Communicating through Portals

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Abstract:

Based on the five key aspects of technology education a series of five tasks were designed and implemented to evaluate Junior Certificate students' (12 to 15-year-olds) capabilities in solving technological tasks/activities and the individual heuristics and problem-solving skills employed. Each of the themed areas are domain dominant as technology is multifaceted that any one activity will have the potential to observe knowledge, skills and attitudes under different areas. The task allows for numerous different individual heuristics to be employed by the participant which should provide a rich source of data to inform on specific incidents of technological capability, problem-solving, and reasoning abilities.

This paper focuses on the pilot of the Design & Communication themed task of the study. Perception has been highlighted as a critical area in problem-solving, (defining the problem space)(Kirsh 2009; Sternberg, Mio et al. 2009); it is of interest to investigate the relationship between reasoning abilities and communication skills (graphic and spatial abilities).

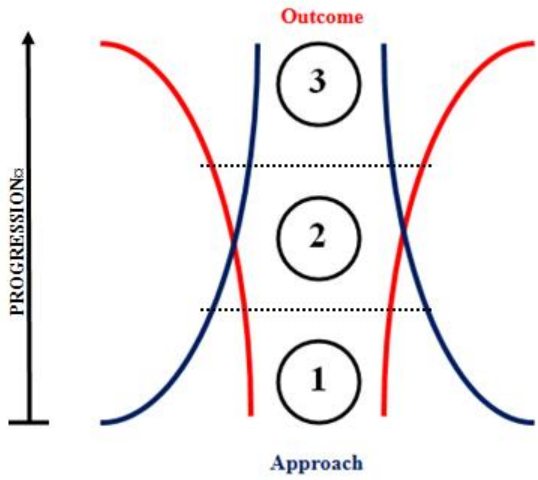
The correlation between reasoning abilities, problem-solving skills and graphical skills was highlighted in the progression of participants' attempts (success/fail). The ability to perceive and ultimately interact with the task area was the defining characteristic on which success or fail of participants attempts depended on.

Introduction:

The task activity was based on the use of a prescribed ICT (Information Communication Technology) based computer task. The availability of information (signage, audio, imagery) for participants to consciously or sub-consciously recognise/disregard throughout the programme was one of the key factors in its selection as main test tool. The program attempts to elicit critical thinking and reasoning skills (deductive/abductive/inductive). The development and application of these skills became apparent as participants progressed through the task. Web-capture software was used to track each student's progress and monitor their decision making. Audio responses were also captured to interpret individual heuristics, conceptual knowledge and decision making.

Participants (N=04) were sourced on voluntary basis; the only constraint employed was that they were early second level students (12-15 yrs old). Each participant was made aware that the test scenario was to be recorded (video and audio capture); and that if they wished at any stage to opt out that they could do so (either individual task item or entire test scenario).

Method



Task Item 3: Level progression
Approach: Competitive: Time constraint and complex problem-solving
Outcome: expansion on procedures and interactions on level progression.

Task Item 2: Layout of level 1
Approach: Detailed sketch, justified by participant
Outcome: Graphical representation on layout of level one

Task Item 1: Complete level 1
Approach: Beginner setting: Instruction & practice.
Outcome: Specific objective (complete level 1)

Figure 1: Task Complexity Design

The theme was subdivided into three task items; which were designed to increase in complexity throughout and allowed for different solutions to be created to mirror the diverse nature of technology (shown in Figure 1). The complexity on progression of tasks was twofold: Approach and Outcome. Each of the task items where chronological in progression and had set goals for the participants to achieve. The successful completion of each task item was dependant on individual perceptions of participants' (setting out goals, identifying relevant information, signage, etc) and the problem-solving skills (reasoning abilities, visualisation skills, etc.) employed.

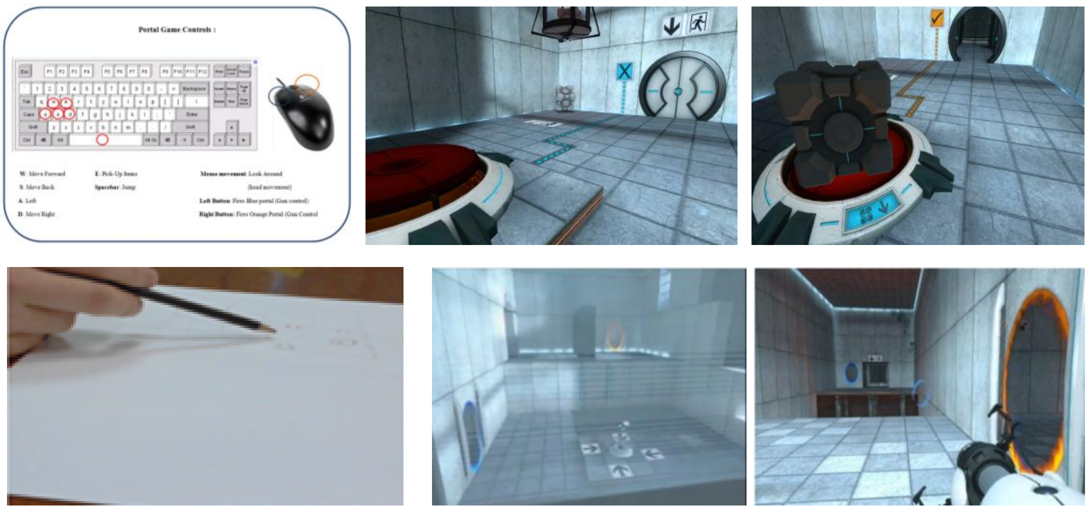


Figure 2: Instruction sheet & Task Item Activities

Task Item 1:

Participants were given game controls schemata and were allocated one minute to familiarize themselves with the computer simulation in a controlled environment (test chamber) before attempting to complete level 1.

Task Item 2:

Participants were asked to sketch the layout of the entire level with as much information as they felt relevant with the intention of supplying another person with enough information to complete this level. The task was designed to elicit participant's spatial abilities, reasoning abilities, and conceptual knowledge which could be inferred from the placement and positioning of portals and objects on the submitted sketch. An area of interest on the design and implementation of this task was to provide insight into how students of this age bracket frame and register problem areas.

Task Item 3:

Participants were asked to complete as much of the computer simulation as they could from level 2 onwards with a 15 minute time constraint. It was predicted that the time constraint would have a substantial effect on the type of individual heuristic employed (Todd and Gigerenzer, 2000).

'Visual and Verbal Protocol Analysis' were employed when collecting and analysing data. Data was collected in two ways, first thinking aloud protocols described as thoughts that emerge and that are then verbalized (Carlson and Bloom 2005; Middleton 2011). The second type of data was the video recordings of the participants' attempts at completing the technological task activities. Inferences of the problem-solving phase were identified from key points on the recordings; individual heuristics were also captured and identified on a retrospective/reactive observation which was aided from verbal explanations' or behavioural responses/expressions.

Web-software was used to record participants' progression and decision making. The results of which were codified and categorized into a purpose designed '26 item Multidimensional Problem-solving Codex' (Spillane, Seery et al., 2012). The codex was designed to include individual heuristics that are associated with individual phases of the problem-solving cycle. The framework was designed to allow the researcher to categorize and track the use of individual heuristics separate to the recognised problem-solving cycle over a variety of generic tasks. Specific individual heuristics have been attributed to the four distinct metacognitive phases of problem-solving to give greater insight into problem-solving. It is also hoped that this will aid the qualitative analysis of participants' attempts.

The use of triangulation was used in the pilot study to validate and improve reliability on the selection and recognition of individual heuristics and cognitive processes in the battery of tasks. Finally semi-structured interviews as regarded as best qualitative practice (Bloomberg, 2008) were held with the participants to validate the findings and amend any discrepancies found .

Results

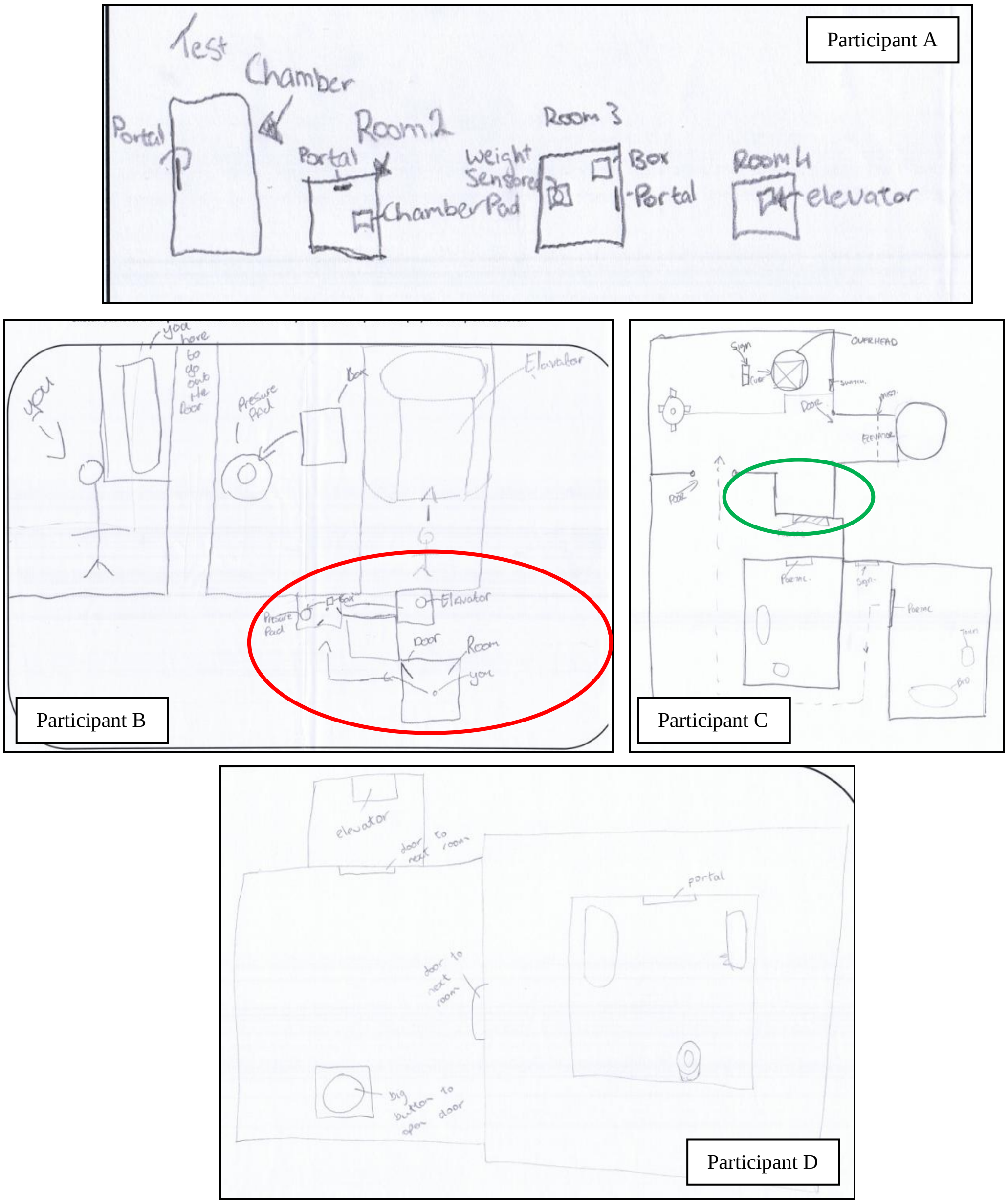


Figure 3: Task Item 2 Layout Sketches

Level Progression:	Participant A: Level 4	Participant B: Level 7
	Participant C: Level 4	Participant D: Level 3

Discussion

While the paper is focused on a small number (as part of a larger study), there was no apparent connection between age or subject selection in the success rate of problem-solving or reasoning abilities. The relevance of this paper with regards to pupils' graphicacy skills is that it highlights the correlation between the level of communication skills and reasoning abilities. Show in figure 2 is the layout solutions produced by participants for Task Item 2. There was evidence of the relationship between reasoning, communication (verbal and graphical) and pattern recognition of the various problem areas in the totality of the test area.

Participant A expressed the layout in linear format, based on the premise that the information was for another user to complete the task. This was described as '*snapshots*' by the participant in the progression of the task when recalling the set procedure in the completion of level 1 (task item 1). The size and proportion of the layout was minimal when compared to the other participants' solutions.

Participant B was the most successful in level progression and the solution produced in the second task highlighted a level of spacial awareness and inductive reasoning abilities that the other participants did not possess (circled in red in figure 3).

Participant C was able to clearly define the layout area of level 1 and highlighted all signage. Similar to Participant B, a clear pathway was mapped on the sketch with notation of procedures set out at critical points. Evidence of Abductive reasoning was also highlighted (circled in green figure 3) as the inclusion of a third portal was position on the back wall of the test chamber.

Participant D was the least successful in the level progression (failing to pass level 3), but did effectively map out the area of level 1. The map area was divided into two parts, as the participant could not visualise the orientation of the test chamber (starting point) with regards to the layout of the rest of level 1(fm the point of having moved through the initial portal).

Certain behavioural types were clearly evident from reviewing participants' cognitive procedures. It highlighted the divergent nature of the technological task as well as the divergent behaviours of participants in this group. The most selected heuristics throughout the computer simulation was the 'generate and test' heuristics. In task item 2 (sketching activity), the means-end analysis heuristic was the most employed, which infers that the nature of the task impacts dramatically on the selection and reliability of heuristics, and problem-solving strategies as proposed by researchers `(Todd and Gigerenzer 2000). It will be of interest to see if participants will achieve a similar result in the other four test areas and if the same problem-solving strategy is employed

The conscious recognition of signage was observed when participants were faced with an impasse on level progression. This would have been either a failure of a proposed solution (generate and test) or the introduction of a new component in the level progression. Subconscious recognition of signage was also observed at the initial stage of problem identification. This cue forming pattern was confirmed in the semi-structured interviews were participants did not acknowledge the use of signage in specific areas of problem-solving, which participants acknowledged as 'eureka moments'.

All of the participants with exception of participant D were motivated through the entirety of the task activity. In the failure to complete level 3 (task item 3), the participant became more fixated on the portal (functional fixated) as a means to completing the level, and this manifested in the rejection of clear signage for the elevator (problem had been solved unknown to the participant). As a result the participant became less motivated and the ability to propose alternate solutions became stagnant.

Conclusion

A clear connection between Attitudes, Skills and Knowledge (ASK) and the development of strategic knowledge and successful problem solving was found through the courses of the research. The use of both conscious and subconscious recognition of signage, symbolism and pattern recognition in the problem-solving process provided the researcher with insight into the type of individual heuristics employed and the performance efficacy of student attempts.

When comparing all four participants initial test results; four distinct characteristics in problem-solving, graphicacy skills, and visualisation were clearly highlighted. While the size of the pilot test is small it is envisaged that certain trends will be highlighted similar to that produced in the pilot scores. It will be of interest to see in the larger study is if the trends on individual heuristic selection and across the diverse nature of tasks will continue or disperse. And to what level of reasoning abilities and spatial dexterity will students of this age bracket be able to employ when dealing with graphical issues.

The use and implementation of the various cognitive procedures gave insight into the level of reasoning that participants produced. Of the four, only one participant who was able to inductively reason in the task item 3 (level progression) and as a result got the furthest of all participants (level seven). Could this participant exemplify the desired behavioural characteristics that we should be promoting in technological classrooms across the broad spectrum of technological activities? And if so, what pedagogical implications will this have in our classrooms?

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