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

Conference or Workshop Item

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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)

Source: Fraefel, 2014
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’
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 tounpack outcomes; (ii) confirm, challenge and extend theory; (iii) basis for further research
## Data collection & analysis

<table>
<thead>
<tr>
<th>Observations</th>
<th>Data Collection</th>
<th>Data Analysis</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>● Video and audio recordings of workshops (including interactions within the virtual collaborative environment) ● Low-inference field notes</td>
<td>● 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)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teacher interviews &amp; learner focus groups</th>
<th>Data Collection</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>● Pre- and post-intervention teacher interviews (n=6) ● Learner focus groups (n=7)</td>
<td>Transcription followed by thematic analysis (Braun &amp; Clarke, 2020): ● Teacher expectations (pre) and reflections (post) ● Learner perspectives of G2D: what worked, what didn’t (and why), what to keep, what to change</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Learner questionnaire</th>
<th>Data Collection</th>
<th>Data Analysis</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>● Retrospective pre-post test survey (n=24)</td>
<td>● Descriptive statistics and statistical tests of significance (related samples Wilcoxon signed rank test), to determine retrospective pre-post-test perception of change (Drennan &amp; Hyde, 2008) ● Thematic analysis of open text comments</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Learning environment ‘meta-data’</th>
<th>Data Collection</th>
<th>Data Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>● Online chat logs and student planning (3D, typed, drawn)</td>
<td>● Contextual analytical sources</td>
</tr>
</tbody>
</table>
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…?

(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’

Case study exploration

(Based on Arnseth et al., 2018)
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)
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

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)

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

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

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

https://www.4wardfutures.org.uk/


Additional slides
# Retrospective pre-post questionnaire (n=24)

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

- Explore relevant literature
- Explore existing resources
- Experience from previous research
- Discuss with technical facilitators and 3D environment designers
- Develop resources and structure for Iteration 1
- Pre-interviews with teacher-researchers
- Start Iteration 1 with FE, and secondary school 1 and 2
- Observe workshops
- FE Teacher interviews, student focus groups and surveys
- Analyse data
- Discussions with project advisory board
- Revise and create additional resources
- Observe workshops
- Run Iteration 2 with FE and new secondary school
- Continue Iteration 1 with secondary 1 and 2
- Observe workshops
- Teacher interviews, student focus groups and surveys
- Analyse data

Various changing COVID lockdowns and restrictions on school activity and research access
<table>
<thead>
<tr>
<th>Course</th>
<th>Student age</th>
<th>Iteration</th>
<th>Teacher pre-interview</th>
<th>Number of teachers</th>
<th>Number of students</th>
<th>Recorded workshops</th>
<th>Student surveys</th>
<th>Teacher post-interview</th>
<th>Student focus groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE college</td>
<td></td>
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<tr>
<td>Creative Digital Media</td>
<td>16-19</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>15 in 3 groups</td>
<td>15: 1.5-2 hours each</td>
<td>12</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Virtual Production</td>
<td>16-19</td>
<td>2</td>
<td>[same teacher]</td>
<td>[same teacher]</td>
<td>9 in 2 groups</td>
<td>4: 1.5-2 hours each</td>
<td>[same teacher]</td>
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<tr>
<td>High School 1</td>
<td></td>
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<tr>
<td>extra-curricular</td>
<td>14-16</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4 in 1 group</td>
<td>4: 1 hour each</td>
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<tr>
<td>High School 2</td>
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<tr>
<td>extra-curricular</td>
<td>14-16</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6 in 1 group</td>
<td>7: 1-1.5 hours each</td>
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<td>High School 3</td>
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<tr>
<td>Engineering</td>
<td>13-14</td>
<td>2</td>
<td>1</td>
<td>16 in 4 groups</td>
<td>20: 50 minutes each</td>
<td>12</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Totals</td>
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<td></td>
<td></td>
<td>3</td>
<td>4</td>
<td>50 in 11 groups</td>
<td>50</td>
<td>24</td>
<td>3</td>
<td>7</td>
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</table>