THE UNIVERSITY OF HONG KONG 香港大學
faculty of architecture 建築學院

cib W78 2023 EC³

Invigorating AEC education using Minecraft:
A case of LiDAR surveying and virtual learning

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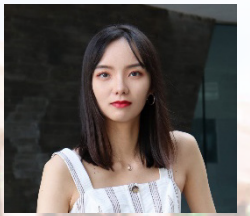


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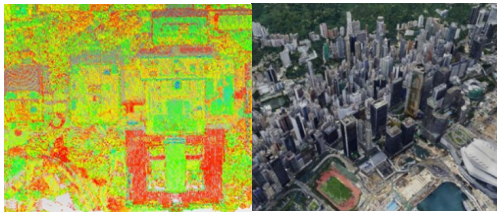
1. Background - subject

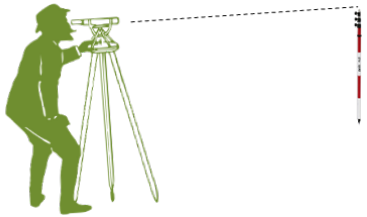
- City evolves, e.g.,
  - New underground dev.
  - Slowly aging buildings
- Surveying is always demanded

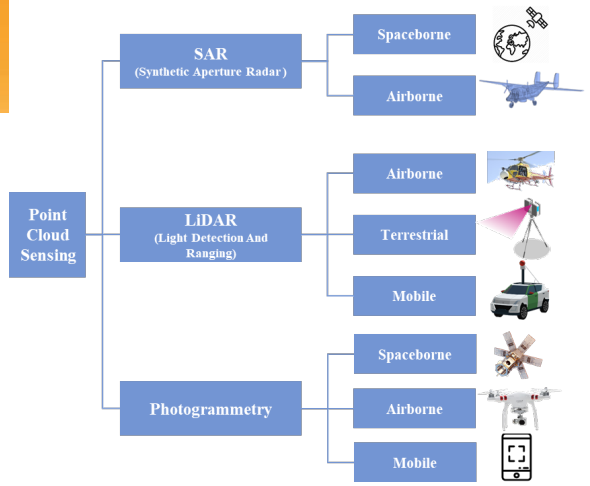
- Surveying tools evolve, too
  - Theodolite (1787)
  - Laser scanner (1993)
  - Color laser (2018)
- Complex data and operations
  - To teach

(Sources: info.gov.hk)



(Sources: Authors 2019, 2022)

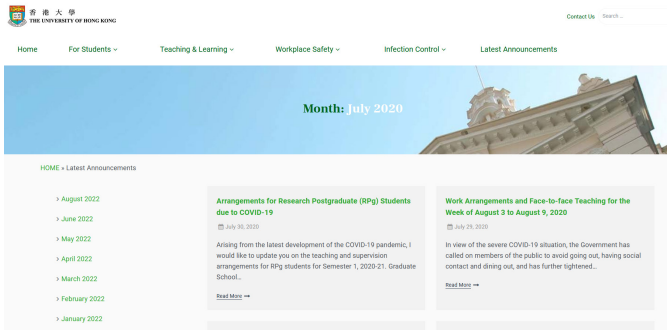




(Sources: Authors 2018)

1. Background - challenges

- Online/mixed teaching mode is necessary
  - Social unrest in Hong Kong (2019)
  - Covid-19 impacts (2020-22)
- Video conferencing software is good, yet we …
  - Experiential learning (e.g., surveying)
  - Interactive, creative 3D contents
    - Hard on a shared video conf. screen
  - Motivating and collaborating students as groups
- Generation Z students
  - born in 1997~2015
  - Internet native
  - Not favor traditional lecturing



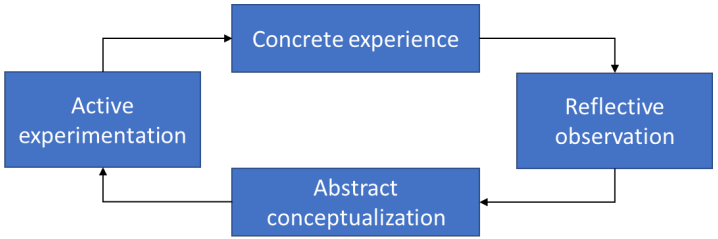
2 Opportunity

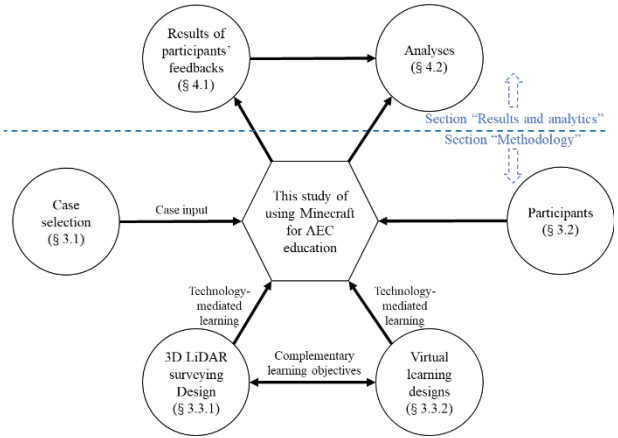
- Minecraft Education Edition (MCEE)
  - Programmable education sandbox platform for 3D worlds
    - A world's top popular game (180M monthly active players)
    - Multi-user interaction (LAN/Internet server)
    - Familiar by Gen-Z
    - With Python/Scratch coding interfaces
  - Free for all HKU staff/student accounts
  - Available for laptop (Mac, Win), iPad, phones
- Example cases
  - UC Berkeley's 2020 virtual graduation ceremony (a)
  - UPenn's virtual student event in 2020 (b)

(source: ABC News 2020; BI 2020)

3 Research design

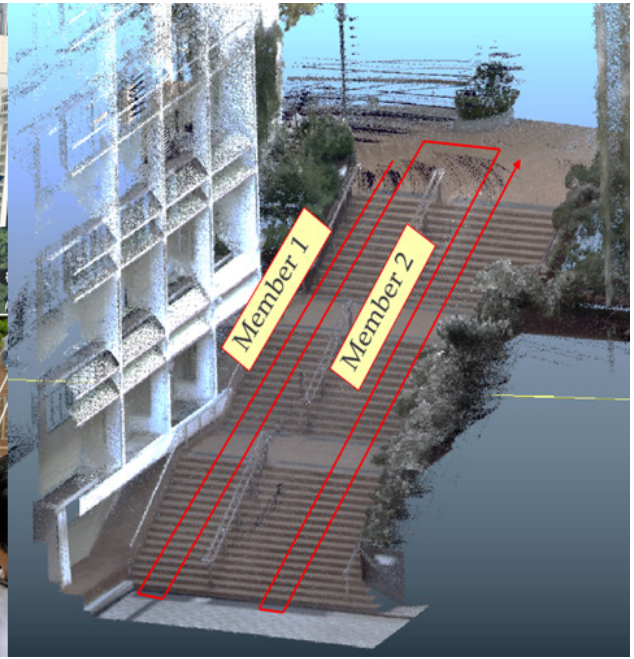
- Pedagogical theory
  - Experiential learning
  - Dewey and Kolb's (1984) cycle model
- Focus in this paper
  - Interactive learning and co-design with groupmates
    - In a shared virtual world, not a shared screen
- Objectives
  - To try MCEE's delivering of 3D T&L contents
    - E.g., gamified urban model to *Gen Z* students
  - To promote group co-design and co-creation with a shared virtual environment in MCEE





4 Case 1: Mobile LiDAR surveying

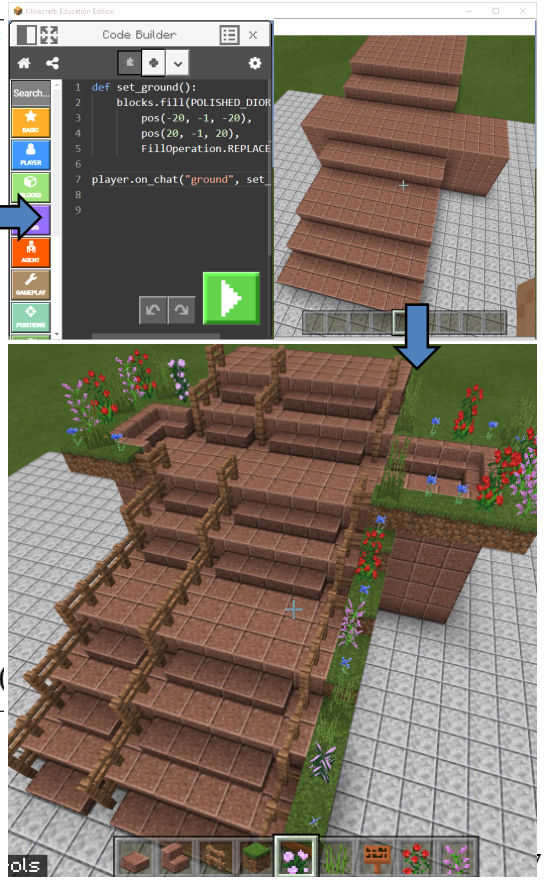
- Case area
  - S.Y.S. Steps
  - Next to our Dept.
- 3D surveying
  - In group
  - With operation tips and guides
- Device: a mobile laser scanner
  - Paracosm PX-80
  - 3 sets



4 Case 1: As-built modeling with MC

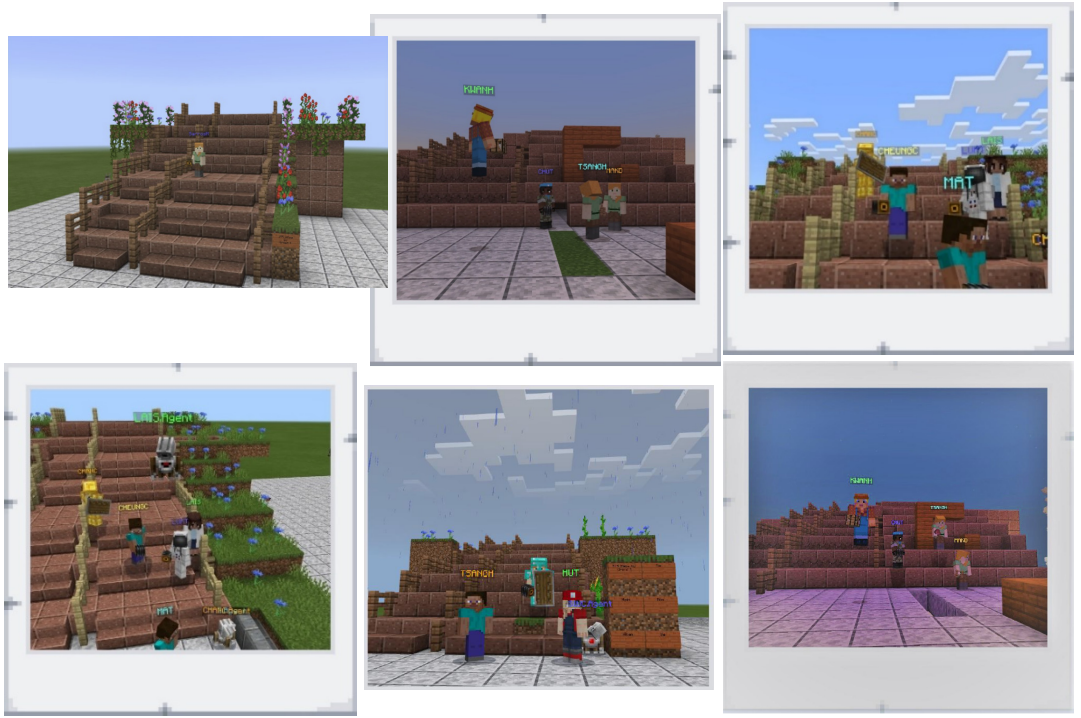
- 3D measurements
  - WDH, slope
- Modeling
  - Python code for regular parts
    - Automatic (1-click)
  - Student's detailing/design


```
def fill_block(mat, x1, height1, depth1, x2, height2, depth2):
    blocks.fill(mat,
        pos(x1, height1, depth1),
        pos(x2, height2, depth2),
        FillOperation.REPLACE)

def sys_steps():
    my_mat = POLISHED_GRANITE
    # first 1/3 of the first flight path
    fill_block(my_mat, 0, 0, 1, 8, 0, 1)
    fill_block(my_mat, 0, 0, 2, 8, 0, 2)
    # repeat 3 times
    for j in range(0,3):
        h = j * 2
        h += 1
        d = j * 6
        d += 3
        # two steps on the flight paths
        fill_block(my_mat, 0, 0, d, 8, h, d)
        fill_block(my_mat, 0, 0, d+1, 8, h, d+1)
        fill_block(my_mat, 0, 0, d+2, 8, h+1, d+2)
        fill_block(my_mat, 0, 0, d+3, 8, h+1, d+3)
        # landing areas
        fill_block(my_mat, 0, 0, d+4, 8, h+1, d+5)
    fill_block(my_mat, -4, 0, 11, -1, 4, 14)
    fill_block(my_mat, 9, 0, 11, 10, 4, 14)

player.on_chat("steps", sys_steps)
```



4 Case 1: Feedback from RECO7613

- Top entries in students' SFTL
  - "Requires my active participation"
  - "Stimulated me to be creative"
- Every student enjoyed interactive T&L with friends
  - A creative scene: Setting fire on fire gathering points
  - Student B: "There are even more benefits compared with traditional education, such as digital liberty, social skills and online security."



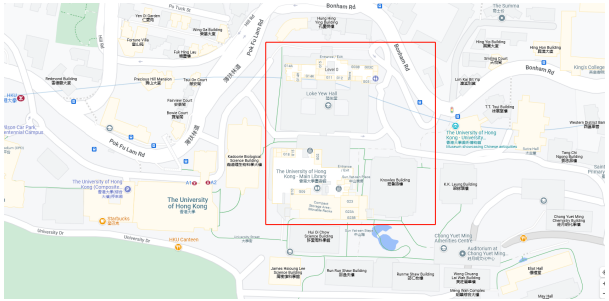
(Sources: RECO7613 21/22)

5 Case 2: Underground facility

- MTR West Island Line
  - under Main Building, HKU
  - Many do not realize
- MC model
  - Under campus
  - With transparent sections
  - (Note: distance to ground reduced by ~40m)

5 Virtual HKU campus above the metro line

- Coverage



- Details
  - Exteriors
  - MTR West Island Line
- Limits
  - 20 players in one world

6 Summary

- Summary
  - Minecraft (MCEE) is programmable media for smart city T&L
    - Helping educators on 3D interactive T&L contents
      1 As-built 3D modeling
      2 Underground facilities
    - Enriching students' group learning experiences
  - Minecraft model is friendly to co-design and co-create
    - Promoting learners-interaction and teamwork
- Future work
  - Extension to other complex 3D surveying T&L
    - E.g., concrete subsurface scanning
  - Extension MCEE's measurement APIs to sustainability T&L
    - Materials, quantity, and CO2 estimation

(Sources: Authors 2022)

Acknowledgement

- Funding support
  - Small Equipment Grant (60%, No. 207051055) + Stanley Ho Alumni Challenge (SHAC)
    - Mobile Color LiDAR Scanners
  - HKU Teaching Development Grant (A/C No.: 101002041)
    - Multi-user Internet Narrative Environment of HKU (MineHKU) for smart city courses and virtual campus events
- Minecraft models and Python codes
  - Free for HKUers
  - Available for research purpose on request

Unleashing Gen-Z students' potential with new T&L!

Q&A