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The role of Digital Libraries in teaching and learning Geography.

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Abstract

Adopting a problem-centred approach helps students to learn Geography more effectively as they are able to identify and generalize about where different resources or activities are spatially located and they learn to associate certain patterns and processes with geographical changes. In an era where web-based student-centred inquiry is gaining popularity as a mode of learning Geography, the role of digital libraries as delivery trucks (in Clark's terminology, 1983) needs to be better understood. An obvious affordance of the digital library is that it organizes information around themes for problems to be solved. This paper describes a developmental project to build a digital library for Geographical assets. This digital library (G-Portal) serves an active role in collaborative learning activity in which students conduct a field study of an environmental problem, within a geospatial context – in this case, beach erosion and sea level rise. G-Portal not only functions as a digital library of information resources, it also provides manipulation and analytical tools that can operate on the information provided. This study examined two specific case studies as part of a larger study which explored the possible the ways the students can use the G-portal find information, create learning artefacts, construct arguments and explore their awarness of the modality of information sources and in the learning artefacts they created. G-portal was sucessful in providing resources which supported the students in finding information and supporting multimodality in the construction their artefacts.

Introduction

In contrast to learning management systems (LMS) that allow the teacher to organize resources in some predetermined structure which then prescribes a fixed learning strategy, digital libraries such as the G-portal provide users the opportunity to take control of their choice of resources, ways of representing and using these resources, creating new resources and even developing their own learning strategies. The G-portal developmental project was initiated as an attempt to improve on the existing capabilities of digital repositories and the move into multimodal representations, in that it hosts digital assets that will are used by students to solve an authentic problem based on real world resources. In order to effectively deploy the G-portal at local schools and test the effectiveness of the various capabilities of G-portal and the associated learning styles, a pilot project was conducted to examine the usability and capabilities of the G-portal. Two case studies taken from the pilot study form the basis for this paper.

Capabilities of the G-Portal

The G-portal provides a range of capabilities that supports learners in their construction of geographical knowledge. In particular, a unique feature of the G-portal is its capacity for personalized project management. In G-Portal, a personal workspace is provided to

each user (or group of users) to build his/her (or their) own collections of resources and annotations in form of personalized projects. A personalized project has the same basic attributes as any project in G-Portal including name and description. The unique attribute of a personalized project is the accessibility, which can be private or public. A private project is visible and accessible to the creator only and a public project is accessible to all the users.

The personalized project management module in G-Portal enables the users to create, manipulate, export and delete their own projects. The capabilities of the personalized project management module can be further classified into five attributes:

Project management. To create a new project, user specifies the basic attributes of the project including name, description, and whether the project is private. The creator can also alter these attributes or delete a personalized project. The concept of personal project space allows individuals to work in their personalized environment with a mix of private and public data and at the same time share part of the data with their team members. This allows students to explore the information, process the information, solve the problem posed and ultimately construct a geographical understanding of it. Transduction of text into images or other modes of representation may also be possible within these personal projects.

Built-in tools. Some built-in tools such as zoom and measurement tools allow the students to query the data spatially. Essentially this allows users to select data by non-linear methods and encourage inquiry based on some analogy of the real world spatial context – the map. A certain degree of manipulation and consequent analysis of the data using these tools may support the learner in constructing meaning of the information.

Layer management. Within a project, layers can be defined to maintain resources in different logical groupings. Properties including name, description and type (resource layer or annotation layer) are specified for each layer. Within a personalized project, appropriate layers can be defined to group resources logically. Note that the layers and the assignment of resources to layers can only updated by the corresponding project owners. Indeed, the project layers emulate what a Geographic Information System does; it represents real world objects in layers. The information on each layer can then be used for comparison and analysis. For example, patterns may be described when objects across various layers are toggled "on" or "off".

Schema and resource management. Every resource in G-Portal is created using a resource schema that serves as a template. In a personalized project, schemas can be user-defined to meet the needs of a learning activity for a user (or team of users). In a personalized project, resources are either entirely created by the user or copied from the other public projects, e.g. the master project created by a teacher for students' reference. In a collaborative learning setting, it is also quite likely to have multiple users exchanging resources among their personalized projects. Essentially the schema and resource management allows the users to re-use objects that have been created by others. While recognising the degree of reliability may differ for object created by different users, such as instructors versus students, the reusability option may support student learning in that new meaning can be constructed out of existing pieces of information, represented as objects in this case.

Personalized Project Export. By providing each user a personalized workspace in G-Portal, the management of the resources (information) becomes much easier for each learning

activity. This allows users to produce the object of the learning activity into a documented artefact.

Intuitively, the research questions that were asked for this study should be crafted around these capabilities. Indeed, the various capabilities of the G-portal indicate that the way students use the portal in searching for information, processing the information and solving the problems posed to them will be limited and influenced by the way G-portal is be used.

Method and approach

The central research question for the overall study was "How do students effectively learn Geography concepts while using the G-portal in their task?" The research agenda focuses on the design of the application and G-portal's ability to integrate and retrieve information for geographical task; and the ease with which students are able to undertake and complete studies of geographical phenomena. Given the research question, the issues that are of specific interest in terms of student processes included:

1. Usability issues — How do students use the G-portal to find, retrieve and create information about the Geographical task?

2. Search Strategies and retrieval techniques — Does the G-portal support effective search strategies well?

3. Multimodality of representation — Can the students use tools within the G-portal to represent information in various modes such image and numerical data?

4. Transduction of information — Can students more easily comprehend the data and its representation through the transductive capabilities of the G-portal?

5. Representation of Geographical and Spatial Information — Does the G-portal support students' spatial understanding of the information?

In order to address these questions, a qualitative methodology to describe how the students use the G-portal for learning Geography was used. The students were given a task of using available geographic data to solve an authentic problem for a resort development consultancy. The detailed task is given in Figure 1 below.

As part of your familiarization with using the G-portal, please complete the following task:

You have been asked to examine Profiles 6IV, 6V, & 6VI by a resort development to assess the state of this stretch of beach at ECP. In particular, why do you think the beach profiles looks different at different times of the year? Investigate this question using the G-portal and other online resources. Present your report (using MS Word or MS Power Point or any other supporting software) to explain your findings. You should include visuals where necessary to illustrate your point. Visuals can be gathered form the G-Portal and from the internet. Remember that your target audience is the developer of the resort.

While working on the task speak aloud and verbalize your thoughts on what you are thinking on doing, what you are doing etc.

You will have 40 minutes to complete the report.

Figure 1: Task given to the students to use G-portal to solve a real life geographic problem.

The research questions emphasise the students' knowledge construction process but require, in addition, a fuller description of the learning activity. As the proposed approach to these questions is based on the learning ecology of design experiments (Cobb et al., 2003), the context of the activity should be firmly placed within the discipline of Geography. Thus, the research and development team worked with some undergraduate students from the second year Coastal and Ocean Systems module at the National Institute of Education. This module traditionally requires the students to investigate a stretch of the local coast and solve some geographical problems resulting from the investigation. An introduction to the G-portal was given at the beginning of the module. The students then accessed the information via the G-portal throughout the semester.

The investigation by the students took place along a stretch of the east coast parkway coast. The main foci of the task was to identify and suggest possible coastline changes and the resulting impacts on the environment and land use of the study area. As the students were performing this task, the way they use the G-portal on the computer, together with a headshot of their faces was recorded into a single video clip. The footage was then viewed and a set of codes were generated (in relation to the research questions). The footage was then coded and the entire activity was then described using these codes.

The five research sub-questions were then rephrased to the following guiding questions to help the research team code the data.
1. How did students find information?
2. How did students form arguments in their discussion/artefacts?
3. Were the students aware of the modality of the information sources and artefacts?
4. How did the students construct artefacts?

After an initial viewing, the research team generated a generic set of codes. Finer details were added as the coding progressed. The codes generated followed the schema of Table 1.

Table 1: Coding scheme for the activity.

Finding Information	Description

Type of Navigation
    Using G-portal Resources
        Using built-in tools
        Schema and resource
        management
    Search Engines
	Refers to the search tool the students use to search for information sources: G-portal's built-in schema or search engines (e.g. Google, Yahoo, Mamma…), subject directory (e.g. Yahoo), Direct url (e.g. www.erosion.com)

Search Type
            Keyword
            Phrase
            Query
            Direct URL
        Search Result Navigation
	The type of search can be either search for a portal object (egg. Profile or photograph), a keyword search (e.g. Beach Erosion); a phrase search (e.g. reasons for beach erosion); a query search (e.g. erosion AND time AND reason) or a direct URL search (e.g. www.erosion.com).

Forming Arguments Procedure	To enable scientific activity, such as experiments and observations, to occur
Investigation	To inquire, in order and with accuracy the aim, steps, results and conclusion of a scientific activity
Sequential explanation	To explain how something occurs or is produced
Theoretical explanation	To introduce and illustrate a theoretical principle and/or to explain events which are counter-intuitive
Causal explanation	To explain events for which there are a number of causes To describe, classify or define a number of classes, or parts, or attributes of a class of objects
Information report	To describe, classify or define a number of classes, or parts, or attributes of a class of objects

Awareness of Modality
    Modality of source
        Text
        Images
        Video or animation
    Modality of artefacts
	Refers to what kinds of modes are used to represent content in the source: text, images, video/animation or/and sound.

Images
        Text
        Numerals
	Refers to the type of modes used in the artefact (e.g. text, numerals and image).

Constructing Artefact
    Piecing Information
        Text
        Images
        Video
	Refers to what kind of content types they choose to use from the sources (text, images, video/animation or/and sound).

Position Montage	Refers to whether or not the students position format modes for presentation (e.g. resize and position an image interacting with a piece of text).
Students layout in artefact	Refers to whether or not the students write titles or and paragraphs of content themselves

Source of information
        from G-portal
        from web
        from prior knowledge
    Work on Artefact
	Refers to where do the content they use come from. Is the content coming from a source on the internet or is the content coming from another source like prior knowledge, text books etc. or is the content from the G-portal?

Copy and paste	Copy and paste content and do no editing of the content.
Cut n paste with formatting	Uses only text copied and pasted with some editing and does not add any content themselves only changes formatting and cuts away some of the content.
Writing and cut and paste	50% copied and pasted and 50% written by the students.
All the content written	All the content written by the students.

It is important to note that not all the codes generated were observed, the full structure was generated based upon the futre possible comparision with post intervention data. For example, while the web search type can be coded as keyword, phrase, query or direct URL searches, only the first two codes were observed in the current data set. The coding generated was based primarily on theoretical possibilities. Indeed, all four types of searches are possible even if only two were observed. It would be incomplete to simply just list two out of the four in the coding scheme. Further, there are several further video

clips that are being coded while this paper is being presented at the conference. The codes will describe alterative search patterns in those clips.

In addition, the analysis included the sequence and duration as each stage of the artefact was constructed. For Danny's group, the learning artefact was a PowerPoint presentation and the time spent on creating each slide has also been included in the representations of the final construction. Cheng's group however produced only one paragraph of explanation as their final product for the activity. In that case, the time spent on constructing the paragraph has been indicated on the representation.

The codes were then plotted against the time spent on the activity to present a sequential overview of how the activity progressed. Not only does this allow the research team to describe in detail how each group used the G-portal in the task, it also provides the basis for analysing the relationship between each coded segment of the activity.

Findings

The coded video clips of the learning activity are presented in Figures 2 and 3. To protect the identity of the subjects and in accordance with the ethical practise in research, the team has assigned pseudonyms to the two groups examined for this paper. Danny and Adirel, in the first group, worked on the task and produced a set of PowerPoint slides. Cheng, Yong and Win, three girls in the second group, produced a word document as their learning artefact. Essentially both groups agreed that there is a strong possibility of beach erosion at the east coast parkway in the short to middle term, and that the developers should serious consider against building a resort at the site. The "solution" provided is reasonable in that the students were correct in identifying the strong possibility of beach erosion given the data they can access from the G-portal, and that resort development might not be feasible as erosion may disrupt or even damage structures erected at the site (due to erosion) and that the development itself may cause more environmental problems.

Information Finding

Based upon the video clips, students sought information either from within the resources on the G-portal or the web. No additional sources of information, such as books or notes were used for the task. In particular, students used the built-in tools and the resource and schema management tools of the G-portal; they also used only the keyword and phrase search types of the web search engine to source their information.

In Danny and Adriel's case, they sought information in a "point and click" strategy using both the built-in tools (such as zooming in and out and point and click) and resource management tool and the web search engine. Using built-in tools started a couple of minutes into the activity and carried on for about 8 minutes. It was at this point that they started their web search for about a minute. Finding information using the G-portal was also carried out in shorter than one minute intervals for constructing the third, fifth, seventh and eighth slides in their PowerPoint presentation. It seems reasonable to describe the information finding pattern as one in which information is found prior to the construction of argument and artefact. Indeed, they would find further information even as they are constructing their artefacts. In a sense they went "back" to the portal to find information sources to support their formation of arguments and creation of artefacts.
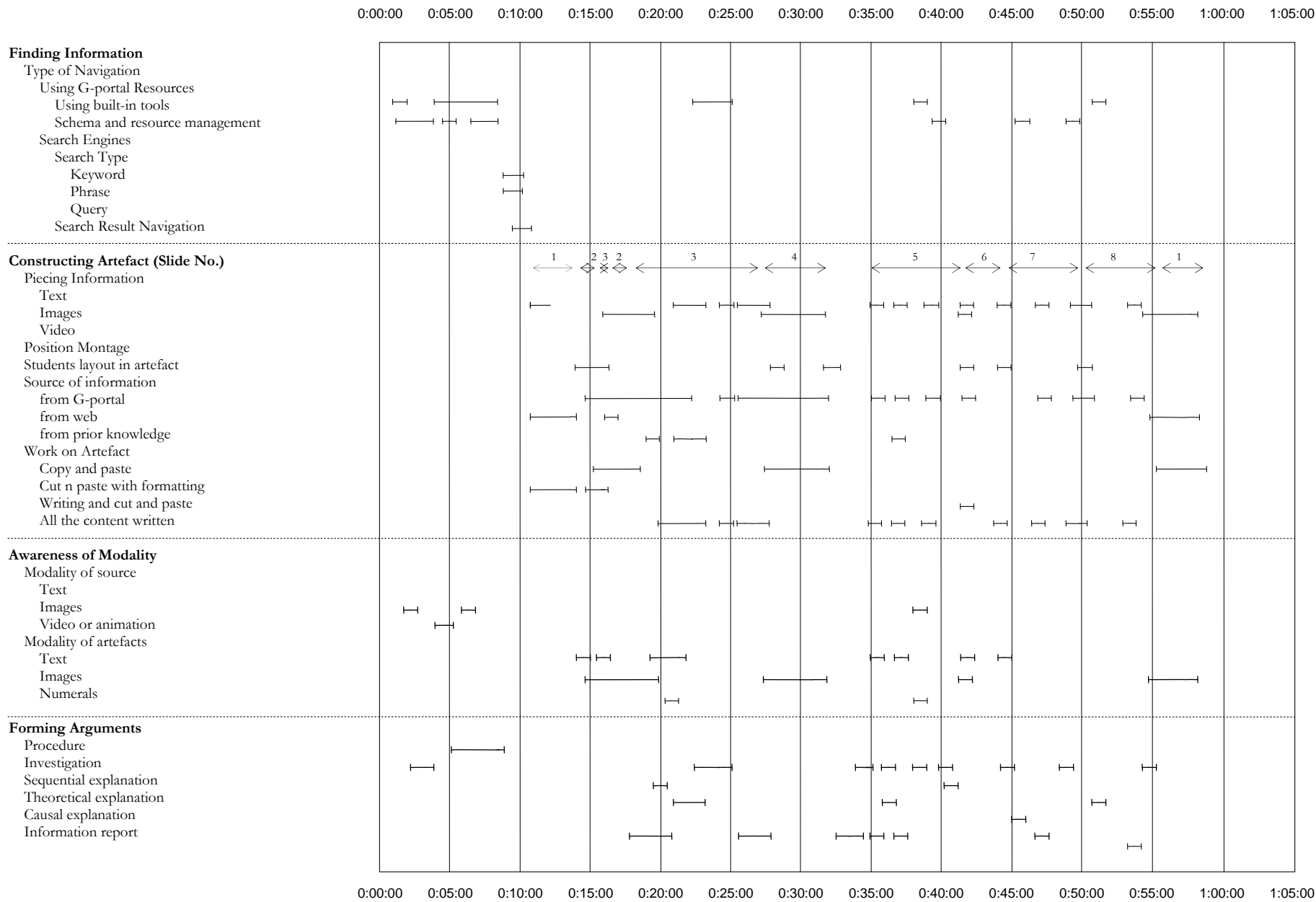
6

Figure 1: Coding of activity for Danny and Adriel.

0:00:00 0:05:00 0:10:00 0:15:00 0:20:00 0:25:00 0:30:00 0:35:00 0:40:00 0:45:00 0:50:00 0:55:00 1:00:00 1:05:00

Finding Information
  Type of Navigation
    Using G-portal Resources
      Using built-in tools
      Schema and resource management
    Search Engines
      Search Type
        Keyword
        Phrase
        Query
        Direct URL

Constructing Artefact (Paragraph number)   Diagrams 1   2 3   Paragraph 1
  Piecing Information
    Text
    Images
    Video
  Position Montage
  Students layout in artefact
  Source of information
    from G-portal
    from web
    from prior knowledge
  Work on Artefact
    Copy and paste
    Cut n paste with formatting
    Writing and cut and paste
    All the content written

Awareness of Modality
  Modality of source
    Text
    Images
    Video or animation
  Modality of artefacts
    Text
    Images
    Numerals

Forming Arguments
  Procedure
  Investigation
  Sequential explanation
  Theoretical explanation
  Causal explanation
  Information report

0:00:00 0:05:00 0:10:00 0:15:00 0:20:00 0:25:00 0:30:00 0:35:00 0:40:00 0:45:00 0:50:00 0:55:00 1:00:00 1:05:00
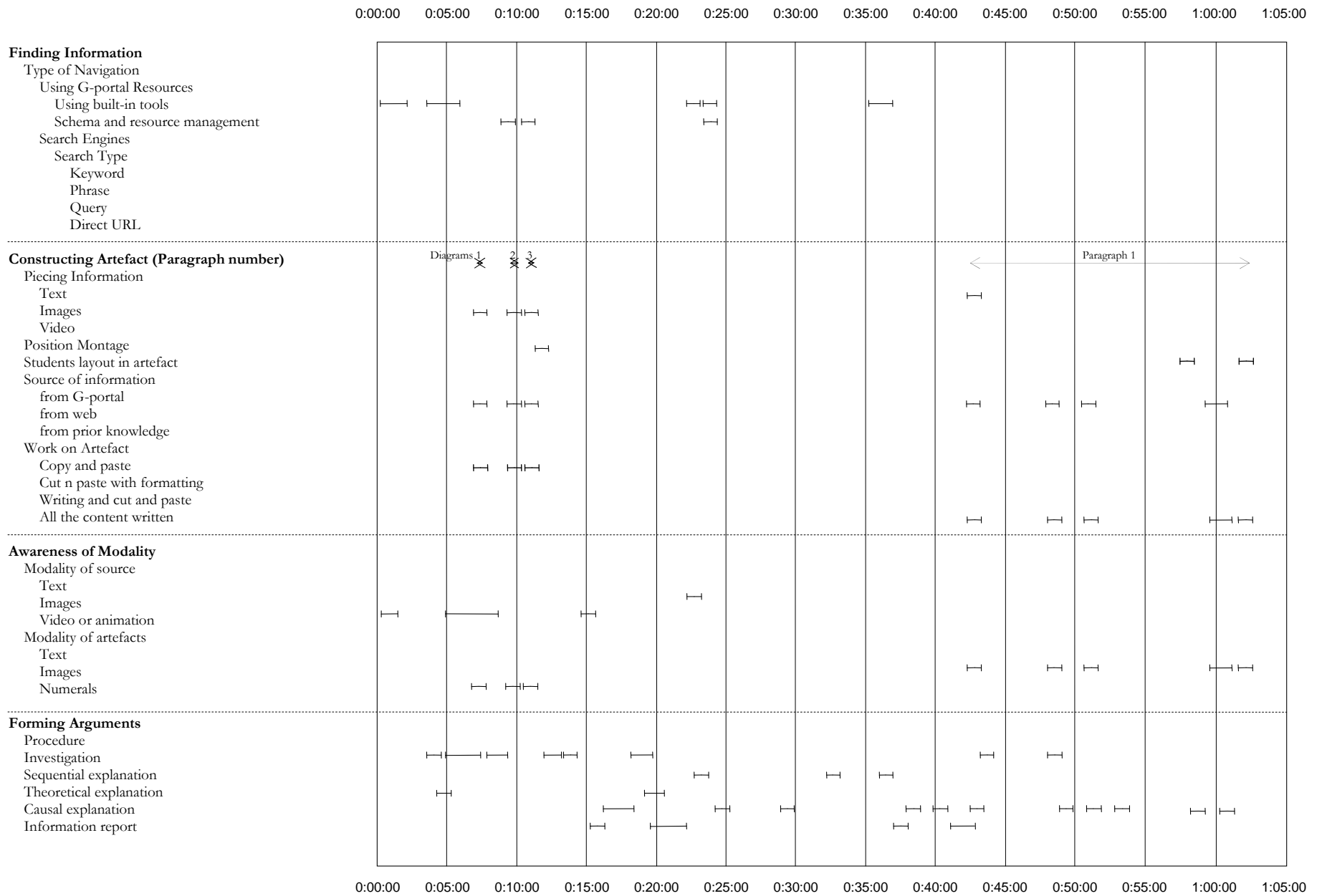
Figure 2: Coding of activity for Cheng, Yong and Win

In contrast, Cheng and her group members used the first two-thirds of the time to search for information and form arguments. The last twenty minutes was exclusively spent on constructing artefacts. Like Danny and Adriel, the group went back to the G-portal to find information that they could use in their textual discussion and the formulation of their argument for the case. This group did not use other Internet sites at all.

Forming Arguments

Both groups were in continuous dialogue amongst themselves as they tried to solve the problem by analysing the information obtained from the resources on the G-portal.

In judging the quality of the arguments generated by the students, we define procedural arguments as those that enable scientific activity, such as experiments and observations, to occur. In other words, any set of procedures that help each group develop their argument or construct their artefacts. Investigation refers to an inquiry of, in order and with accuracy the aim, steps, results and conclusion of a scientific activity. Sequential explanation can be defined as arguments that explain how something occurs or is produced. When the groups seek to introduce and illustrate a theoretical principle and/or to explain events which are counter-intuitive their apporach to argument can be termed as theoretical explanation. Theories may be scientific theories or personal theories in this case. While scientific theories introduce and illustrate a theoretical principle to explain events, personal theory explain such events through personal experience or beliefs.

Causal explanation tries to explain events for which there are a number of causes or factors. A more general approach of information report refers to how the discussion describes, classifies or defines a number of classes, or parts, or attributes of a class of objects. It also refers to a more general description of the phenomenon, issue or object.

The two cases selected showed two different approaches to forming arguments in performing the given task. Cheng's group created a learning artefact which is basically a paragraph of text. The group was involved more in procedure during the first 20 minutes of the activity in which they determined how they would find information to build their arguments and hence provide a solution to the question posed. Sequential arguments were presented early in the task (before 21 minutes) while investigation of the information found took place three times from about 20 minutes to 35 minutes into the task at short one minute intervals. This indicates a possibility that the students in this group tried to explain the chronological development in the profiles first, and then investigating the possible reasons for the observed patterns. They then formed most of their theoretical and causal arguments towards the end of the task (from about 35 minutes to 62 minutes). The main reasons stated for their arguments are derived from the theoretical and causal arguments. Indeed, the following quotation comes from the artefact:

> "From the analysis done, the scarp of the 3 profiles have not changed drastically particularly for profile 6(VI). Thus, it can be deduced that resort that is intended to be constructed in the area near the 3 profiles will be less vulnerable to erosion. It is more advisable for the developer to build the resort inland though the coastline along the 3 profiles have not undergone aggressive erosion. Interventions such as beach nourishment could have taken place and serve as a possible explanation for the accretion in some of the profiles."

In Danny and Adriel's case, procedure was determined early in the task from about 5 minutes to 9 minutes into the task. This was preceded by some investigation of the data. In other words, the students "played around" with the G-portal and investigated the information sources before commencing on the task by determining their approach. Also investigation, sequential, theoretical and causal explanation were given for each of the slides on which they provided some "solutions". Unlike the previous group that left the analysis and explanation to the end, the group found information, formed arguments and created artefacts on a slide by slide basis. They ended the slides by giving an information report on what they have decided on and provided the advice that "Overall, the beach is highly vulnerable to erosion and thus it is not advised that resort development should be carried out". Certainly one could argue that this is due to the nature of the software application used (MS Word for Cheng's group and MS PowerPoint for Danny's group). However, there is a clear difference in their awareness of modality between the two groups. Danny's group for example relied more on visual resources and created artefacts rich in images while Cheng's group used only text in their artefact.

Awareness of Modality
Modality refers to the mode in which information is represented. In this case, both the resources and the artefacts produced by the students can be represented in various modes such as text, images or even videos and animation. One of the general conclusions available from current research is that, while multimodal text analysis has advanced significantly over the last fifteen years (Jewitt & Kress, 2003), there is now a need to move from a description of the structure and meaning-making potentials of multimodal texts, to a detailed description of how learners can and do those potentials in everyday education settings.

Modality in sources refers to an awareness of the modes of representation in the information sources on the G-portal or from the web. Given that Cheng's group sought information only during the earlier part of the task, it was not unexpected to find that the coding for awareness of modality in source coincided with their information finding phase. They mostly used visual images from the G-portal and tried to cut and paste some of the images on their artefacts. However, they only used these images at the beginning to their artefact and is not referred to in the written text. The artefact was therefore represented as images from about 6 to 12 minutes but represented as text from 40 minutes till the end of the task. The visual modes of representation in the information was apparently transducted into textual explanation of their arguments and suggested solutions to the question posed. This can be further discussed in the next section on constructing artefacts.

Danny's group showed that they only used information as represented by images from the G-portal and the web. They even found a panorama movie of the site from the G-portal. However, the artefacts were a mixture of text and images. There were two instances whereby numerals were used. This was when a rate of erosion was calculated and typed on the slides. Certainly the final conclusion was written as text format and the students used various visuals from the G-portal to piece together the final artefact. While Danny's group used more than one mode of representation in their final artefact, compared with Cheng's group, the situation may be described as employment of multimodality. Hence, Danny's group showed more evidence of multimodality.

Constructing Artefacts

Danny and Adriel's group spent most of the time on their task constructing artefacts. Indeed, they were working through the artefacts while they found more information or while they discussed the arguments for the case. Cheng's group, on the other hand, mainly constructed their artefacts only towards the last 20 minutes of their task, while spending most of the time before 42 minutes into the task.

In terms of piecing information, or the kind of content types they choose to use from the sources, Cheng's group only used image resources from the G-portal on two occasions. Cheng's group was the only group who in one instance positioned a montage where students positioned and formated modes for presentation (using resize and positioning of the image). While this is a rather limited employment of multimodality, there is an irony that the group decided to abandon the processed images for a more text-based approach. In contrast, Danny's group used text as well as images from the G-portal to construct their artefacts.

While Cheng's group only used sources from the G-portal in constructing their artefacts, Danny's group also used the web in a couple of instances. In particular, the information was represented as images. They used the image from the web in the introduction slide, more to decorate the slide than to achieve any other purpose. Hence it cannot be considered as an employment of multimodality. However, Danny's group used images of the profiles to support the arguments that they propose on the slides. In particular, each slide with a profile image was followed by a slide of explanation.

Working on artefact refers to whether the students used the content they take from a source, the extent the students synthesize the information to fit to an appropriate answer to the task and whether the students write additional content. Cheng's group initially copied and pasted some images of profiles from the G-portal onto their artefact (about 7 to 11 minutes) but decided to leave the explanation to the end, in the form of a written paragraph. Hence there is no apparent transduction of modes of representation here until the end of the task where the analysis of the images and the arguments formed resulted in a piece of text.

Danny's group copied and pasted some images of the profiles in their artefact. There were two instances in which they calculated the approximate rate of erosion from the images of the profiles. There is clearly transduction of information from a graphical mode to a numerical mode (at about 20 and 38 minutes into the task). The rest of the artefact was written in text based on the arguments they have formed after analysing the information from the G-Portal.

Hence Cheng's group showed very limited employment of multimodality while Danny's group showed that at least three modes of representation was present, namely, text, numerals and images.

Discussion and Conclusion

In terms of finding information, the students used only the built-in tools and the resource and schema management tool of the G-portal. While one group showed that they did use the web to find additional information, it was primarily to find an image they

could use to decorate their introductory slide. This presents the development some challenges. For example, the non-use of other G-portal capabilities such as personal project management and layer management may indicate that these capabilities are not easily accessible to the user. These are areas that the user interface could be improved on.

It can be argued that the software application that the students choose to construct their artefacts influences the way they approach the task. For example, Cheng's group chose to use MS Word and this lead to more discussion on the procedure followed by analysis then theoretical and causal explanation for their solution. Danny's group used MS PowerPoint and this led to theoretical and causal explanations after each beach profile was analysed. Certainly, a counter-argument could be the antecedent learning styles of the two groups of students. This is an area that further research can be conducted on.

While Danny's group used three modes of representation, namely text, numerals and images, Cheng's group only created one piece of text artefact with three diagrams that have not referred to. Again this can be attributed to the application chosen and its affordance on the way information can be represented. This becomes clearer upon examining the way the students created their artefacts in that Cheng's group mostly "wrote" their learning artefact while Danny's group copy and pasted images, calculated rates of erosion and "wrote" explanations.

As a preliminary study, the analyses of the artefacts suggested that the G-portal was useful to some extent in providing resources to support the students in finding information. There is evidence that at least one of the two groups was able employ multimodality in the construction of their learning artefacts and that the way students approached the task was determined to some degree by the software application they chose to work with.

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