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STEM/STEAM initiatives in Undergraduate Music Education

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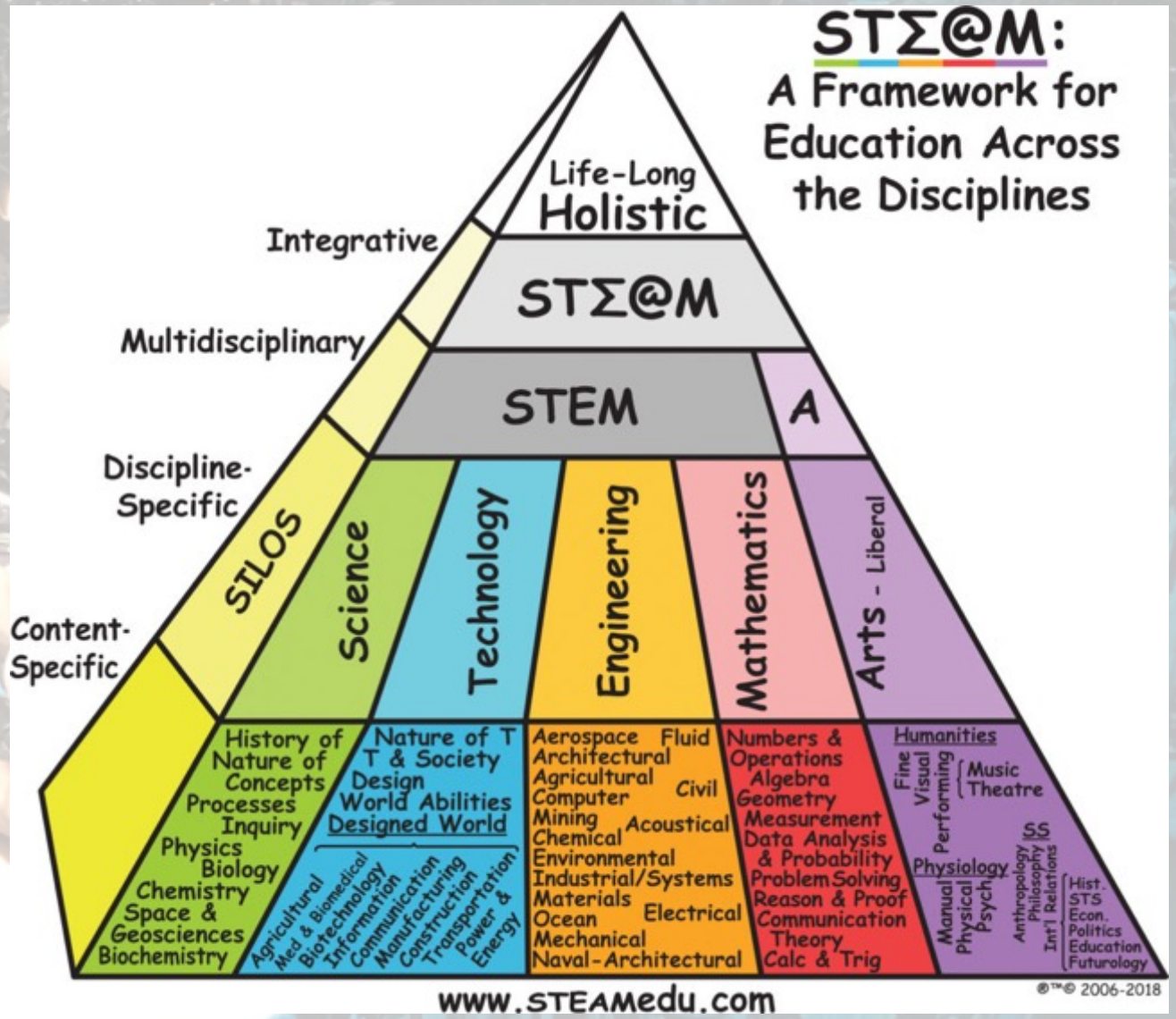
Why STEM?

- Science, Technology, Engineering, Mathematics
- In response to the increasingly complex and diversified world
- The needs for interdisciplinary approach in education
- Different attributes (Partnership for 21st Century Skills, 2011)
  - Information and computer literacy, leadership skills, creativity
  - communication skills, critical thinking and problem-solving skills

Why STEAM

- Variation of STEM
- Drawing on design principles for creative solutions (Jolly, 2014).
- Application of STEM into the Arts
- Better integration of the disciplines for arts solutions (Rinne, Gregory, Yarmolinskaya & Hardiman, 2011; Miller & Knezek, 2013).

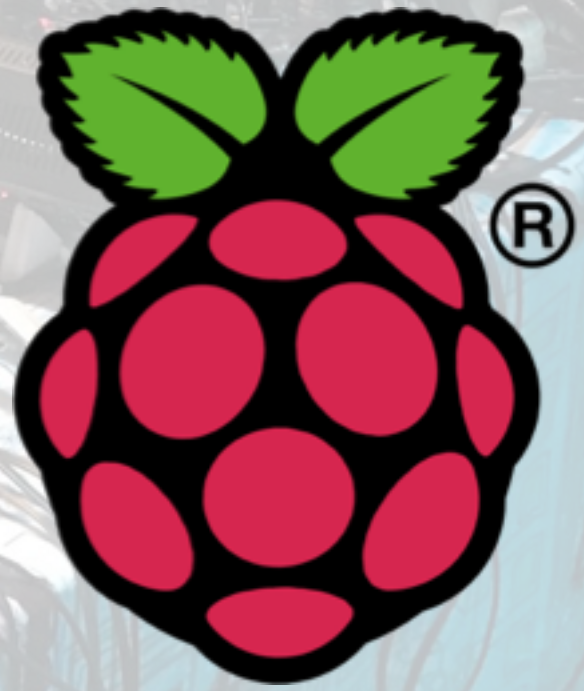


1. Live coding

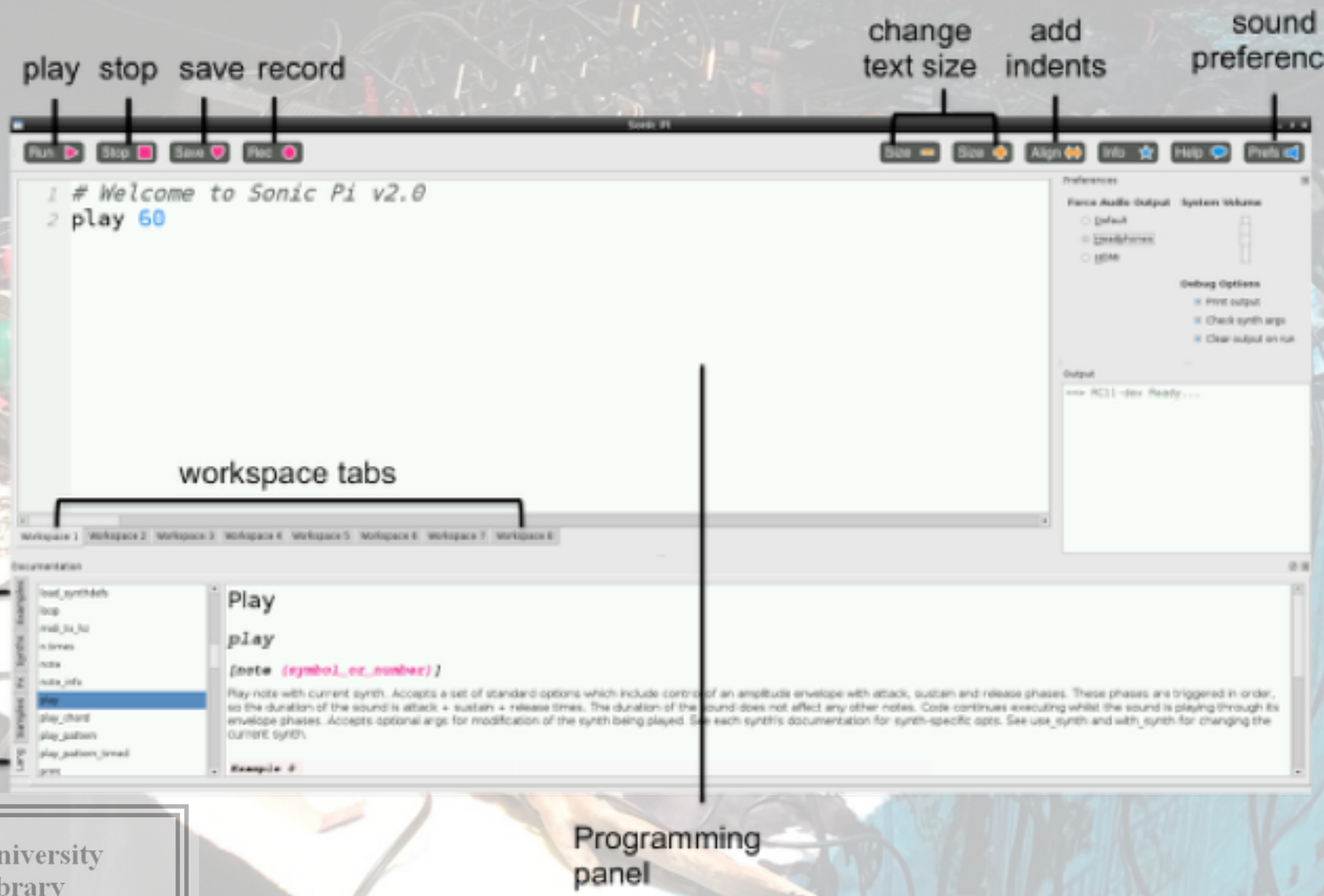
- A performing arts form featuring
  - The writing of source code
  - The use of interactive programming
  - Improvisation, i.e. composing and playing music at the same time

(((Sonic π)))

- Live coding environment
- Designed to support both computing and music lessons in schools
- Free and cross-platform
  - Windows, MacOS, Linux, Raspberry Pi

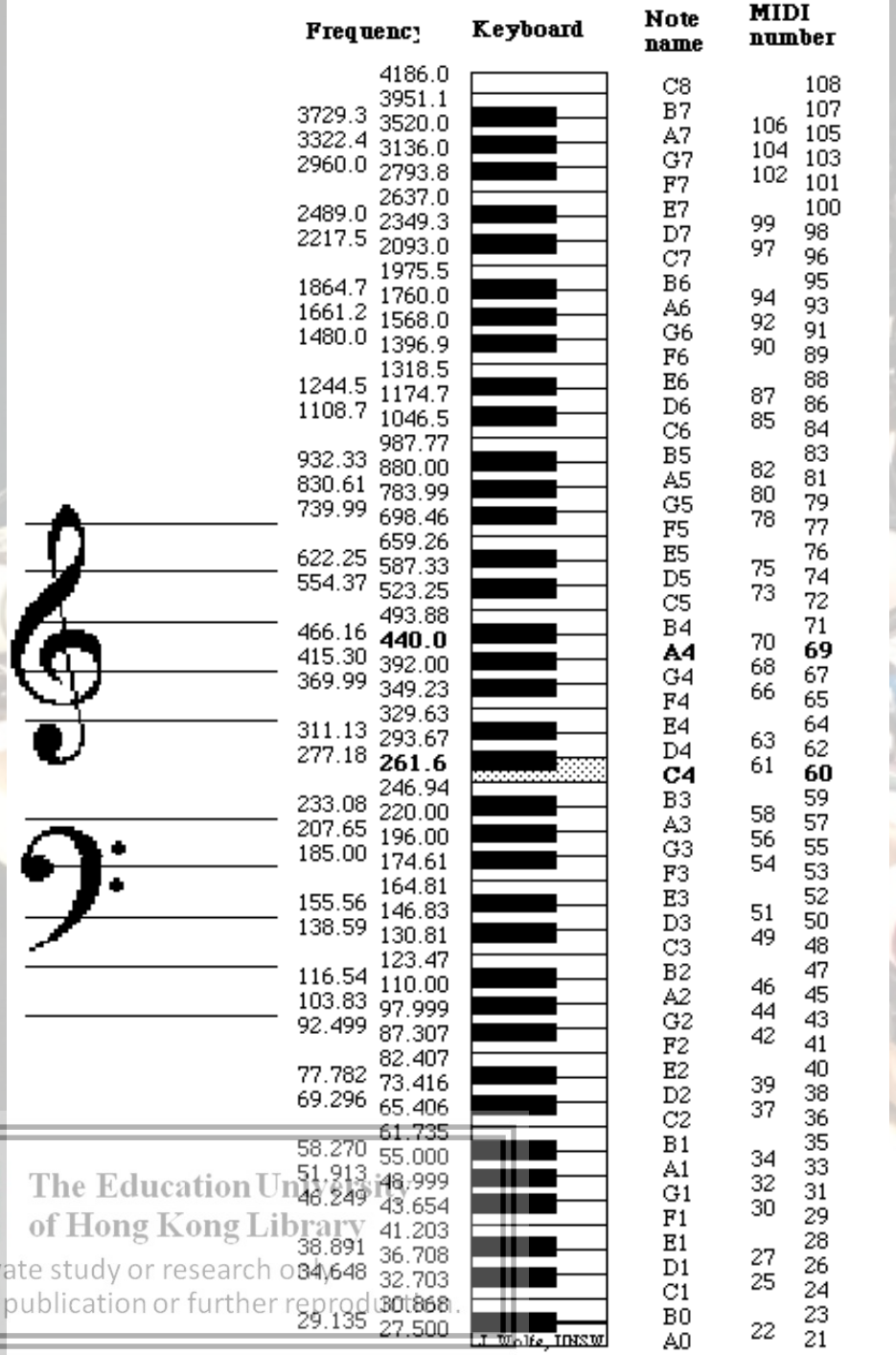


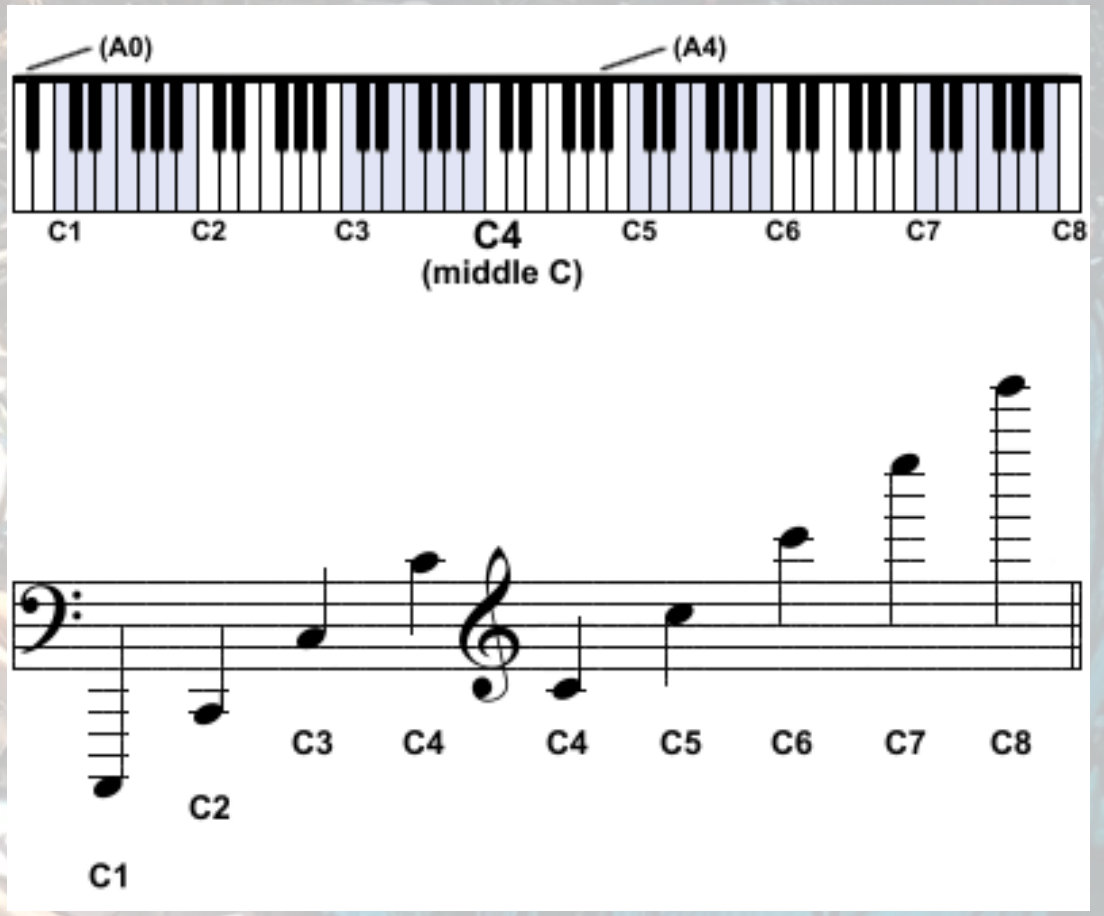
Sonic Pi: Live & Coding



play

- play :C4
  - Play the note C4 (with default synthesizer)
- play 60
  - Play the note with MIDI number 60 (i.e. C4)
- play :60
  - What happen?





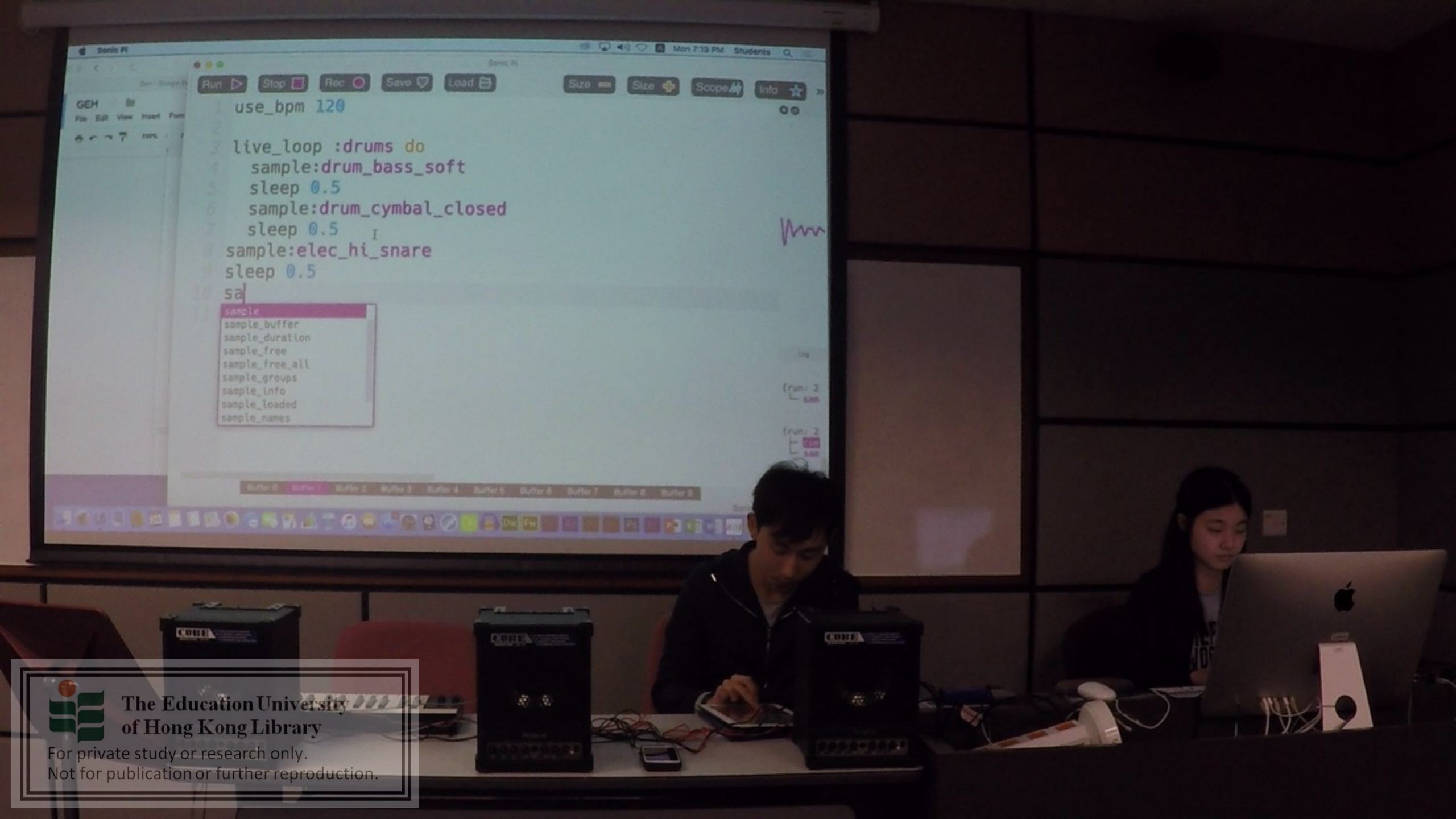
sleep

- sleep 1
  - Wait for one beat. Try and listen the differences of the two codes:
- play :C4
  play :E4
- play :C4
  sleep 1
  play :E4

loop

- loop the quoted commands (The best thing computer can do)

```
• loop do
      play :C4
      sleep 1
      play :E4
      sleep 1
  end
```



Semi-structured interviews (Cheng, in press)

- 39 undergraduate students from EdUHK
- Took part in the general education course *Introduction to Music Technology* in 2017
- Consists of both music education students and non-music majors

Findings – Experience in live coding

- *I never learned programming before, and when I was asked to write a piece of code for music, I made a lot of mistakes with computer grammar (syntax), and I spent a lot of time fixing those problems. Sometimes I didn't even know what the problem was. (Student D)*
- *The most difficult part for me was memorizing the code. This is similar to learning a new language, in that we have to memorize words and their structures. (Student E)*

Findings – Experience in live coding

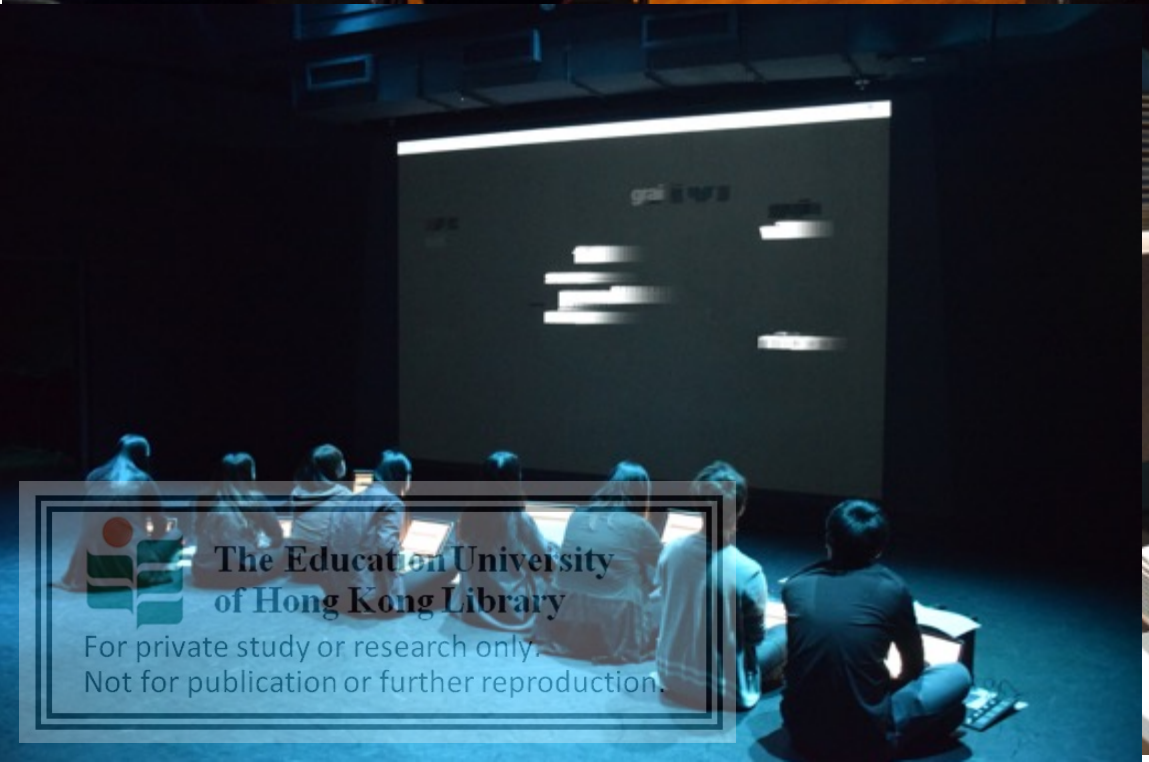
- *I have certain ideas on what programming can do in terms of music performance, and yet it's difficult to put these into practice. It's hard for me to write an algorithm that performs music by itself, as I had hoped. (Student G)*
- *I tried to search for some examples from the internet to solve my problem, but there was nothing available. It's much harder to find references than other types of programming. (Student H)*

Live coding as a STEAM activity

- Perform music with computer music skills
- Technological and mathematical way to interpret music
- An alternative way of music performance for non-instrumentalists

2. Laptop orchestra

- Perform music collaboratively *with* and *through* computers in a socially and musically connected environment (Crook, 1994)
- Previous research for students' development of musical skills:
  - Aid social construction/shape creative identities (Ben-Tal & Salazar, 2014)
  - Development of aural skills, musical and creative thinking, engagement in the music learning process (Manaris, Stevens & Brown, 2016)



Survey & semi-structured interviews (Cheng, in press)

- 80 music education undergraduate students from EdUHK
- Members of the EdUHK laptop orchestra (n=80)
- Members of the EdUHK orchestra (n=80)
- To compare the differences of musical skills development in laptop orchestra

Findings – Survey results

		Mean	Standard Deviation	p-value
Ability to listen to other players during ensemble playing	Laptop	3.83	0.85	0.023
	Orchestra	3.74	0.95	
Ability to use physical gestures or eye contact to communicate with other players	Laptop	3.50	0.94	0.025
	Orchestra	3.66	0.80	
Ability to adjust my dynamics nuance in my part as the music goes	Laptop	2.94	1.04	0.000
	Orchestra	3.69	0.61	
Ability to make corresponding adjustments from the conductor's cues	Laptop	3.81	0.77	0.036
	Orchestra	3.75	0.95	
Understanding of the musicological significance of orchestra music	Laptop	3.79	0.91	0.811
	Orchestra	3.53	0.86	
Appreciation of the importance of ensemble skills	Laptop	3.73	0.75	0.087
	Orchestra	4.01	0.77	

Findings – Technical skills development

- *I think that the samplers we used in iLOrk sound more like the original instruments than synthesizers, which we've used before in the Music Technology course, because samplers are actually recorded from the acoustic instrument, while synthesizers, as the conductor told us, are "calculated". (Student N)*

Findings – Technical skills development

- *Sometimes I was asked by the conductor to tune a softer or harder tone for my (electric) double bass, but I had no idea how to do this – although I know adjusting the knobs on my double bass or the bass amplifier should be the right way… After several weeks I was familiar with all the parameters of the knobs, and then I could easily tune a suitable tone, either on request from the conductor or my awareness. (Student Q)*

Laptop orchestra as a STEAM activity

- Computer as a musical instrument (Brown, 2014)
- Technological way to create, intrepet and perform music
- An alternative way of music performance for both musicians and non-instrumentalists

Future research

- Theoretical underpinning of STEAM
- Validation of STEAM as a conceptual framework
- Empirical findings upon the STEAM framework
- Pedagogical approaches in STEAM

References

- Ben-Tal, O., & Salazar, D. (2014). Rethinking the musical ensemble: A model for collaborative learning in higher education music technology. *Journal of Music, Technology and Education, 7*(3), 279-294.
- Brown, A. R. (2015). *Music technology and education: Amplifying musicality* (2nd ed.). New York, NY: Routledge.
- Cheng, L. (in press). Musical competency development in laptop ensemble. *Research Studies in Music Education*.
- Cheng, L. (in press). Teaching live coding of electronic dance music: A case study. *Dancecult: Journal of Electronic Dance Music Culture*.
- Crook, C. (1994). *Computers and the collaborative experience of learning*. London, UK: Routledge.
- Jolly, A. (2014). *STEM vs. STEAM: Do the Arts Belong? Education Week: Teacher*. Retrieved from http://www.edweek.org/tm/articles/2014/11/18/ctq-jolly-stem-vs-steam.html
- Manaris, B., Stevens, B. Brown, A. R. (2016). Favourites: ADD JythonMusic: An environment for teaching algorithmic music composition, dynamic coding and musical performativity. *Journal of Music, Technology and Education, 9*(1), 33-56.
- Miller, J., & Knezek, G. (2013). STEAM for student engagement. *Society for Information Technology and Teacher Education International Conference*, 3288-3298.
- Partnership for 21st Century Skills. (2011). *Framework for 21st century learning*. Author. Retrieved from http://www.p21.org/
- Rinne, L., Gregory, E., Yarmolinskaya, J., & Hardiman, M. (2011). Why arts integration improves long-term retention of content. *Mind, Brain, and Education, 5*(2), 89-96.