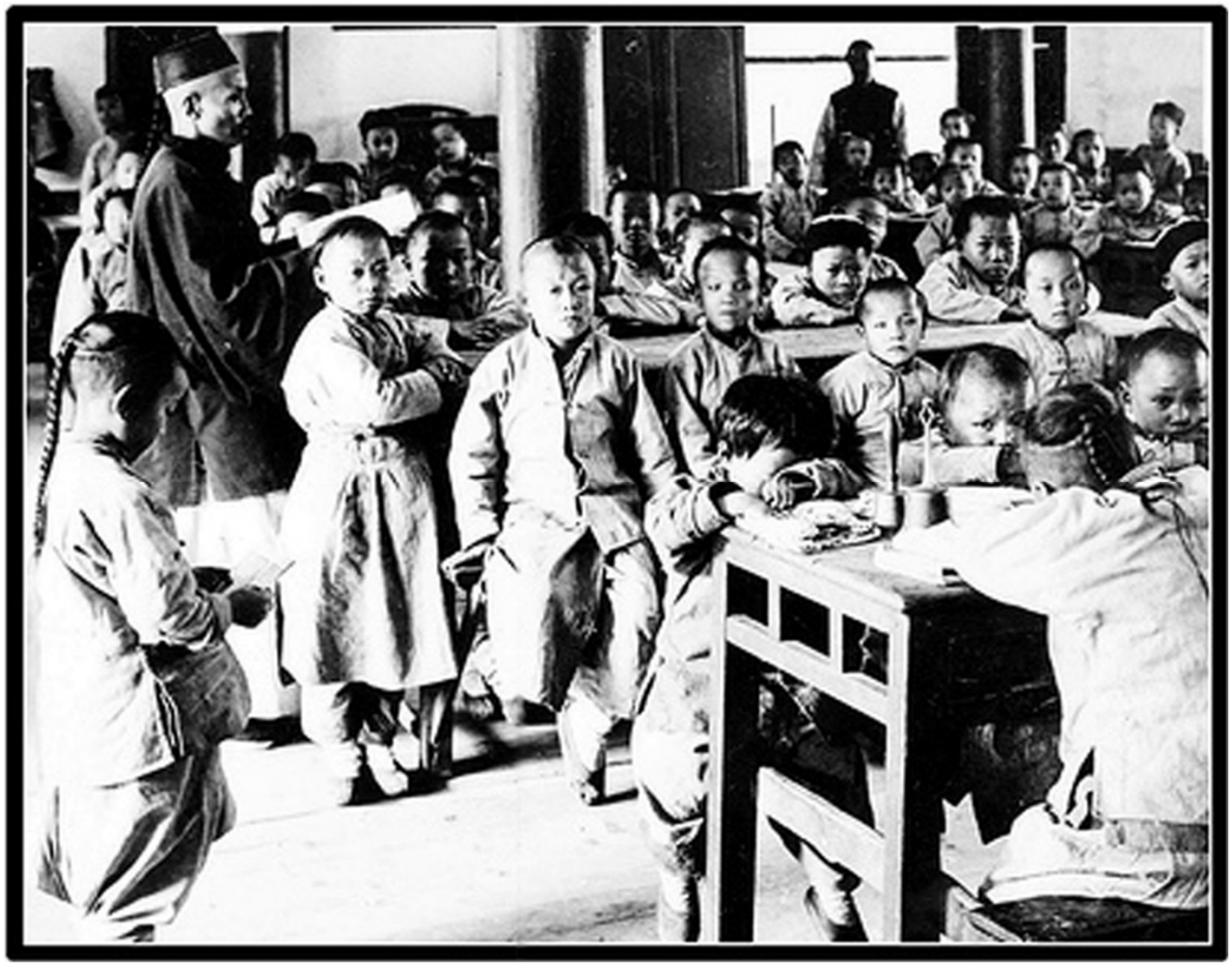
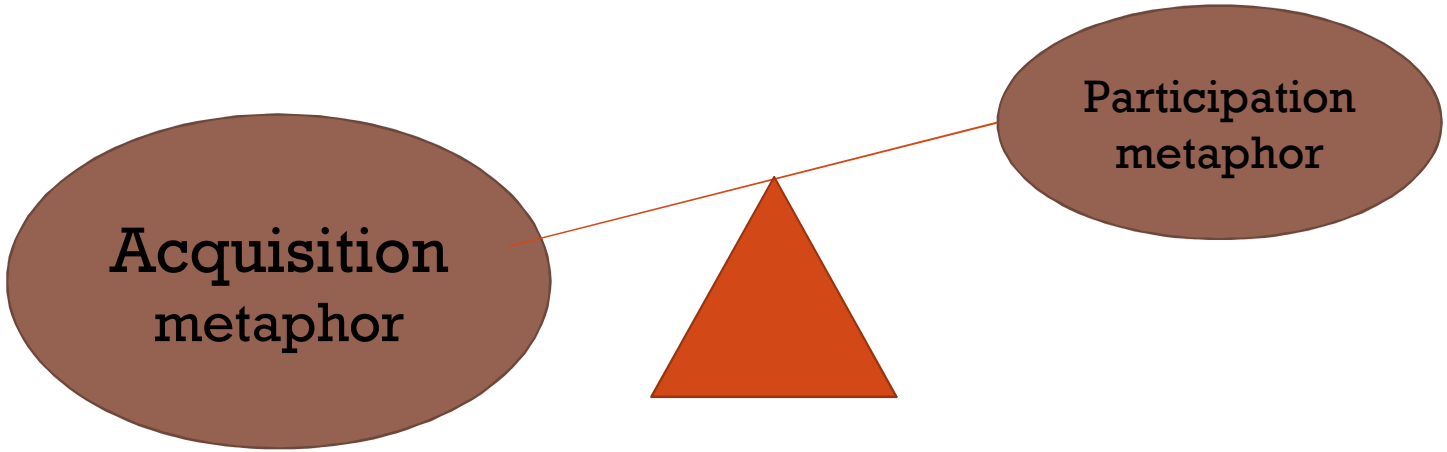


A CLASSROOM 100 YEARS AGO

Chinese school children and teacher at the American Board of Missions, Peking, China -- Library of Congress Stereograph Collection

CLASSROOMS NOW

TWO METAPHORS (SFARD, 1998)



Knowledge acquisition metaphor: "Learners are guided to assimilate pre-given structure of knowledge."

Participation metaphor: "learning is an interactive process of participating in various cultural practices and shared learning activities" (Paavola and Hakkarainen, 2005)

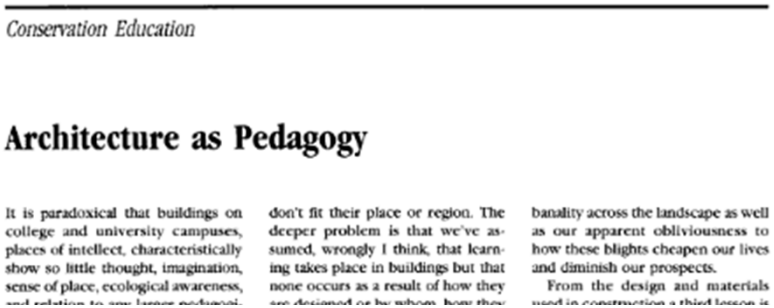
建築與空間是教育理念的縮影

ARCHITECTURE AS PEDAGOGY (建築即教學法) – BY DAVID ORR

Orr, D. W. (1993). Architecture as pedagogy. *Conservation Biology*, *7*(2), 226-228.

ARCHITECTURE AS PEDAGOGY — BY DAVID ORR

- "Academic architecture is a kind of crystallized pedagogy and that buildings have their own hidden curriculum that teaches as effectively as any course taught in them."



Conservation Education

Architecture as Pedagogy

It is paradoxical that buildings on college and university campuses, places of intellect, characteristically show so little thought, imagination, sense of place, ecological awareness,

don't fit their place or region. The deeper problem is that we've assumed, wrongly I think, that learning takes place in buildings but that none occurs as a result of how they

banality across the landscape as well as our apparent obliviousness to how these blights cheapen our lives and diminish our prospects.

From the design and materials

Orr, D. W. (1993). Architecture as pedagogy. *Conservation Biology*, *7*(2), 226-228.

ARCHITECTURE AS PEDAGOGY – BY DAVID ORR

- Education is a quiet process requiring no interaction and the human relationships is not the main concern
- With a uniform appearance, creativity can be nurtured in dry and boring places short of imagination.

PERCEIVED SPACE PEDAGOGY

1. Field trip simple orientation
2. Lecturing
3. Large class teaching
4. Small group teaching
5. Project meeting/discussion/presentation
6. Small group meeting
7. Group project space
8. Project-based learning/ Jigsaw

What are these space perceived for teaching/learning by teachers/students:

PERCEIVED SPACE PEDAGOGY

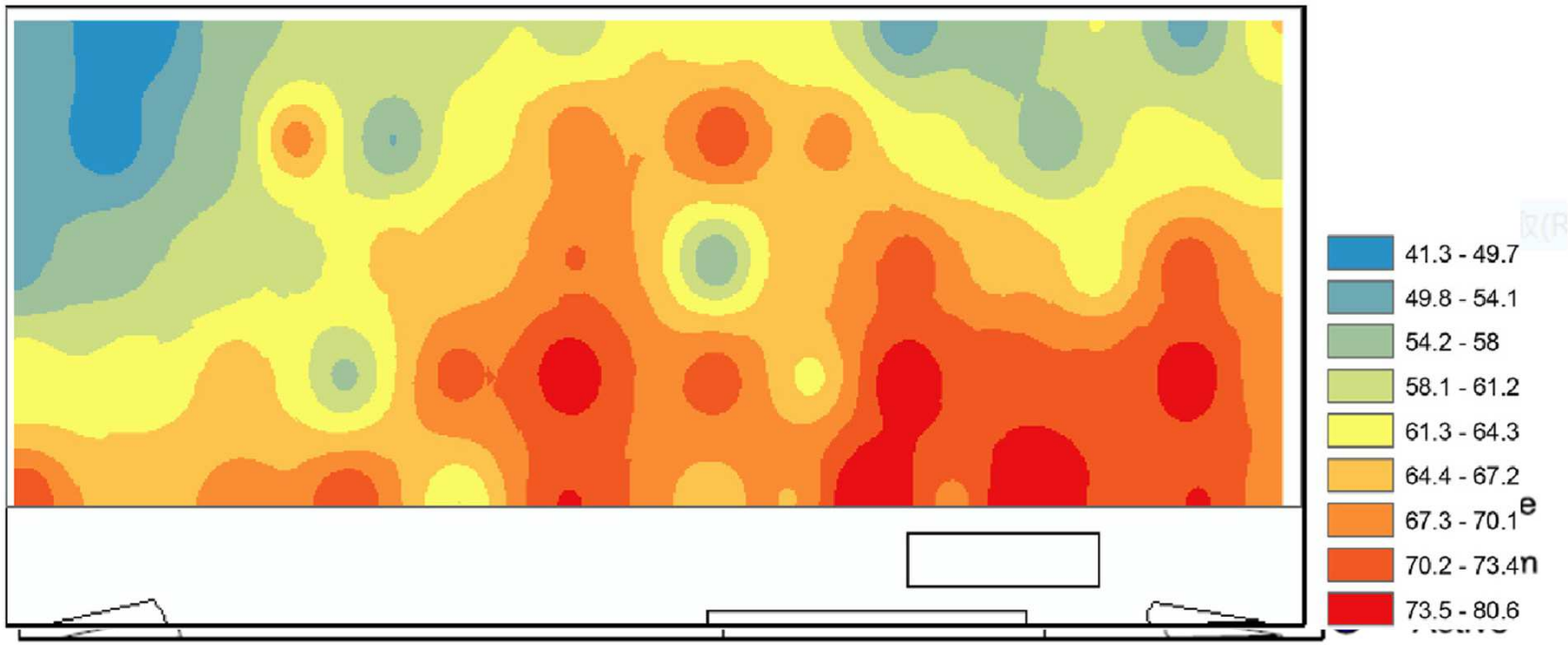
- Spaces and furniture arrangement have their own affordances in supporting teaching/learning.

- Perceived affordances: ”the perceived and actual properties of the thing, …. That determine just how the thing could possibly be used. [...] ” by Norman (1988)

- Spaces have significant impact on teaching and learning!

SPACE MATTER !

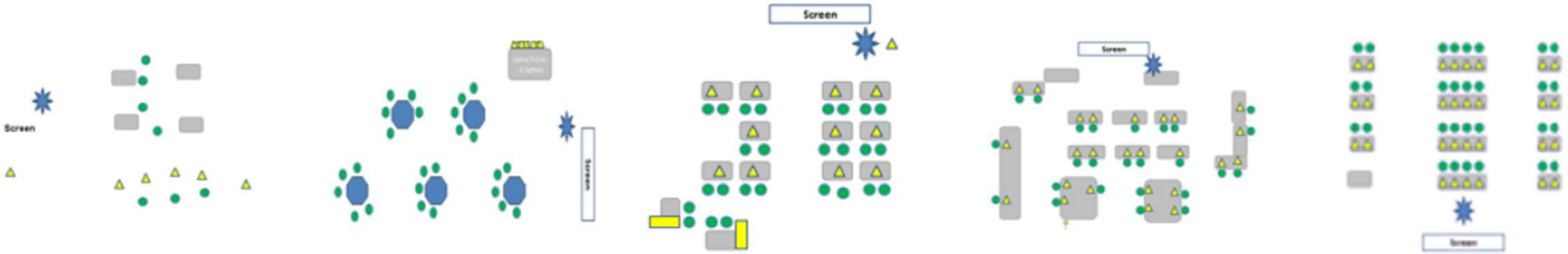
- A significant relation between student success and their locations in the space.



Waktola, K. D., (2015). Visualizing the spatial dynamics of student success, Applied Geography, 60 (2015) 77-83.

SPACE MATTER !

- Analysis of 85 lessons with visual maps and activities



Free ranging | Small group | Paired working | Distributed | Front facing

Crook, C., & Bligh, B. (2016)

- The design of the room or the configuration of the furniture significantly influence the social organization in the class.
- Teachers will choose the teaching practice according to the space.

EDUCATIONAL BUILDING & SPACE EVOLUTION

創校77年

圖片來源: 桃園新明國小臉書

創校14年

圖片來源: 彰化信義國中小臉書

創校66年
921後重建

圖片來源: 南投內湖國小臉書

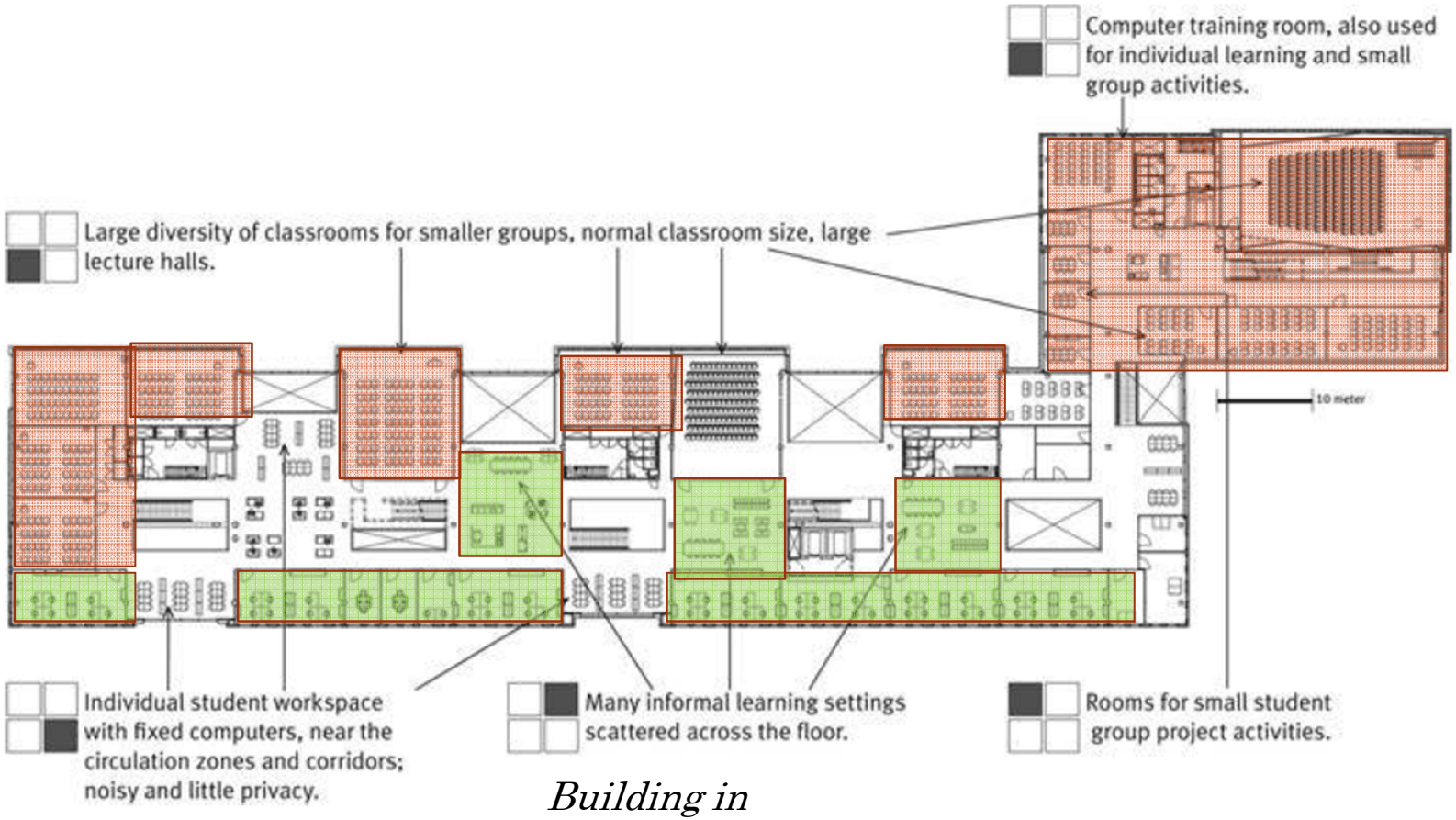
'inside out school' in ghana

The school serves as an important community center for the village

EDUCATIONAL BUILDING EVOLUTION

Beckers, R., van der Voordt, T., & Dewulf, G. (2015). A conceptual framework to identify spatial implications of new ways of learning in higher education. *Facilities*, *33*(1/2), 2-19.

EDUCATIONAL BUILDING EVOLUTION



Building in 2010

Beckers, van der Voordt, & Dewulf (2015)

Learning & Teaching Center, U of Maryland at College Park

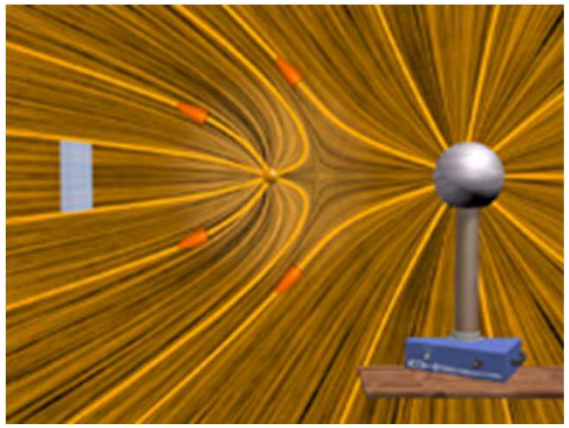
ACTIVE LEARNING CLASSROOM (ALC)

1997

Beichner, R. (2008). The SCALE-UP Project: a student-centered active learning environment for undergraduate programs. *An invited white paper for the National Academy of Sciences*.

ACTIVE LEARNING CLASSROOM (ALC)

TEAL classroom (MIT)



2001

Images from http://web.mit.edu/

ACTIVE LEARNING CLASSROOM (ALC)

Collaboration classroom (National Central University, Taiwan)

2005

ACTIVE LEARNING CLASSROOM (ALC)

2012

Collaborative learning studio, Indiana University
Photo from https://learningspaces.iu.edu/explore/rooms/SB015.html

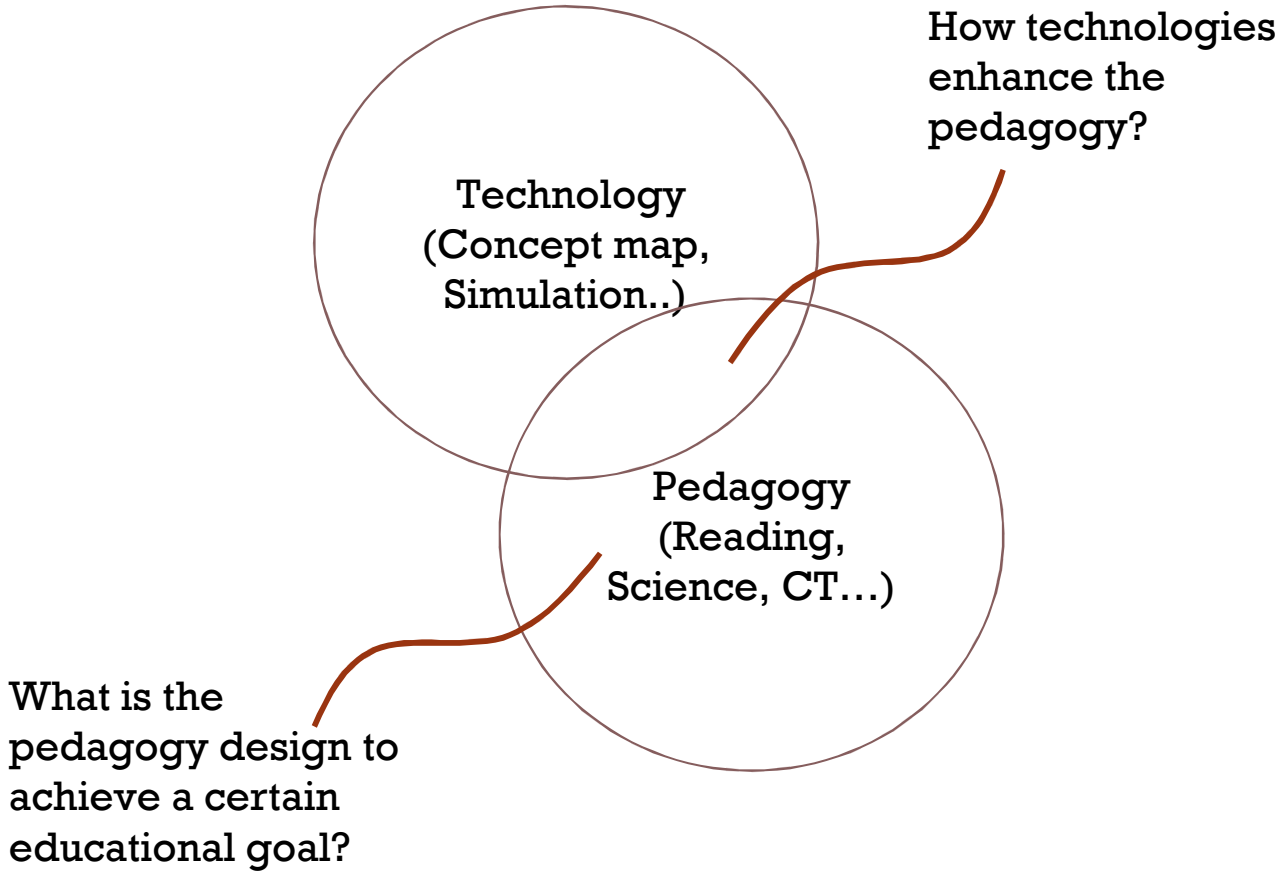
ACTIVE LEARNING CLASSROOMS

- Colorful and bright lighting
- Movable and flexible furniture for accommodating different types of collaborative activity
- Multiple writing surfaces for small group discussion
- Shared displays for small groups

TERP Classrooms at University of Maryland

RESEARCH

PEDAGOGY & TECHNOLOGY(PT) FRAMEWORK

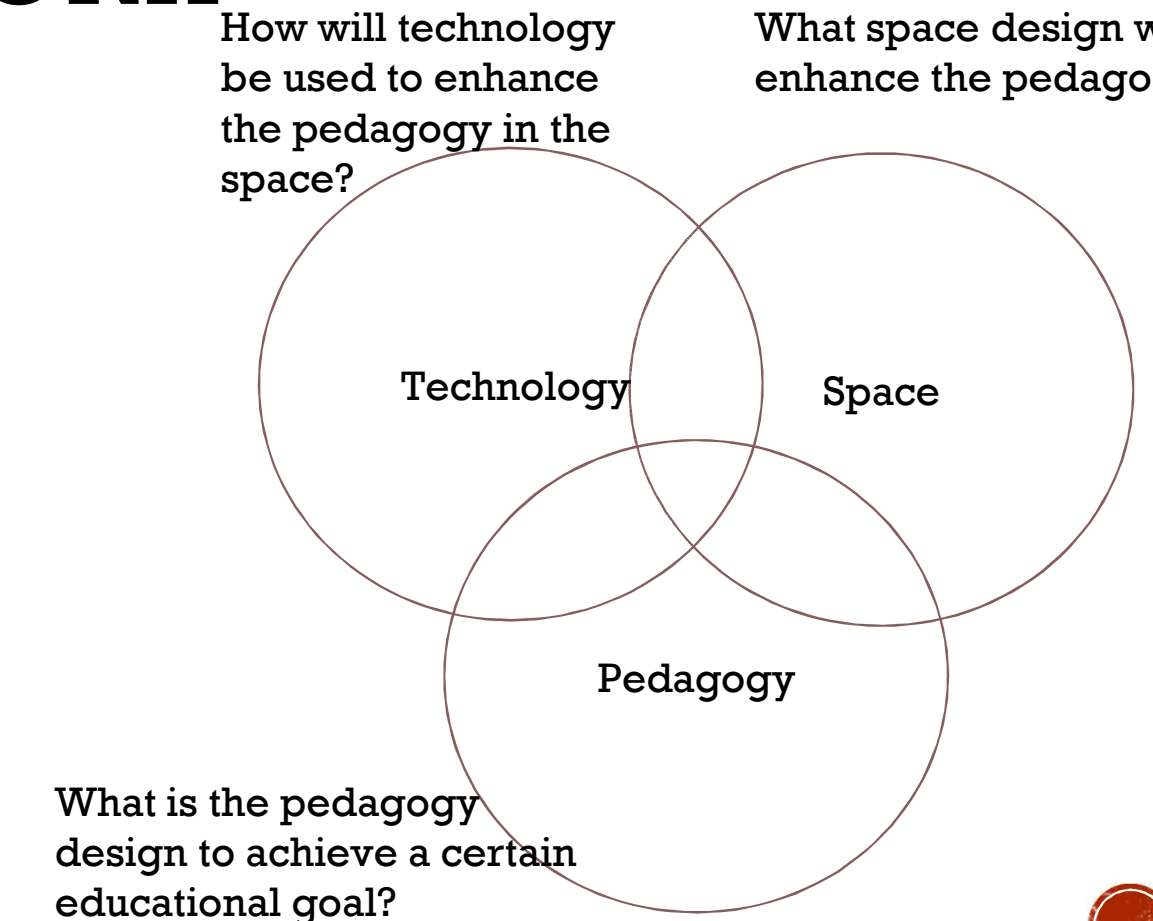


PST FRAMEWORK

- The Next Generation Learning Spaces Project by Radcliffe Wilson at University of Queensland

- Technology does not work in an empty environment where only the technology itself exists.

- It should also comply with the affordance and constraint of the space.

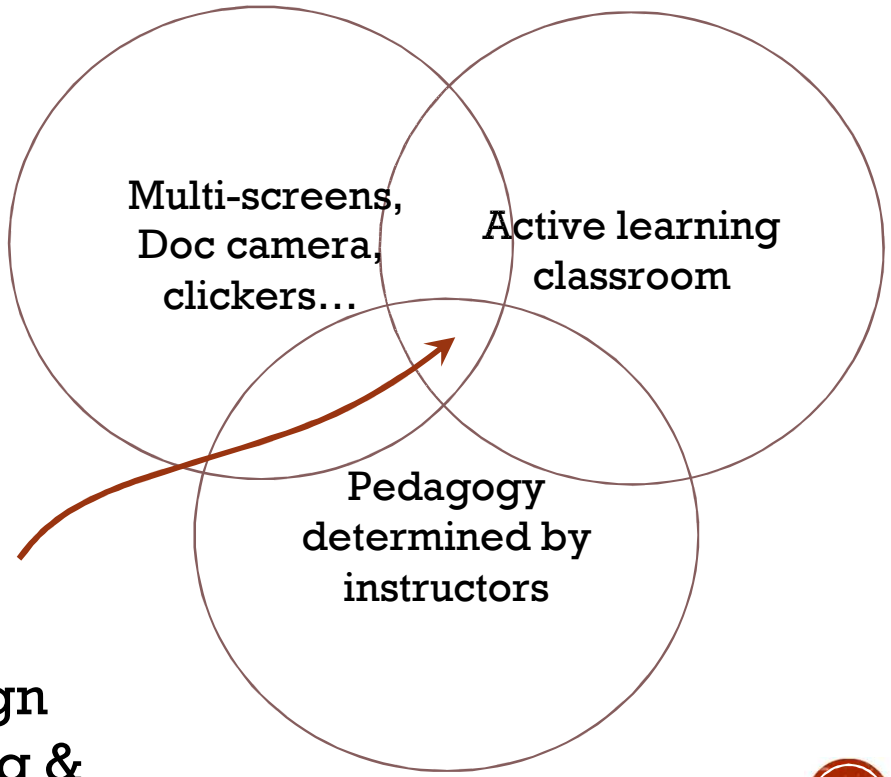


Radcliffe, D., Wilson, H., Powell, D., & Tibbetts, B. (2008).

STUDY 1: ACTIVE LEARNING CLASSROOM

THE ALC

- Pedagogy: determined by instructors
- Space: Active learning classroom(multiple round tables, white boards…)
- Technology: Multi-screens, Doc camera, clickers…



How the space & technology design supports teaching & learning?

Instructors' Belief and their teaching practices

	Group work	Reflective writing	Full class discussions	Students writing on whiteboards
Constructivist's view	r= .40*	r= .34	r= .43*	r= .33

The instructors who hold a higher level of constructivist's view were more likely to apply group work outside class time and use reflective writing, but less likely to ask students to read primary literature.

Instructors' Belief and their feeling

	Enthusiasm	Happy
Transmissive view	r= -.42*	r= -.52*

Instructors' transmissive view was negatively correlated with the positive feeling in using the ESJ classrooms.

EVIDENCE-BASED RESEARCH

- Evidence-based research is necessary to understand how ALC supports active teaching/learning.

- Stains et al. (2018, March). Anatomy of STEM teaching in North American universities. Science, 3 359(6383), 1468-1470

- Analyzing STEM teaching practices based on on-site classroom observations from over 2000 classes

-- Classroom observation tool (GORP) and protocols (COPUS)

- Providing clear data for determining the impact of educational interventions

SCIENCE EDUCATION

Anatomy of STEM teaching in North American universities

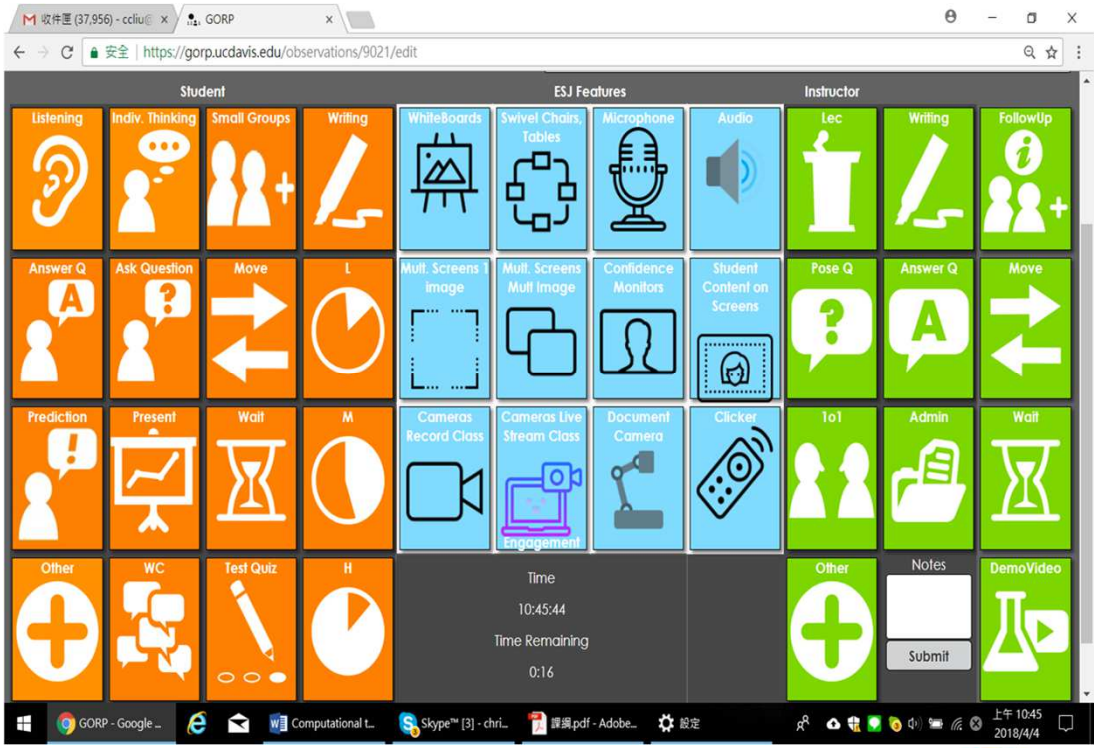
Lecture is prominent, but practices vary

By M. Stains, J. Harshman, M. K. Barker, S. V. Chasteen, R. Cole, S. E. DeChenne-Peters, M. K. Eagan Jr., J. M. Esson, J. K. Knight, F. A. Laski, M. Levis-Fitzgerald, C. J. Lee, S. M. Lo, L. M. McDonnell, T. A. McKay, N. Michelotti, A. Musgrove, M. S. Palmer, K. M. Plank, T. M. Rodela, E. R. Sanders, N. G. Schimpf, P. M. Schulte, M. K. Smith, M. Stetzer, B. Van Valkenburgh, E. Vinson, L. K. Weir, P. J. Wendel, L. B. Wheeler, A. M. Young

and governmental bodies have called for and supported adoption of these student-centered strategies throughout the undergraduate STEM curriculum. But to the extent that we have pictures of the STEM undergraduate instructional landscape, it has mostly been provided through self-report surveys of faculty members, within a particular STEM discipline [e.g., (*3*–*6*)]. Such surveys are prone to reliability threats and can underestimate the complexity of

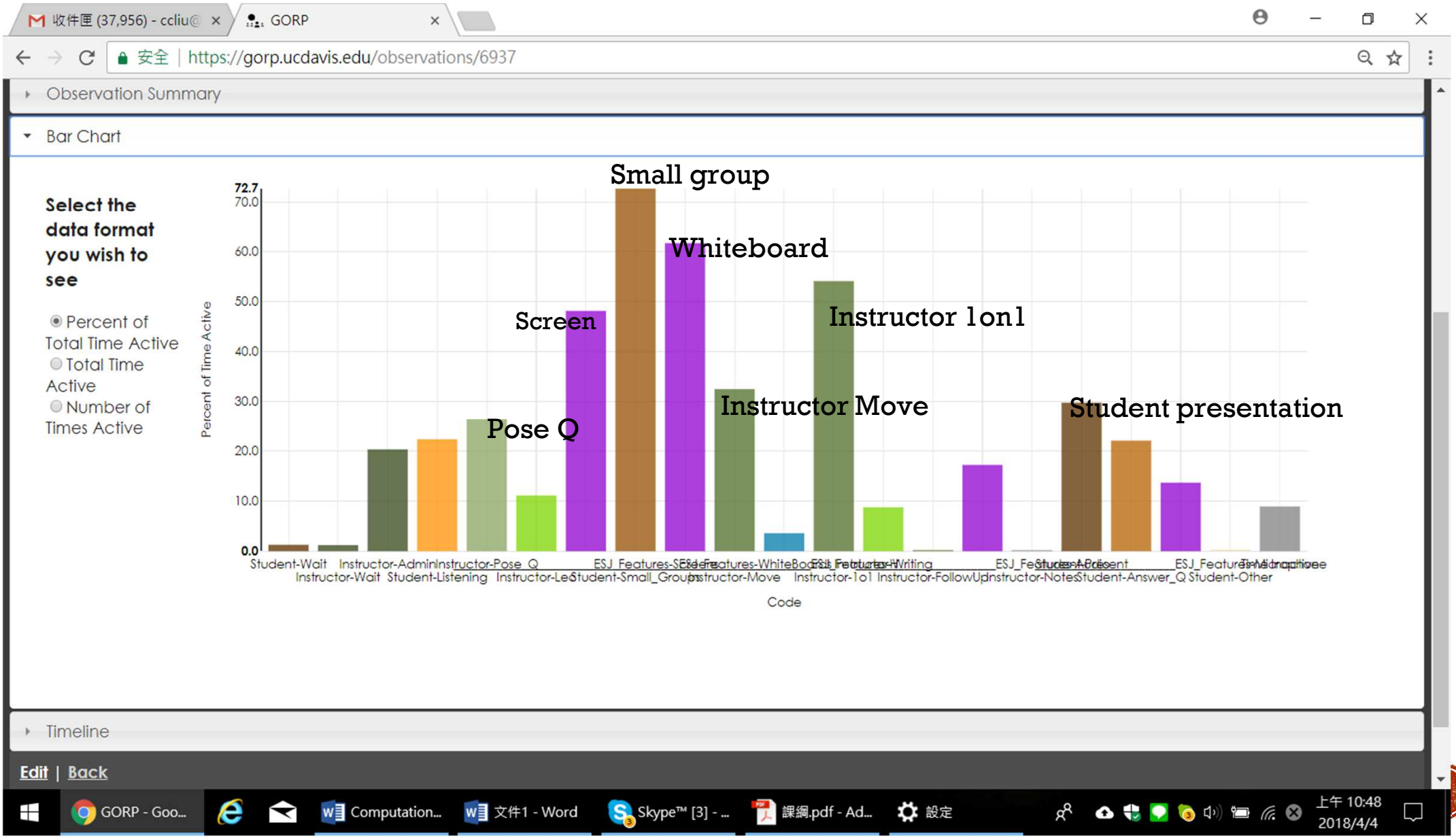
EVIDENCE-BASED RESEARCH

- GORP Class Observation Application developed at UC Davis (https://gorp.ucdavis.edu/)
- Using the PST (Pedagogy, Space and Technology) as the framework to design observation protocol.
- Pedagogy: What teaching/learning activity was observed?
- Space and Technology: What facility or technology was used?



ACTIVE LEARNING CLASSROOM

- One of the TERP classrooms in University of Maryland
- 6-round classroom: round tables with 6 seats for students groups
- White board: Each round table is provided with a white board
- Podium: The teacher computer is connected to the projectors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GORP
安全 | https://gorp.ucdavis.edu/observations/6937
Observation Summary
Bar Chart
Select the data format you wish to see
Percent of Total Time Active
Total Time Active
Number of Times Active
Small group
Whiteboard
Screen
Instructor 1on1
Instructor Move
Student presentation
Pose Q
Percent of Time Active
72.7
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Student-Wait
Instructor-Wait
Instructor-Admin
Student-Listening
Instructor-Pose_Q
Instructor-Lec
Student-Small_Group
Instructor-Move
Instructor-1o1
Instructor-FollowUp
Instructor-Notes
Student-Answer_Q
Student-Other
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Timeline
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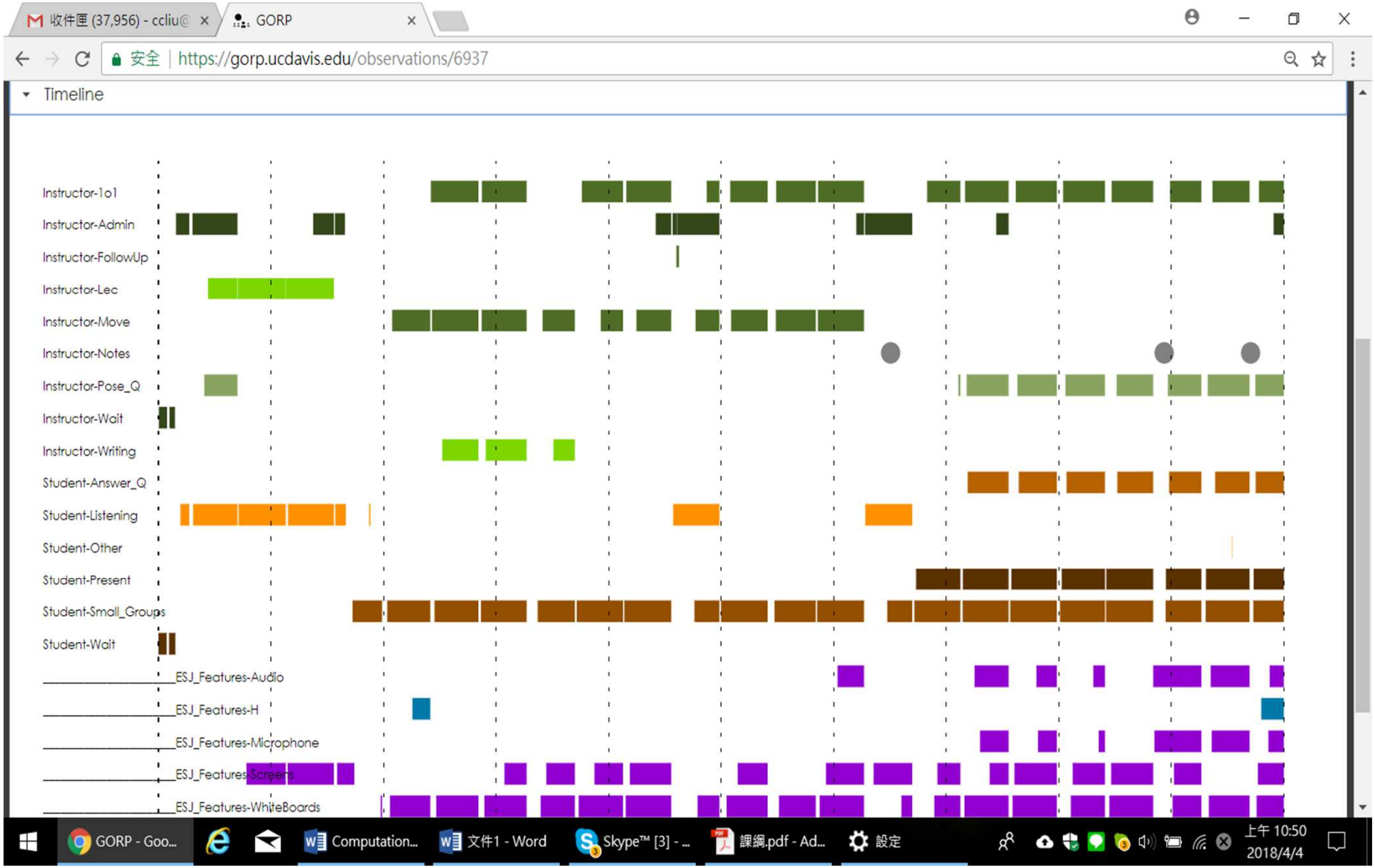
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Timeline
Instructor-1o1
Instructor-Admin
Instructor-FollowUp
Instructor-Lec
Instructor-Move
Instructor-Notes
Instructor-Pose_Q
Instructor-Wait
Instructor-Writing
Student-Answer_Q
Student-Listening
Student-Other
Student-Present
Student-Small_Groups
Student-Wait
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ESJ_Features-Microphone
ESJ_Features-Screens
ESJ_Features-WhiteBoards
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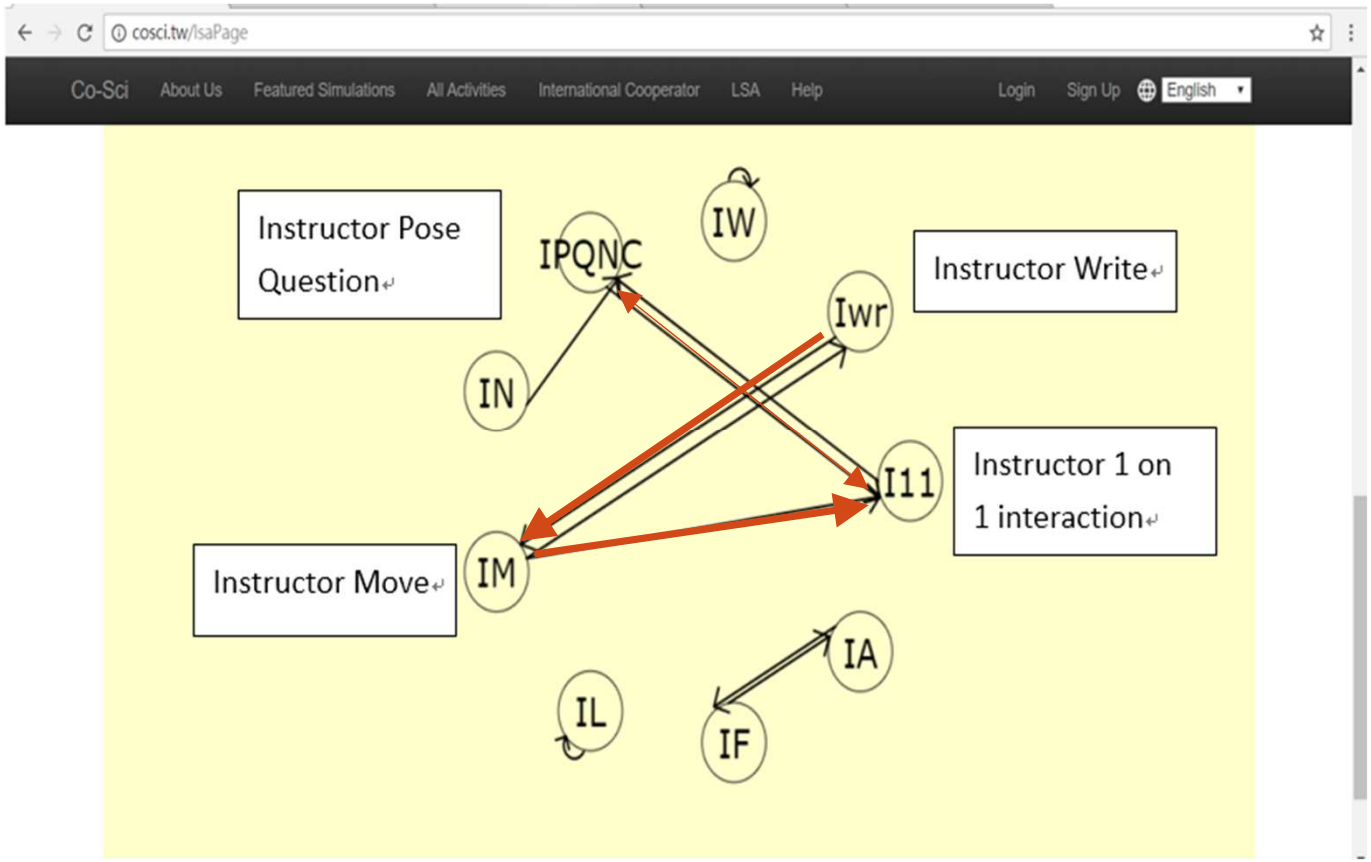
2018/4/4

THE STUDY

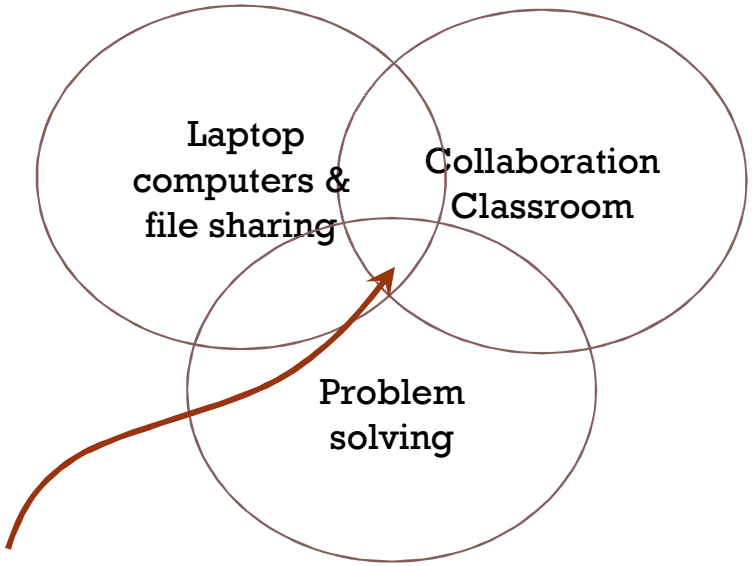
- Lag Sequential Analysis of Classroom Activities (http://cosci.tw/lsaPage)
- Critical instructional path
- Started from posing a question and then 1 on 1 interaction with students
- Moving to interact with students after writing on whiteboard



STUDY 2: COLLABORATION CLASSROOM

COMPLEX PROBLEM SOLVING

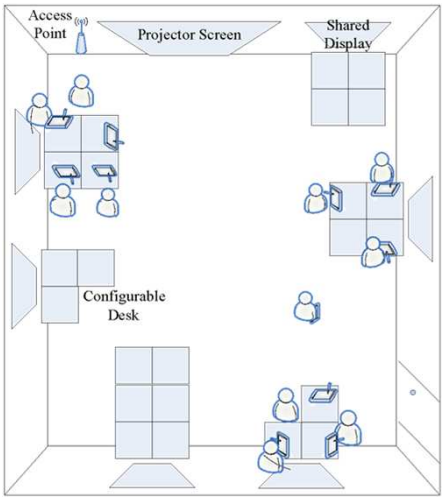
- Collaboration pedagogy: students learn in groups to solve problems.
- Space: a collaboration classroom where tables were arranged to form group workstations
- Technology: students bring their own laptop computers to the classroom

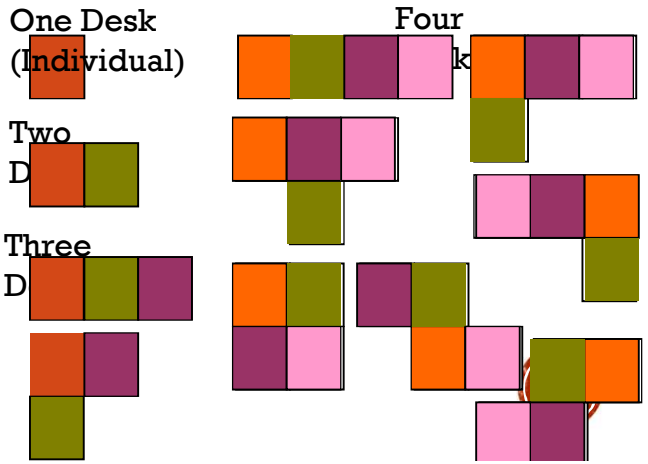


How should technology be used to enhance the pedagogy in the space?

COLLABORATION CLASSROOM

- As an image of how the institute values collaborative learning in 2005.
- The classroom contains six work stations.
- Furniture was designed to flexibly support diverse types of collaborative activities.





PROBLEMS OF TECHNOLOGY

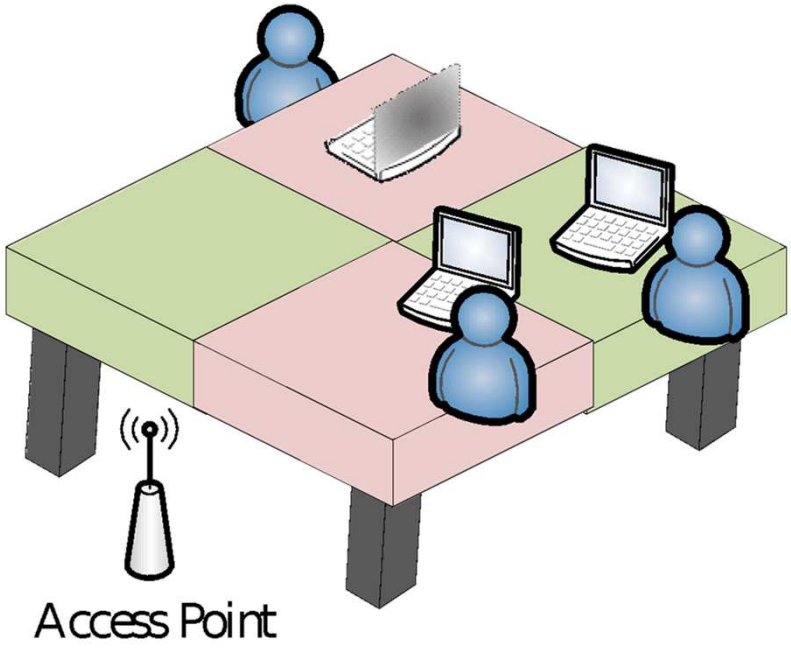
FUSING TECHNOLOGY IN SPACE PEDAGOGY

$$\text{Intimacy} = f \begin{cases} \text{eye-contact} \\ \text{physical proximity} \\ \text{intimacy of topic} \\ \text{amount of smiling} \\ \text{etc.} \end{cases}$$

- *"Eye-contact is linked to affiliative motivation,"* -- Michael Argyle & Janet Dean, *Sociometry, 1965*

THE IMPACT OF SPACE PEDAGOGY

如何在合作學習教室中使用這些平板電腦?



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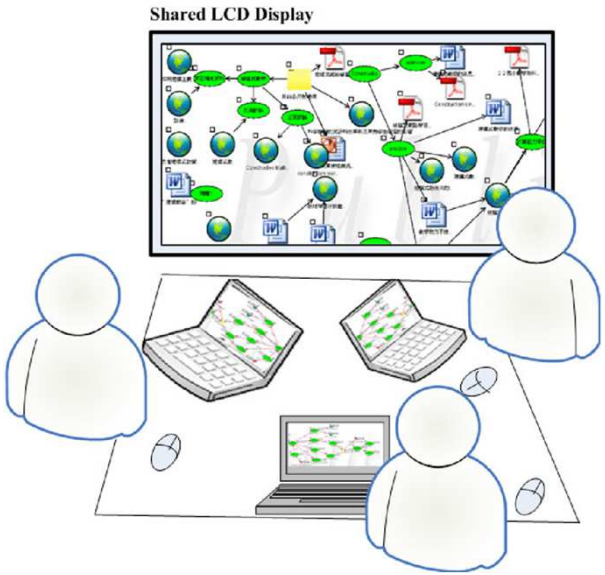
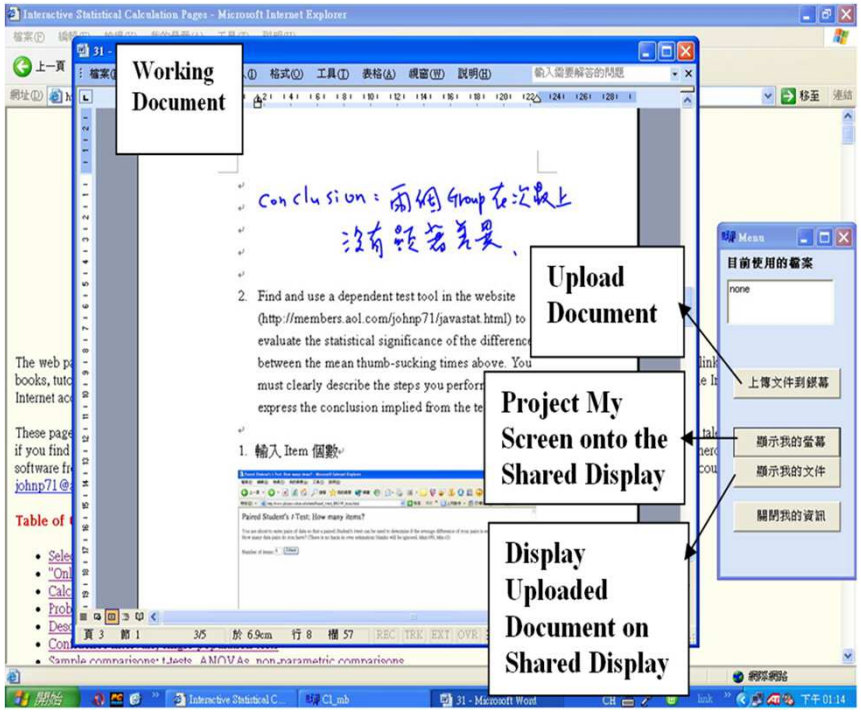


FUSING TECHNOLOGY IN SPACE PEDAGOGY

- **Personal workspace**
  - Sharing their works in personal devices and displaying the documents on the shard display.
  - Projecting screen video from individual device screens to the shared display via the wireless network.

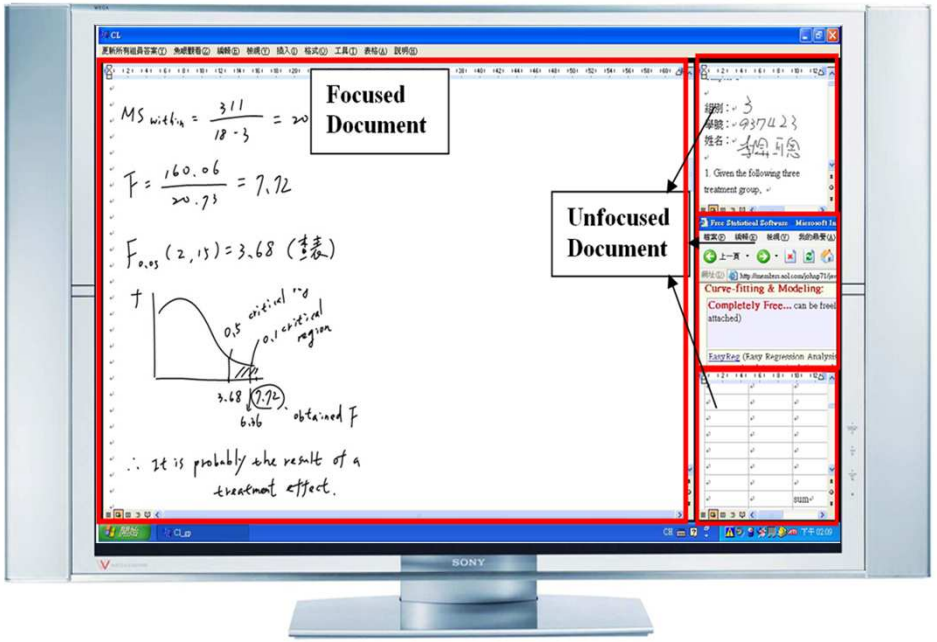


FUSING TECHNOLOGY IN SPACE PEDAGOGY

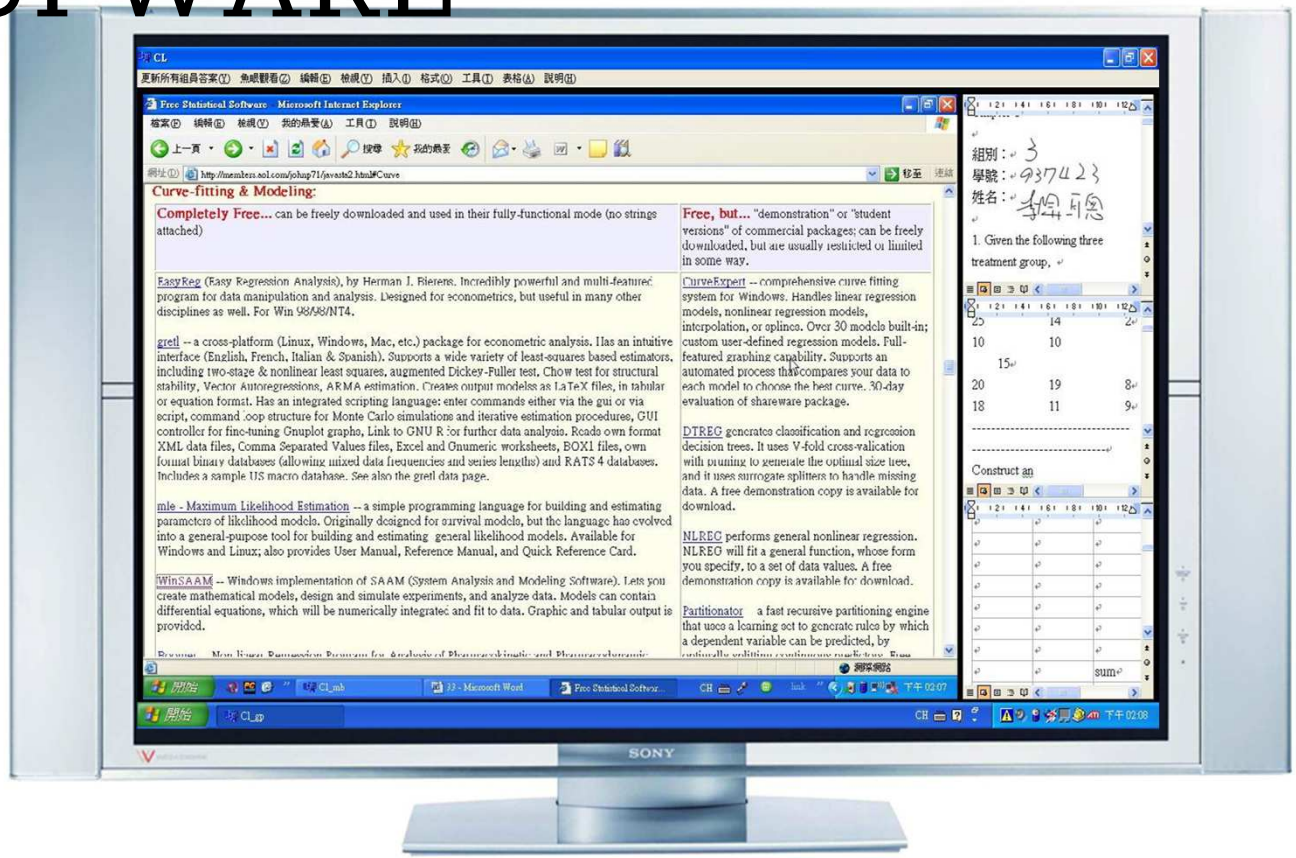
- **Shared display**

  - Displaying all the individual works

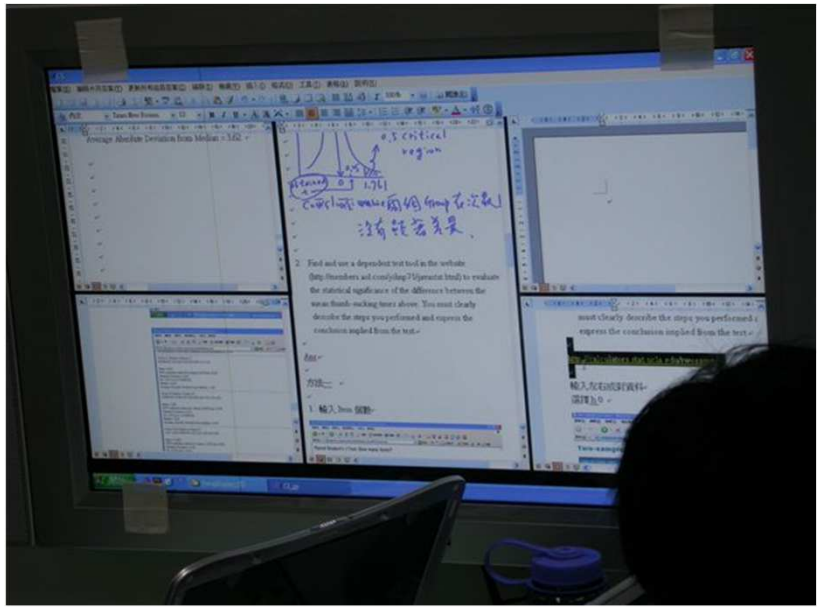
  - Using fish-eye layout in which only the focused document is enlarged while others are shrunk on the shared display.



THE SHARED DISPLAY GROUPWARE



FUSING TECHNOLOGY IN SPACE PEDAGOGY



A COMPARATIVE EVALUATION

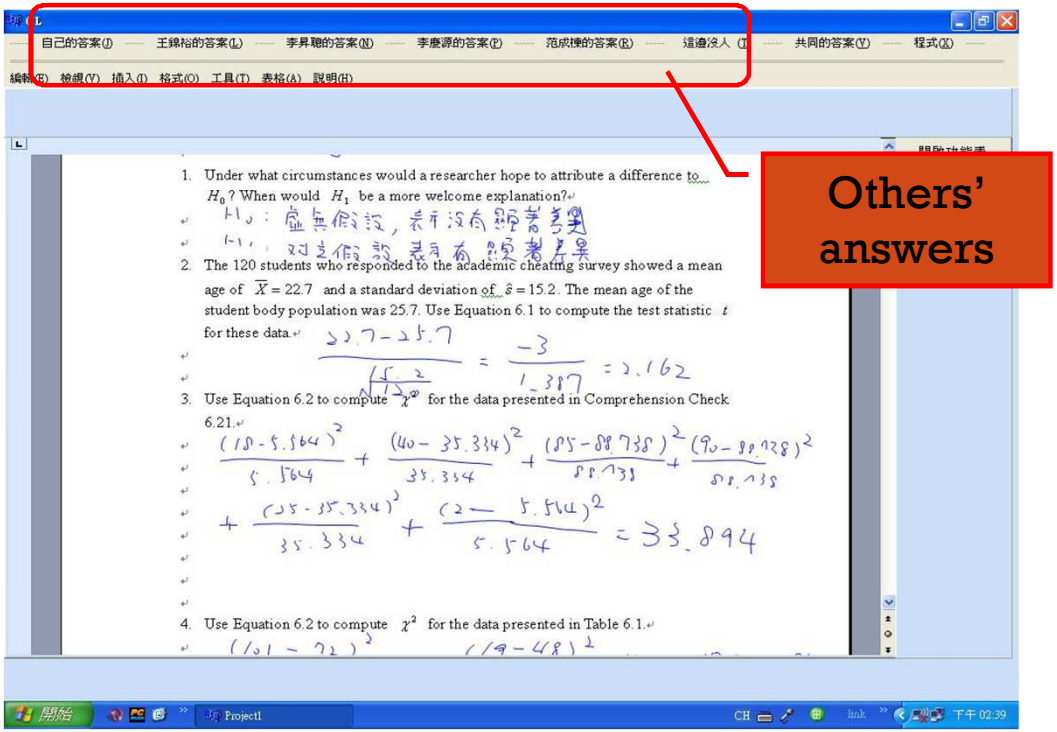
- Comparing student reactions in three settings
  - Tablet-PC-Only setting: Students worked with Tablet PCs only.
  - Network-File-Sharing setting: Students' Tablet PC could retrieve all the working files of each other
  - Shared-Display: students worked: Students worked with the Tablet PC with the shared display

A COMPARATIVE EVALUATION

- Tablet-PC-Only Setting
  - Students used only Tablet PCs to complete and share their individual answers and complete a common answer.

A COMPARATIVE EVALUATION

- Network-File-Sharing setting
  - Students can view the answers of others on their own Tablet PCs through the wireless network and application programs.



A COMPARATIVE EVALUATION

- 12 video cameras on the ceiling to record the collaborative activities of the 6 workstations.
- One targets on the shared display while the other on the whole group activity.
- Microphones were set up right under the displays and tuned to avoid the interference form other groups.

COMMUNICATION BEHAVIOR

-- TABLET-PC-ONLY

- Students naturally communicated mostly with their partners who sat closest to them.
- Students did not share common visual focus while discussing.
- They have to guess others' visual focus.

Video

COMMUNICATION BEHAVIOR

-- NETWORK-FILE-SHARING

- Students view the documents of others on their own Tablet PCs.
- In addition, they have to turn to others' Tablet PCs to know the locations their partners are referring to.
- Students frequently used "location indicators" such as "LEFT" and "RIGHT" while explaining their document.
- They have to guess others' visual focus.

Video

COMMUNICATION BEHAVIOR --

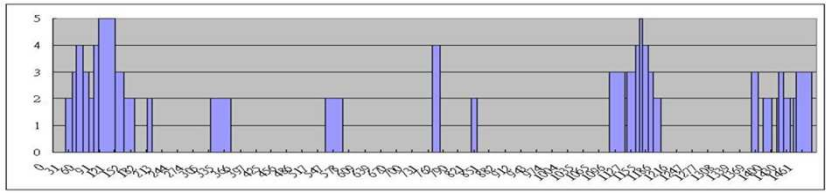
SHARED-DISPLAY

- Students' attentions were attracted to the shared displays.
- Students frequently used their hands to refer to individual documents on the shared displays
- They continued watching the shared displays.

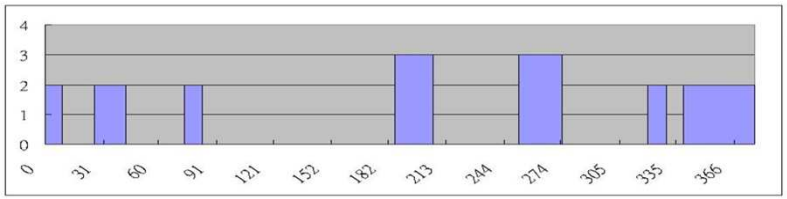
Video

STUDENTS PARTICIPATION GRAPH

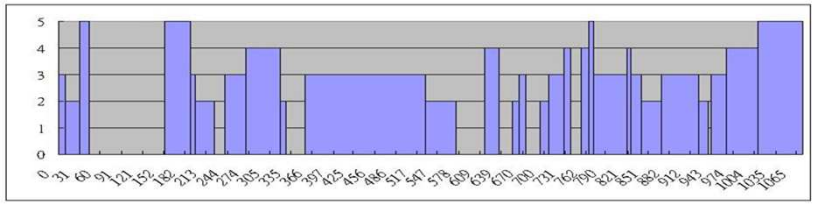
Tablet-PC-Only setting



Network-File-Sharing setting



Shared-Display setting



- Table-PC-Only & Network-File-Sharing : short communication period and low participation rate.

➔Fragmented pattern

- Shared displays: More participants joined the discussion and conversation lasted longer.

HAND POINTING BEHAVIOR

- More frequent pointing behavior in the environments with shared displays.

	Group 1	Group 2	Group 3
Tablet-PC-Only	19	6	8
Network-File-Sharing	2	7	0
Shared-Display 1	12	42	10
Shared-Display 2	25	40	13

EYE CONTACT BEHAVIOR

- **Tablet-PC-Only environment:** high eye contact frequency
- **Network-File-Sharing**: Most students focused completely on their own Tablet PCs.
- **Shared-Display environment**: Students were attracted to the shared displays and continued watching the shared displays.

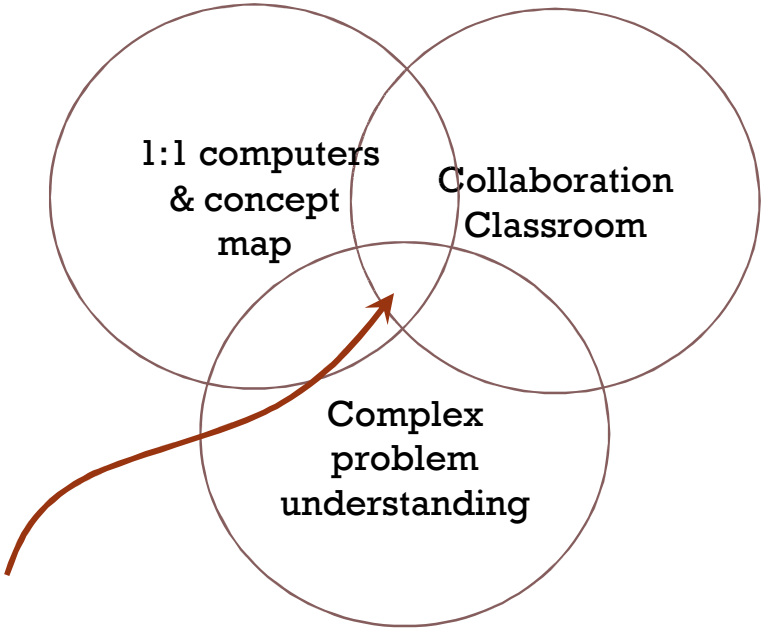
	Group 1	Group 2	Group 3	
Tablet-PC-Only	79	73	77	High
Network-File-Sharing	20	34	7	Low
Shared-Display 1	31	66	23	
Shared-Display 2	32	31	16	

Shared focus

STUDY 3: COLLABORATIVE CONCEPT MAPPING

UNDERSTANDING COMPLEX SOCIAL PROBLEM

- Pedagogy: students learn in groups to advanced their understanding of complex social problem.
- Space: a collaboration classroom where tables were arranged to form group workstations
- Technology: students bring their own laptop computers to the classroom



How should technology be used to enhance the pedagogy in the space?

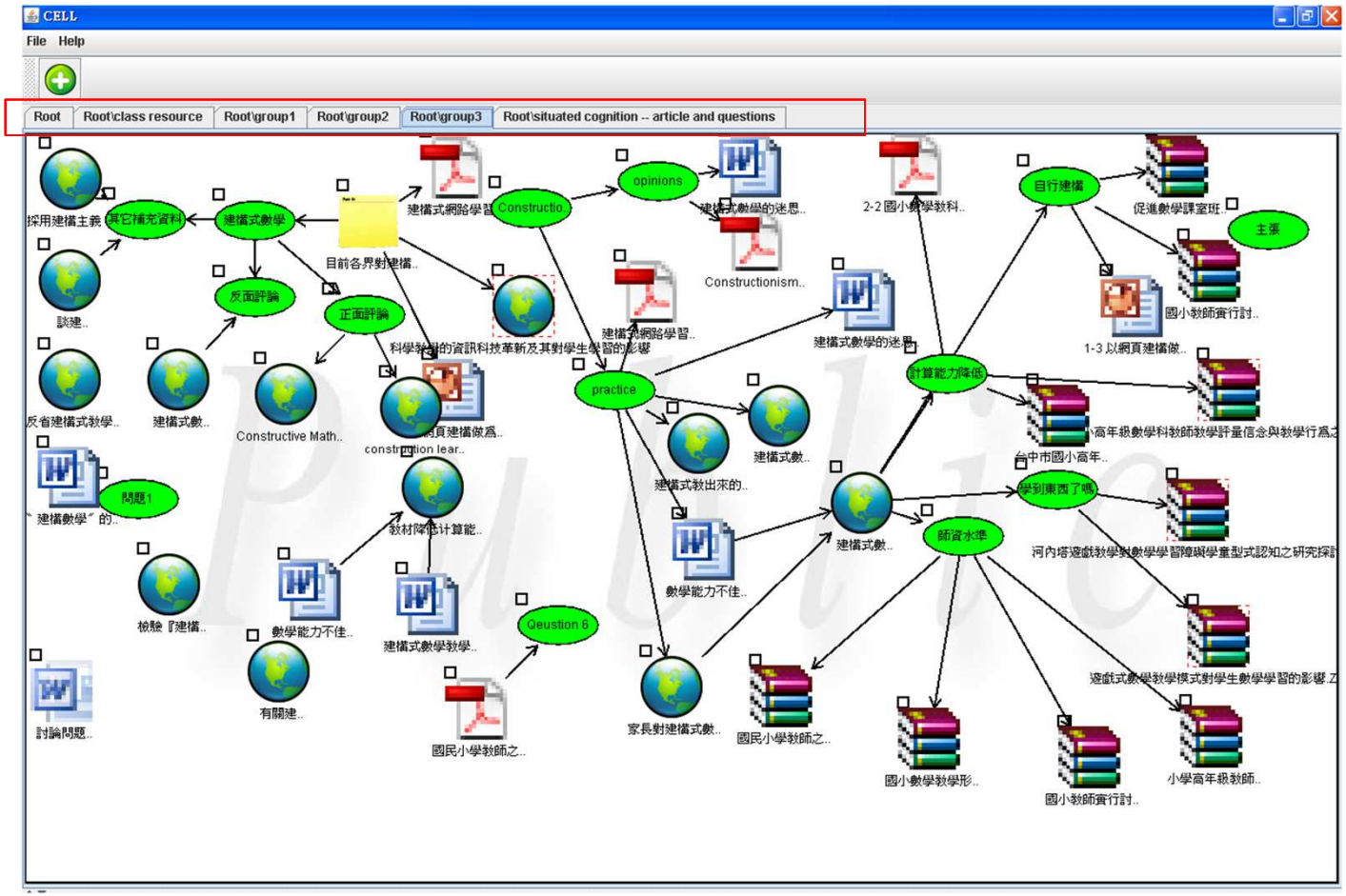
UNDERSTANDING COMPLEX SOCIAL PROBLEM

- Students collaborated to form a perspective on complex social problems.

Taiwan's nationwide constructivist-approach of mathematics curriculum has been ongoing for 12 years. Parents and teachers complain the effectiveness of the curriculum and express the desire to resume the ‘traditional’ curriculum.

If you are a teacher in an elementary school, what can you do in response to the society’s voice?

Customizable class structure: whole class work area, group work areas

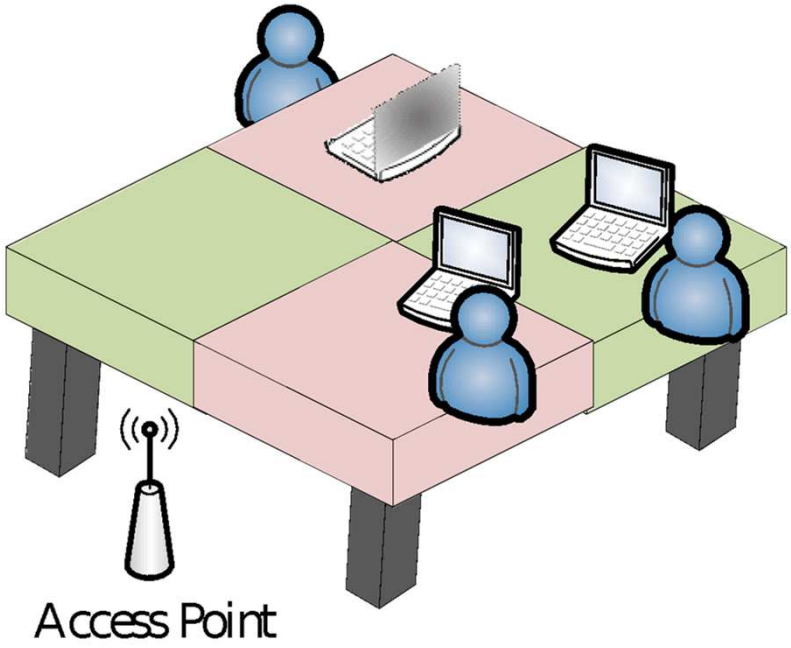


Several sharable items: Web links, documents (Word or PDF), concepts, and open-ended reflections

Video

THE IMPACT OF SPACE PEDAGOGY

如何在合作學習教室中使用**Concept Map**軟體?



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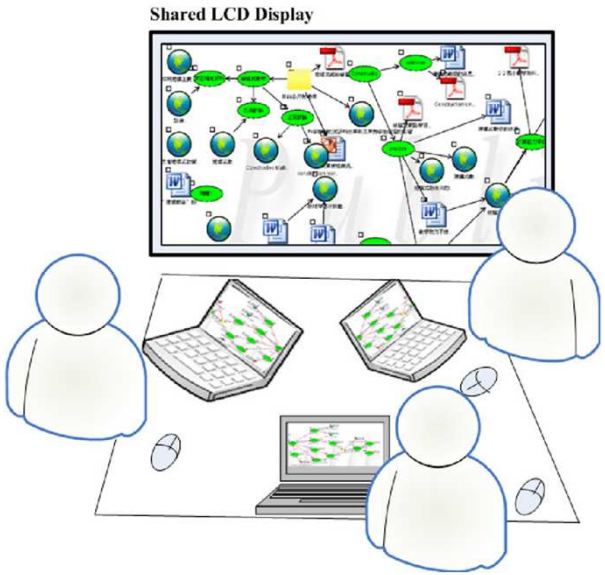
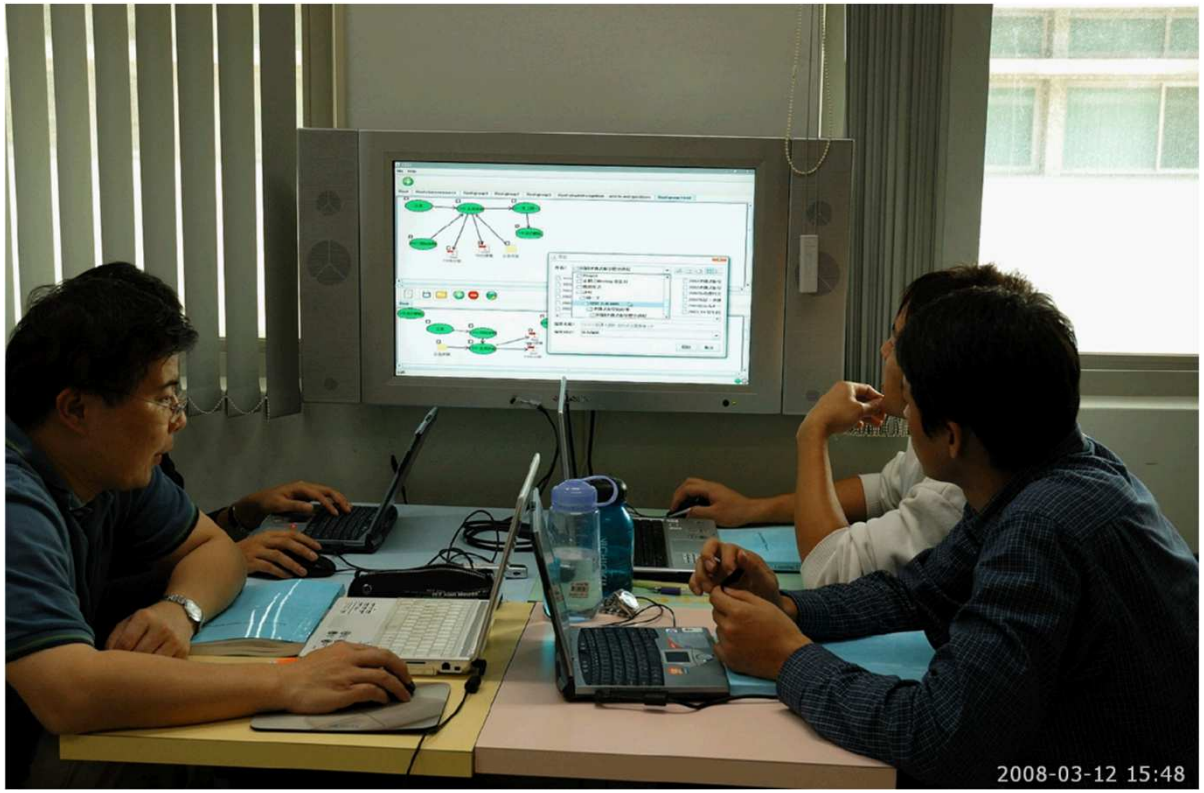


FUSING TECHNOLOGY WITH SPACE PEDAGOGY

- Personal device: individual searching, reading, and reflection

- Shared display: group shared focus, integration of resources and ideas



RESULTS(CONCEPT MAP)

Table 1. Statistics of the students' mind mapping behaviours

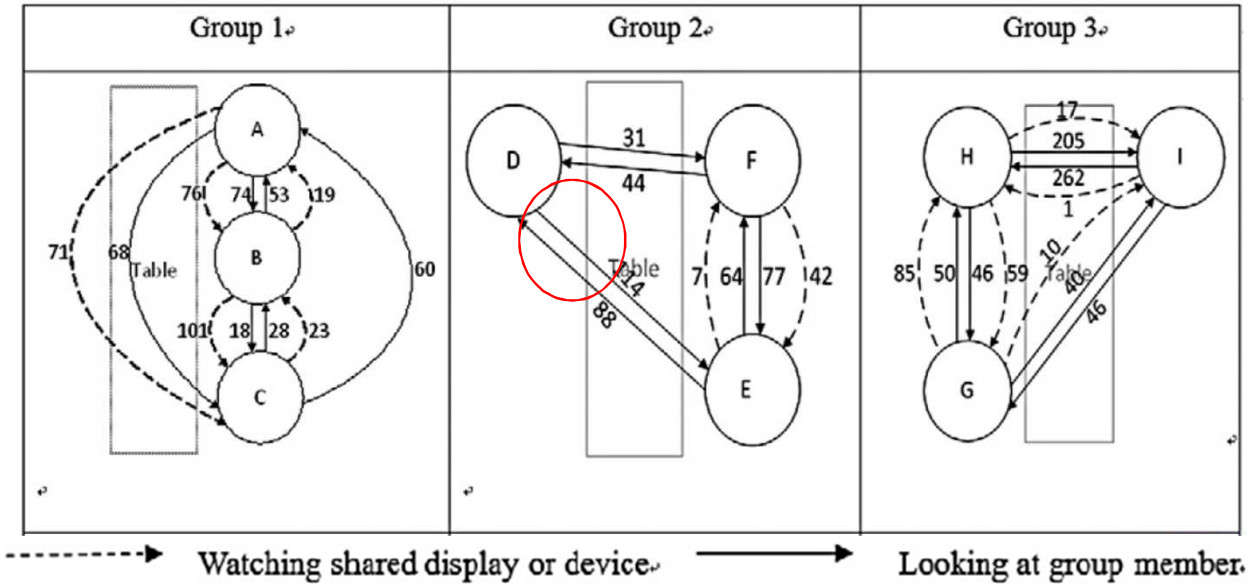
	Non-SDG	SDG
Number of IBIS nodes	21	33
Number of reference nodes	39	52
Number of summary nodes	10	14
Times of being browsed (all nodes)	191	505
Times of being browsed (per node)	2.73	5.1

IBIS = issue-based information system; SDG = shared-display groupware.

- The students generated significantly more IBIS nodes with the SDG.
- More reference nodes with the SDG
- They browsed the nodes more often with the SDG.
- The visually shared workspace of the SDG makes it easier for group members to be aware of the nodes shared by others

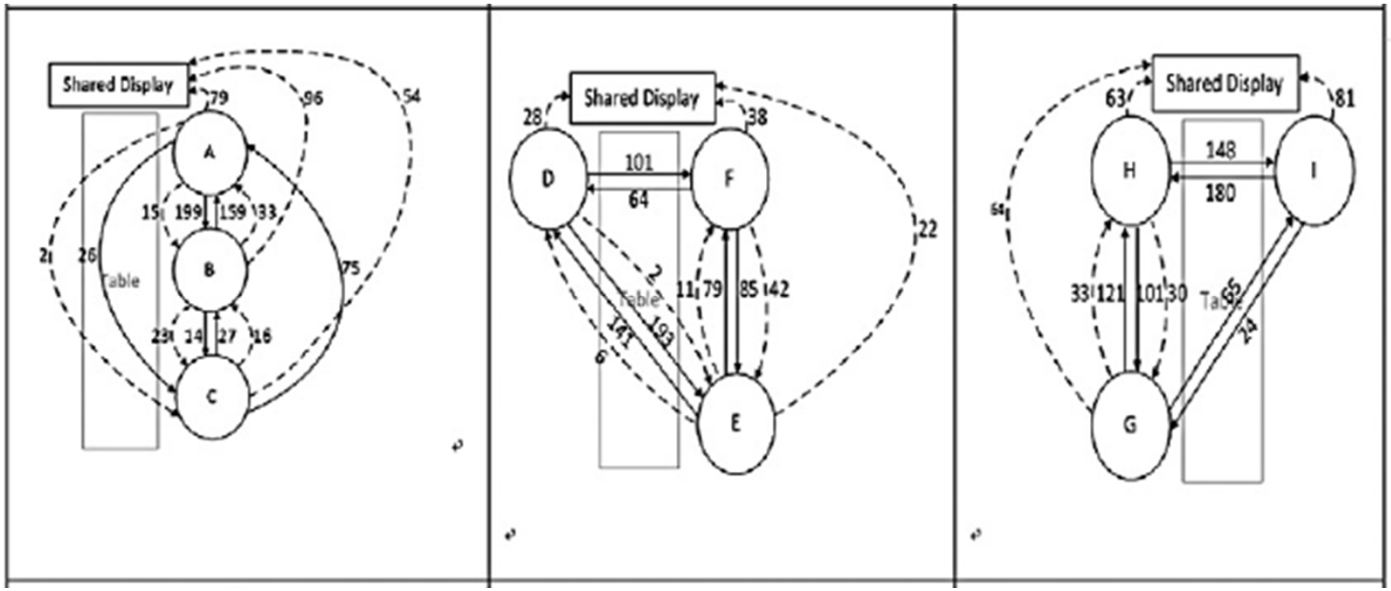
RESULTS(VISUAL FOCUS)

- Students' visual focus was distributed among all the members mobile computers without a common centre.
- The physical location may have limited the communication between the students who were not sitting close together.



RESULTS(VISUAL FOCUS)

- The shared display was referred to most frequently.
- Almost all members of each group, regardless of their physical location, watched the shared display more frequently than they watched
- The SDG helped establish a joint discussion in which all the members can easily participate.



ECOLOGICAL DESIGN OF LEARNING ENVIRONMENT

當環境改變時，物種會慢慢隨之改變

ECOLOGICAL DESIGN OF LEARNING ENVIRONMENT

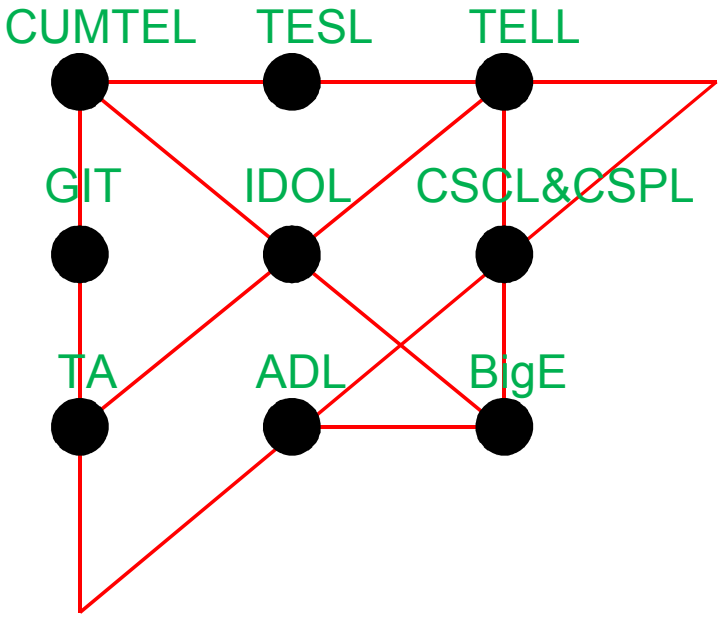
- Computers do not exist in an empty space where they are the only objects that students can learn with.

- Learning environment should be designed based on ecological principles:
  - Variety of perceived space pedagogy
  - The environment involves multiple entities including computers, furniture, teachers, and peers
  - Each entity may display a certain affordance.
  - One entity may promote or hinder the effectiveness of another entity.
  - The combination of entities may show a different affordance .

OPEN ISSUES AND FUTURE WORKS

- What is the evaluation framework to evaluate educational buildings and spaces? Lightening, air conditioning, material, interior design..
- Teachers participate in educational building construction project?
- How technology development team, educators and architects work together?

面對問題時人們常受限於固著的思考習慣(Weisberg & Alba, 1981)



THANK YOU!