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Developing learners' dialogic collaborative problem-solving skills in a real-time 3D environment

Louis Major, Alison Twiner, Rupert Wegerif & Mark Waters

EARLI SIG 20-26, Utrecht, 14-16 September 2022



Background & research need

Strong evidence indicates **digital technology** can be used to support - and potentially transform - educational dialogue to improve learning (e.g. Major et al., 2018; Mercer et al., 2019)

Educational potential of **game-based approaches** also established (e.g.): learning outcomes ($g > 0.33$; Clark et al., 2016) and complex ‘C21st’ competencies (Qian & Clark, 2016)

Research has begun to explore **gaming in the context of educational dialogue** (Ravenscroft, 2007; Silseth, 2012; de Sousa, 2018)

However: “... ***there is a lack of knowledge of how teachers and students can utilize games and features of games as relevant tools for talk and learning***” (Arnseth et al., 2018)

Background & research need

Gaming2Development (G2D: 2020-21) contributes to addressing this evidence gap by investigating the role of educational dialogue in a game-based context

Novel approach: not examining learning ‘through games’ or the role of ‘gamification’. Rather it involves learners problem-solving **in - and around - a real-time 3D game (RT3D) development environment** (Unreal)

RT3D = graphics technology that generates immersive interactive content faster than human perception



Project RQs and aims

RQ:

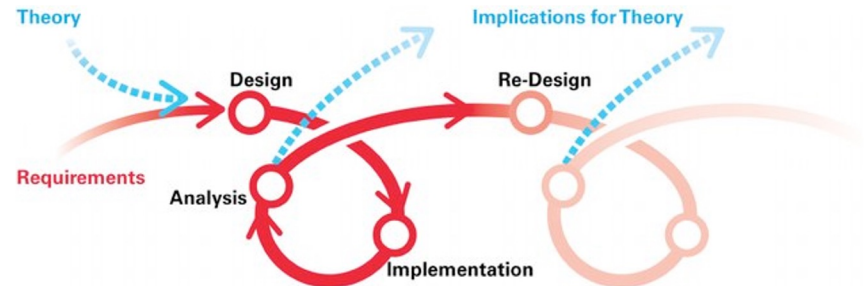
“How can dialogue in - and around - a real-time 3D development environment be enabled to support collaborative problem-solving?”

Secondary aims:

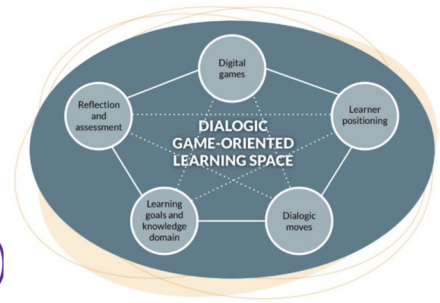
- How to provide equitable access (during C-19) to computationally demanding tools
- Development of *(i)* RT3D graphic skills; *(ii)* links to careers and ‘world of work’

Methodological framework:

Design-based research (DBR)
(today focusing on an explanatory case study)



Conceptual framing



‘Games as Tools for Dialogic Teaching’ model (Arnseth et al., 2018)

- Pedagogical model for researching and designing game-based learning environments. Proposes five dimensions to create a dialogic space for learning

‘Dialogic intervisualising’ (Bridges, et al., 2020)

- Combining verbal discussion and visual resources to co-construct understanding. Situated within a dynamic and collaborative process of facilitator-guided, scaffolded inquiry to explore a problem

G2D extends these in a new way: learners are not passive ‘users’ of an existing game, but are transitioning to being creators in a powerful collaborative environment

Underpinned by **dialogic space theory** (Wegerif, 2007): meaning is not found in one voice or perspective, but through ‘inter-animation’ or ‘inter-illumination’

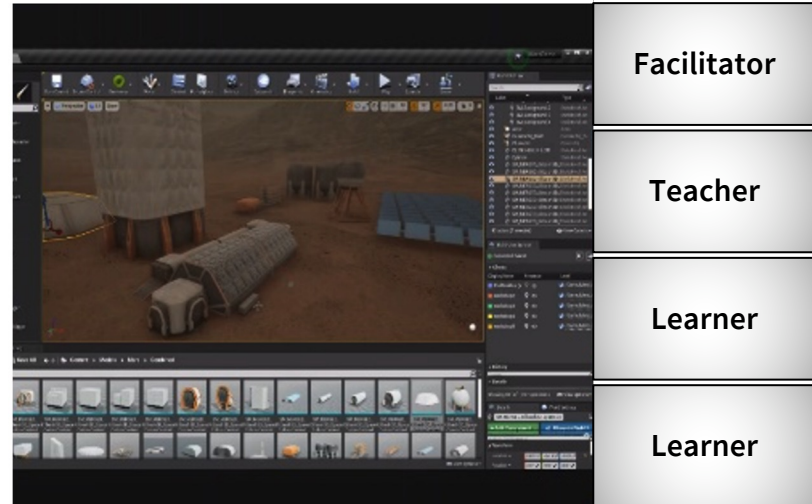
G2D: Developing a socio-technical system

Access to RT3D tools can be out-of-reach due to need for powerful hardware

Working with **4WARD FUTURES**, we iteratively developed an innovative prototype providing access to virtual machines with required software / processing power

While (reasonable) internet access was needed, this enabled Unreal to be used remotely on low-spec hardware during C-19

Virtual collaborative environment facilitates 'dialogue' - both 'in' and 'around'



G2D: Challenge-based learning approach

Learners aged 13-19 - in North England - engaged in small-group 'challenge-based learning' (online) in real-time

This integrated:

- Materials and strategies to promote dialogue (e.g. Dawes et al., 2000)
- 4wardfuture's '**Constructing a Life on Mars**' (CALOM)
- Intro to Unreal and virtual collaborative workspace

Learners were tasked to design and build a settlement for 200 people on a virtual Mars

Early scaffolding, later less imposed structure



Participants

- Facilitated workshops lasting up to 12 hours
- 4 teachers as teacher-researchers (computing, digital media, engineering) from 4 institutions (3 secondary and 1 further education)
- 50 students across 11 groups (different experiences due to changing C-19 restrictions)

Analysis today focuses on empirically-rich single-case involving 5 Creative Digital Media students (aged 16-18) collaborating remotely

This **explanatory embedded case** (Yin, 2009) illuminates dialogic possibilities within the virtual collaborative environment when C-19 disruption could be minimised. Provides **(i)** opportunity to unpack outcomes; **(ii)** confirm, challenge and extend theory; **(iii)** basis for further research

Data collection & analysis

	Data Collection	Data Analysis
Observations	<ul style="list-style-type: none"> • Video and audio recordings of workshops (including interactions within the virtual collaborative environment) • Low-inference field notes 	<ul style="list-style-type: none"> • Transcription of audio followed by Sociocultural Discourse Analysis (Mercer, 2004), to identify extracts for annotated transcription and multimodal analysis (drawing on Twiner, et al., 2021)
Teacher interviews & learner focus groups	<ul style="list-style-type: none"> • Pre- and post-intervention teacher interviews (n=6) • Learner focus groups (n=7) 	<p>Transcription followed by thematic analysis (Braun & Clarke, 2020):</p> <ul style="list-style-type: none"> • Teacher expectations (pre) and reflections (post) • Learner perspectives of G2D: what worked, what didn't (and why), what to keep, what to change
Learner questionnaire	<ul style="list-style-type: none"> • Retrospective pre-post test survey (n=24) 	<ul style="list-style-type: none"> • Descriptive statistics and statistical tests of significance (related samples Wilcoxon signed rank test), to determine retrospective pre-post-test perception of change (Drennan & Hyde, 2008) • Thematic analysis of open text comments
Learning environment 'meta-data'	<ul style="list-style-type: none"> • Online chat logs and student planning (3D, typed, drawn) 	<ul style="list-style-type: none"> • Contextual analytical sources

Challenges & study limitations

- **2020 launch = need to adapt:** action research contributing to practice (linking schools and learners working remotely during school closures). DBR contributing to the ‘doing’ of education
- Rigour embedded through data analysis (e.g. coding of data, methodological triangulation, discussion as team and with partners and teacher-researchers)
- Rival explanations and generalisation to theory = analytical generalisation
- Nonetheless, we acknowledge potential methodological / practical limitations

Findings:

How can dialogue in - and around - a real-time 3D development environment be enabled (to support collaborative problem-solving)?

Characterising G2D's findings

- Students understood and implemented strategies to help them work and communicate effectively together. 'Dialogic intention' is important
- Students rose to the challenge: in technical build, and co-ordinating group ideas and outcomes, to support rich multimodal learning experiences and outcomes
- Breaking the comfort barrier – is this to do with technology, or interaction through technology, or interaction in general...?

Arnseth et al (2018) 'Games as Tools for Dialogic Teaching' and **Bridges et al (2020)** 'dialogic intervisualising' offer valuable frameworks to break this down

Case study exploration



(Based on Arnseth et al., 2018)

(1) Digital (gaming) environment

G2D environment (Mars landscape, Parsec or Splashtop for access to Unreal Engine; assets and edit facility);
Video conference tool (MS Teams, Zoom or Google Classroom) – video, audio, typed chat; jamboards

(2) Learner positioning

Creators of ideas;
Team members with a shared task;
Drawing on previous gaming experience

(3) Dialogic moves

Ground rules;
Utterances in a multimodal dialogic frame

(4) Learning goals & knowledge domain

CBL: Learning and applying development and creation skills, effective collaboration, creativity and problem solving

(5) Reflection & assessment

On ideas, contributions, as well as evidence and rationale around final developed 'product'

Digital environment - planning

L: I think we need like a layout design, of what our thing should look like.

F: That would help in the long run tomorrow, so we don't just ask or fumble around.

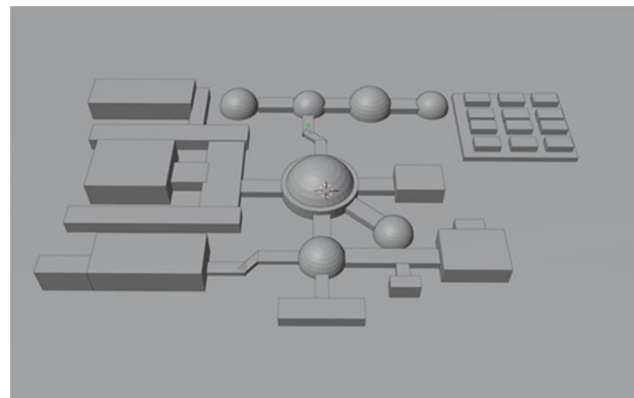
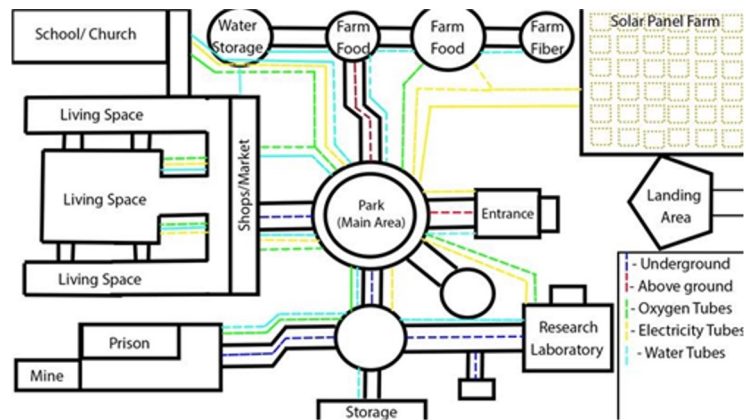
Z: [nods]

F: It would be great if we have a plan

Z: Well if I'm... if I'm looking at what we have, do you want me to make the plan?

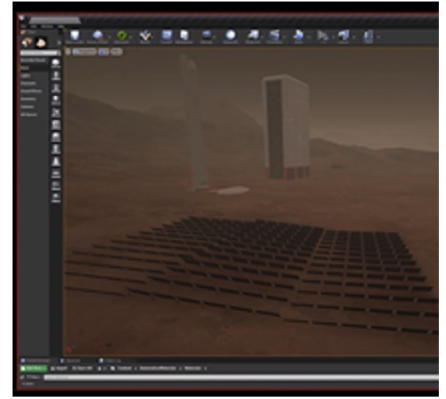
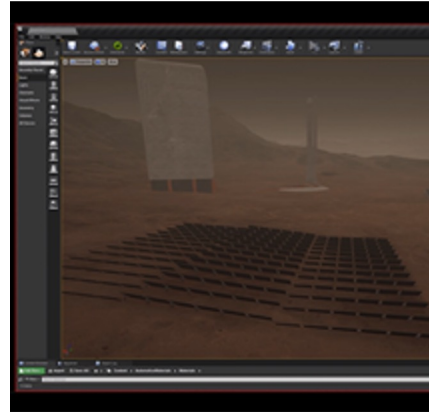
L: Yeah you can make the, I was thinking of putting like power, main power generation, in the middle of it all

(student group discussion)



Digital environment - acting

digital mechanisms and dialogic
co-ordination of action and manipulation



J: Right, I can see a potential problem, can anyone else see it?

L: There'll be a big old shadow on the solar farm.

J: *[laughs]* exactly

F: It's not there on my screen.

L: You see that big obelisk there F, it'll make a shadow onto the solar panels *[pause]*

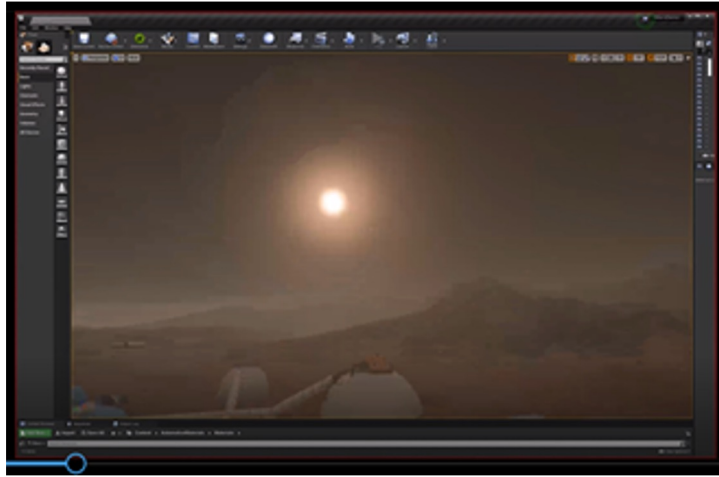
F: Oh I see

L: And then there'll be less sun for them to gather

L: Probably might have to end up moving that elsewhere; or maybe like the solar farm, somewhere

J: There we go, that's solved it

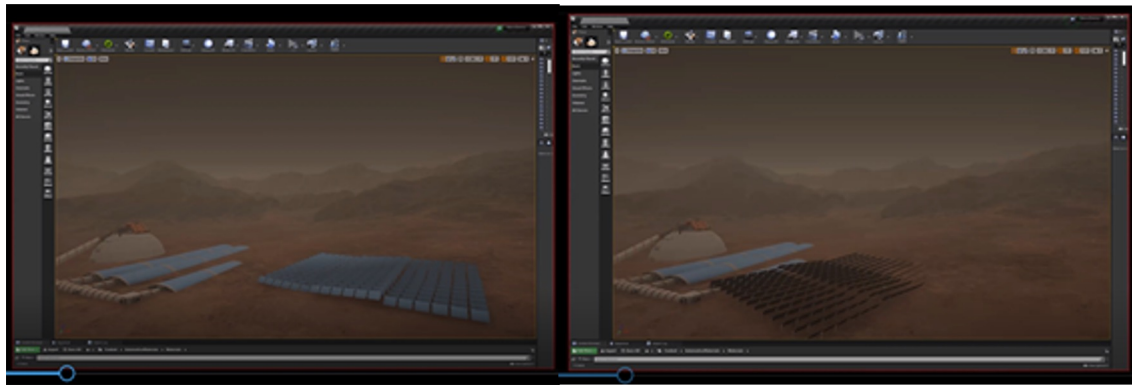
F: Oh no, now it's completely wrong. If you look where the sun is, it's not a right angle



F: It should be 90 degrees left [?]

Z: No but if the sun moves, it still picks it up

F: Yeah but, it's not in the right position



L: I can just imagine all the scraping on the floor as that happens! Like a Tom and Jerry type scraping



Learner positioning, dialogic (& digital) moves

learners as agentic creators of digital content, working collaboratively through multimodal dialogue toward contextualised meaning making

L: I can er draw things, cos I can't, I don't have Unreal on this laptop do I?

F: No

L: If I draw things, send it to you via Instagram thing, then you can show...

F: Unless Z's questioned face says otherwise?

L: I think I was thinking like too far into it

Z: No it's fine

F: Don't spend too long on this, because, we already have the models. Unless we're gonna make more? Is that what you were thinking?

Z: Well, I was already, what I was gonna sort of do, I was gonna go through the er, Unreal thing and see what models we have actually got, and see what stuff we can actually use for what.

F: Are we allowed to do that?

L: Should be?

F: In that case, I'm still, I'm still on parsec

D: So am I

F: I'll connect *(student group discussion)*

Learning goals & knowledge domain

Z: Solar panels are pretty much done

F: Copy and paste yeah? Very good. Did you already have them all saved, because that was – it doesn't take long to have a loophole, if you have two then you copy it then you have four, then eight, then sixteen...

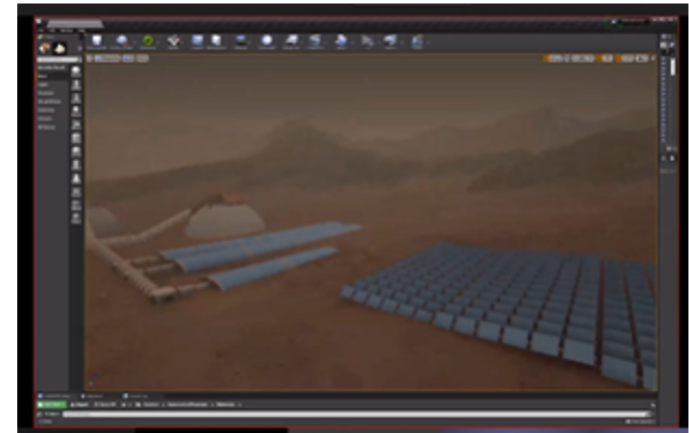
Facilitator: Yeah you've got, in the solar panel models you've got one that's got multiple solar panels in there. So you've got one that's got a single one – if you just need like a single one to power something like a beacon or something like that. And then you've got a solar panel array model as well

F: Oh yeah I see it now. Because yesterday I tried building it out of, out of, what it was

Facilitator: Yeah I couldn't figure out why you were doing that

F: I could only see the models. Until they're placed I can't see them (workshop 2)

curricular orientation balanced with space for 'rich points' of learning to occur, in and around the digital environment



Making space for 'rich points' or 'frame clashes' in interaction (Agar, 1994; Green, et al., 2008)

Implications & where to next

Analysis exemplifies that a digitally-mediated dialogic space for learning can be enabled:

- equitable access of a (sophisticated) socio-technical system
- students utilising unique dialogic affordances in G2D environment: genuinely multimodal, collaborative problem-solving featuring manipulable digital artefacts in real-time (not static images)
- flexible curricular orientation balanced with ‘rich points’ of learning in and around the digital environment
- **Start of a conversation? Possibilities for future collaboration (e.g. DEFI, DTCE, etc...)**

@Louis_Major_ @Alison_Twiner

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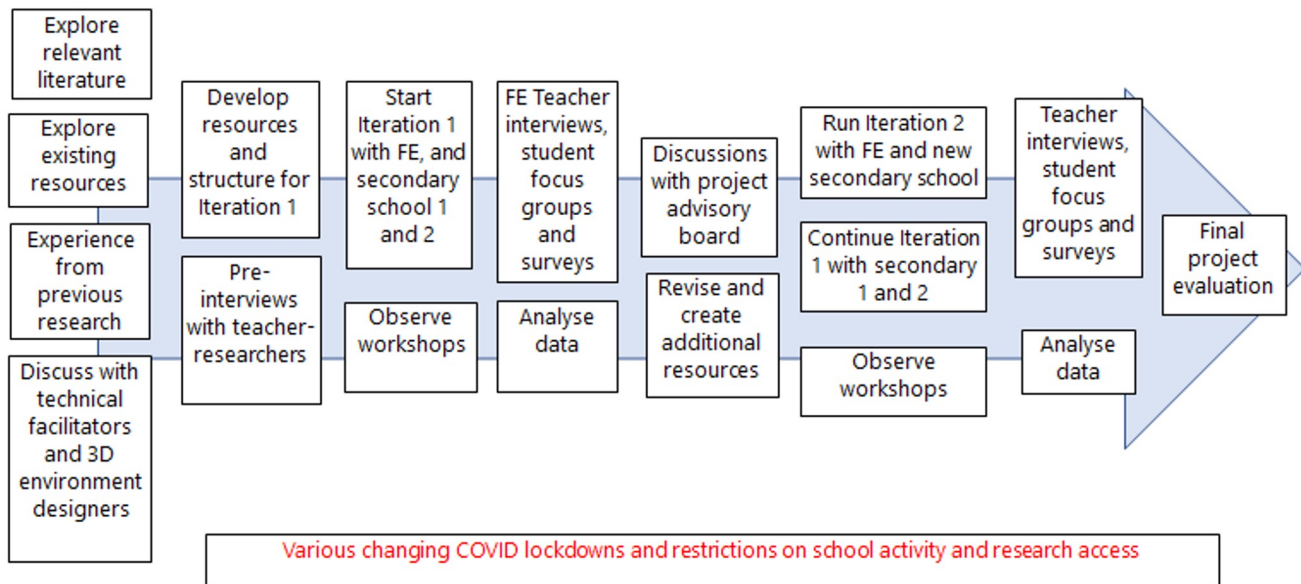
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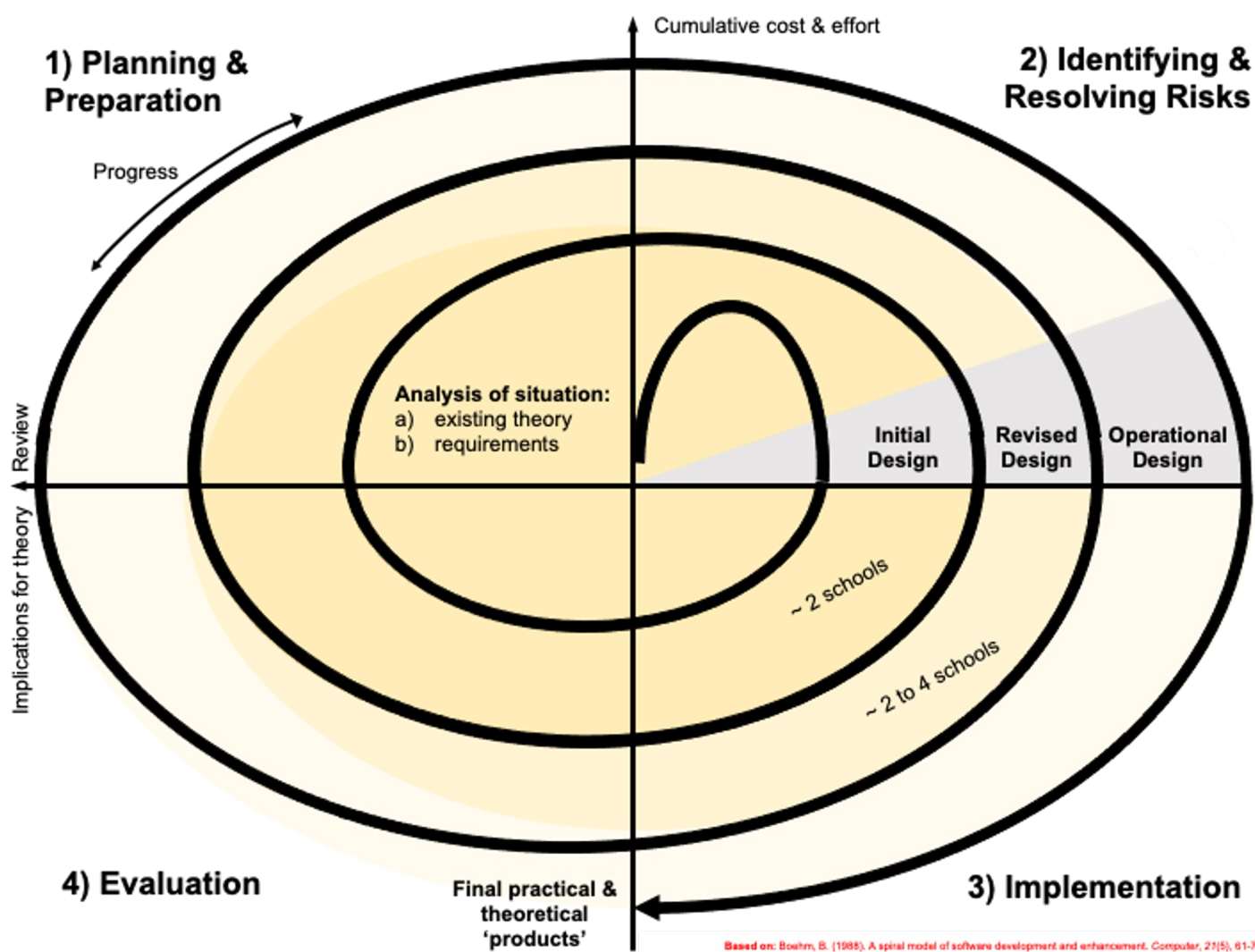
Additional slides

Retrospective pre-post questionnaire (n=24)

GTDT model	Statement	Average 'pre'-rating	Average 'post'-rating	Average increase
(2) Learner positioning	"I feel confident to present my ideas to others"	3.04	3.58	+0.54 (z=2.804, p=0.005)
(3) Dialogic moves	"I think group work is important"	3.63	4.13	+0.50 (z=2.521, p=0.05)
	"I enjoy working in a group"	3.42	3.83	+0.42
(4) Learning goals & knowledge domain	"I think I have some of the skills I will need in the workplace"	2.75	3.83	+1.08 (z=3.841, p=0.000)
	"I know some of the skills people need in the workplace"	3.04	4.04	+1.00 (z=3.750, p=0.000)
(5) Reflection & assessment	"I can reflect on what I've done well, and think about how I can improve my work"	3.29	4.00	+0.71 (z=2.722, p=0.01)

Data collection & analysis





	Course	Student age	Iteration	Teacher pre-interview	Number of teachers	Number of students	Recorded workshops	Student surveys	Teacher post-interview	Student focus groups
FE college	Creative Digital Media	16-19	1	1	1	15 in 3 groups	15: 1.5-2 hours each	12	1	2
	Virtual Production	16-19	2	[same teacher]	[same teacher]	9 in 2 groups	4: 1.5-2 hours each		[same teacher]	
High School 1	extra-curricular	14-16	1	1	1	4 in 1 group	4: 1 hour each			
High School 2	extra-curricular	14-16	1	1	1	6 in 1 group	7: 1-1.5 hours each		1	1
High School 3	Engineering	13-14	2		1	16 in 4 groups	20: 50 minutes each	12	1	4
Totals				3	4	50 in 11 groups	50	24	3	7