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Comparing Notes, analyzing teachers' and students' perceived concept importance based on highlighting architecture study documents

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1. ABSTRACT

Precedent studies are an important learning strategy for architectural design (Oxman 1999). Students are often instructed to search for interesting case studies and articles from published design folios or architectural magazines. The components of these case studies usually include graphic representation such as diagrams, drawings and pictures of the design, as well as textual information that describes the site condition, design intent, and innovative techniques used in the project. Some articles also include reviews and critiques from architectural historians or art critics.

Many students use highlighters to mark on the document to call out ideas and concepts that they perceive as important. Text is considered an important part of design representation (Dong 1997, Tang 2006). Annotation is a behavior that facilitates text comprehension (Wolf 2001). If text highlighting reveals what concepts and ideas are perceived as important by students, the question is, then, if a teacher is given the same case study document, would he or she also highlight the same key words and concepts? How different might they be?

We are interested in identifying how these design concepts are perceived differently by students and teachers. The hypothesis is that for more experienced students their perceived important concepts would be closely related to what the teacher marked as important.

Our study is consisted of two parts. The first part of the research was to collect from study texts what students would mark as important. We consulted architectural professors to select a set of study documents to give to a group of architecture students and ask them to highlight important keywords and phrases. We then gave the same article to their instructors to perform the same task and collected their responses.

These student notes with highlighting marks represent the level of understanding of the subject matter by the students. The notes from the teachers provided us the information of what concepts they perceived as important.

2. METHODOLOGY

2.1. RESEARCH APPROACH

The first phase of our research aims to identify the patterns which hepls us to understand the relationships between the level of importance defined for concepts from both teachers and students.

We started by asking an associate professor of the College of Architecture at Georgia Institute of Technology, to review a particular study material for her area of expertise. She was asked to identify, using a yellow highlighter, all those text elements she considered to be important for the correct understanding of the subject matter contained in the document.

We designed our experiment to obtain information about the level of importance perceived by students when reviewing the same document. We asked a group of graduate students from the the College of Architecture at Georgia Institute of Technology to review the same study document. The group was composed by three females and three males. Their age ranged from 25 to 36 years old. Most of them were highly qualified. Their educational level ranges from recently admitted PhD students to a Post Doctoral Fellow. The basic demographics of the participants in the experiment are shown in Table 1.

Table 1. Participants demographic information

Name	Age	Educational level
Ann	26	First year PhD Student
Betty	27	First year Masters Student
Carol	35	First year PhD Student
Paul	33	Second year PhD Student
Robert	29	Second year PhD Student
Steve	36	Post Doctoral fellow

We selected students with high level of expertise in the subject area treated in the study document in order to compare their marking patterns to the ones marked by the teacher. The students were asked to identify two different kinds of concepts in the study document. They were asked to identify by highlighting in yellow all the concepts in the study document they completely understood both the meaning and the context of the concept. The purpose of including the contextual relationship of the concept is to understand how these students understand the text beyond isolated concepts.

The students were also asked to highlight in pink, all the concepts they were not sure either about the meaning or the context but still considered important in the study document. The reason for gathering this information is so that we could assess if the students understand which elements of the text were of significance even though they might not have fully understood them yet. Our hypothesis is that for more experienced students their perceived important concepts would be closely related to what the teacher marked as important.

2.2. EXPERIMENTAL PROCEDURES AND CONSTRAINTS

We asked the participants to highlight no more than three consequent words, the we re akso asked not to go back and review previous markings. To avoid the possibility for some of them correcting their own markins, and also to prevent the highlighting of the entire paragraph or a large area of it.

2.3. TEXT ANALYSIS

The text selected for the experiment is "Computing in architectural design : reflections and approach to new generations of CAAD " by Rabee M. Reffat (2006) within the document we identified the following number of discourse units:

- 11 Sections
- 77 Paragraphs
- 3 Graphic components
- 2 Table components

We established an analytical framework for the highlighting protocol study. The document was divided in different scales of discourse units. The units identified are:

- Page number: 1 to 16
- Section: A to L, organized in alphabetical order, as they appear in the document.
- Paragraph: each paragraph was identified by the page number in which it is located and a sub-index identifying the position of it on the page.
- Sentence: consist of a subject and a predicate.
- Graphic component: refers to either a diagram or a picture. Graphic components were identified using the same classification scheme used for the paragraphs.
- Table component: refers to information displayed by using rows and columns. Table components were identified using the same classification scheme used for the paragraphs.

A section usually contains a couple of paragraphs, one graphic and some table components. Each paragraph contains several sentences. Those paragraphs that span two pages were considered as one when dividing the document in units (Fig 1).

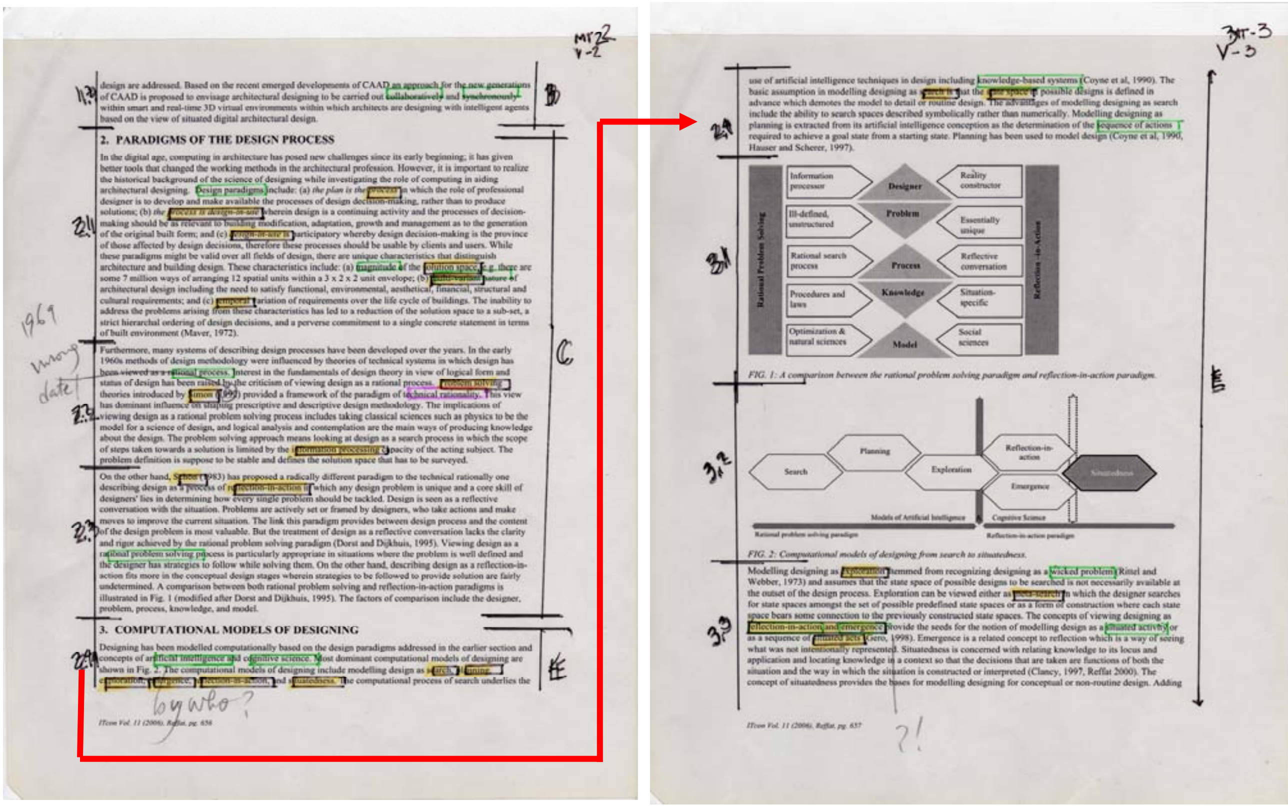


Figure 1: Pages 2 and 3. Paragraph 4 of page two (numbered as 2.4) is identified in the label page 3 (top).

3. EXPERIMENTAL SETUP

The experiment was set up to collect two different types of data. We obtained information about the amount of highlighting operations performed by the student participants. This information would help us understand the level of comprehension by students when evaluating a study document. We also collected the marking patterns from the teacher. We could use this data to understand the level of similarities between the highlighting patterns displayed by the students and the teacher.

Why are we doing this kind of experiment? We are interested in the implication for education. If we can understand and assess the learning patterns of students by looking at their highlighting behavoir in the text documents, maybe in the future we will be able to build intelligent paper capable of understanding the highlight behavior of students and use that to either help reveal important study patterns and strategies to help the students or the teachers to improve their own teaching efforts.

Our hypothesis is that the marking patterns done by students with higher level of expertise will be closer to those by the instructor than those done by novice students. Our research method is to count the patterns and score them and see ifexpert studen ts have higher matching score to the teacher's pattern. We counted each of the highlighted elements produced by the test subjects. We organized the gathered information under two categories, these are: (1) Elements highlighted in yellow are called known text elements, (2) Elements highlighted in pink are called unknown text elements.

Table 2: Spreadsheet showing the numbers and the locations for the highlighted text elements.

document section	A	B	C	E	D	F	G	H	I	J	K
Ann(known)	11	23	7	13	51	15	67	68	35	0	0
Ann(unknown)	0	0	4	10	0	0	0	0	0	0	0
Betty(known)	8	16	23	19	16	16	21	26	0	0	0
Betty(unknown)	0	1	0	0	0	3	2	0	0	0	0
Carol(known)	1	6	18	13	4	0	8	6	8	0	0
Carol(unknown)	5	0	6	4	9	7	7	6	1	0	0
Paul(known)	0	13	9	4	8	9	25	19	10	0	0
Paul(unknown)	0	0	7	4	3	2	6	1	0	0	0
Robert(known)	8	10	5	9	16	48	62	32	31	0	0
Robert(unknown)	1	2	1	0	2	5	11	6	1	0	0
Steve(known)	9	28	34	17	20	27	40	56	32	0	0
Steve(unknown)	1	7	3	6	7	6	31	6	0	0	0

3.1. DATA GATHERING.

The extraction of the experimental data was performed by transferring both, the positions and the colors of highlight markings for each individual text element to a transparent plastic sheet. Then the data was compared by overlapping the transparent plastic sheets containing the patterns obtained from both students and the teacher, in order to verify levels of similarity.

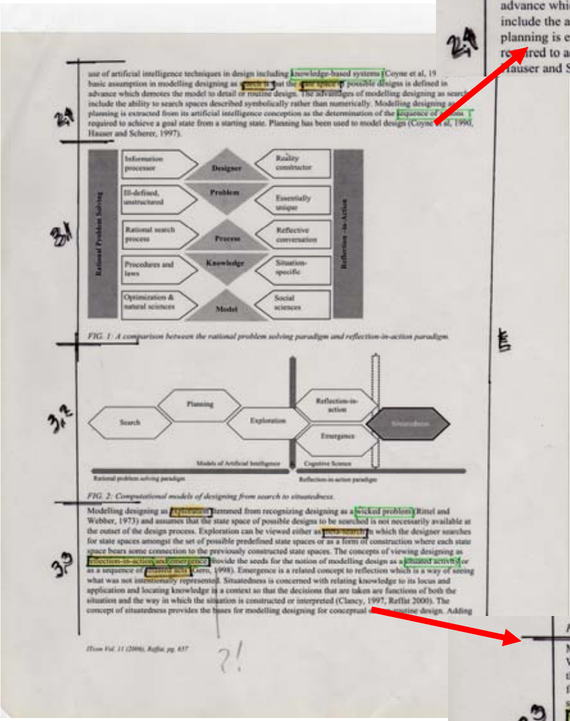
To identify how similarly both parties perceived the significance of some particular concepts inthe study document, we developed a scoring scheme to measure the proximity of text elements. We used the teacher's copy as a template document. This document contains solid yellow markings on each page. The yellow making were then transferred to the transparent plastic sheet with black bounding boxes, to avoid any possible confusion with the highlight markings extracted from the students' documents.

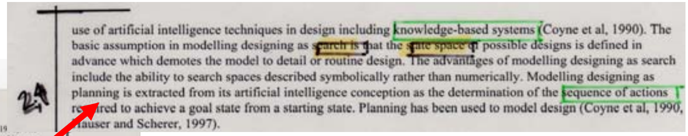
We transcribed the marking patterns of all the students as color boxes on transparent sheets. These boxes bound the text elements identified by the students. Each page of the study document has a corresponding transparent sheet containing pink and yellow boxes.

Below is the scoring scheme:

> Direct correspondence = 4: the compared text elements are located in the same position.
>
> Sentence correspondence = 3: the compared text elements are located within the same sentence.
>
> Paragraph correspondence = 2: the compared text elements are located within the same paragraph.
>
> Section correspondence = 1: the compared text elements are contained within the same paragraph.
>
> Non correspondence = 0: no correspondence found between the compared text elements.

The scoring was assigned only to the closest correspondent element marked by the student in relation to those marked by the teacher, as seen in (Fig 2). This approach was used to avoid the possibility of high scores from excessive highlighting.





use of artificial intelligence techniques in design including knowledge-based systems (Coyne et al, 1990). The basic assumption in modelling designing as search is that the state space of possible designs is defined in advance which denotes the model to detail or routine design. The advantages of modelling designing as search include the ability to search spaces described symbolically rather than numerically. Modelling designing as planning is extracted from its artificial intelligence conception as the determination of the sequence of actions required to achieve a goal state from a starting state. Planning has been used to model design (Coyne et al, 1990, Hauser and Scherer, 1997).

Figure.2.a:

Highlighting correspondence at the level of phrase score = 2.

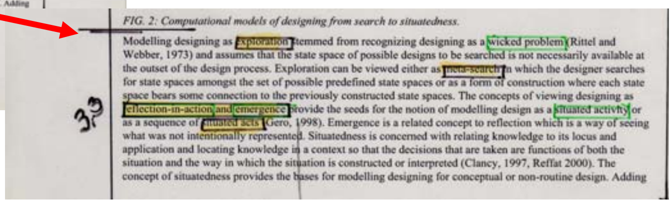


FIG. 2: Computational models of designing from search to situatedness.

Modelling designing as exploration stemmed from recognizing designing as a wicked problem (Rittel and Webber, 1973) and assumes that the state space of possible designs to be searched is not necessarily available at the outset of the design process. Exploration can be viewed either as meta-search in which the designer searches for state spaces amongst the set of possible predefined state spaces or as a form of construction where each state space bears some connection to the previously constructed state spaces. The concepts of viewing designing as reflection-in-action and emergence provide the seeds for the notion of modelling design as a situated activity or as a sequence of situated acts (Gero, 1998). Emergence is a related concept to reflection which is a way of seeing what was not intentionally represented. Situatedness is concerned with relating knowledge to its locus and application and locating knowledge in a context so that the decisions that are taken are functions of both the situation and the way in which the situation is constructed or interpreted (Clancy, 1997, Reffat 2000). The concept of situatedness provides the bases for modelling designing for conceptual or non-routine design. Adding

Figure 2.b:

Highlighting correspondence, direct

Correspondence score = 4.

Figure 2: Picture showing the overlays of the extracted data from Robert's highlighted document page 3 when compared to the instructor's study document.

The score pertaining to each individual was placed in a table (see table 3) corresponding to different discourse units defined for the text used in the experiment. This table enables us to easily identify areas of both low and high scores within the analyzed study text. As shown in Table 3, there is no score entry in section A. Section A is the introduction to the paper and is not percieived to be important by the participants.

The scoring was placed in a table for the interpretation of the data. The table is organized as follows: from left to right the labels are discourse units, section, page, paragraph, sentence correspondence (sc), and direct correspondence (dc). Scores are placed in the intersections between discourse unit element and the the columns of the names of the test subjects.

	experimental data								
	subject ID			Ann	Betty	Carol	Paul	Robert	Steve
	section	unit/page	paragraph						
		1							
	A			0	0	0	0	0	0
		1	1.1						
		1	sc						
		1	dc						
		1	1.2						
		1	sc						
		1	dc						
		1	1.3						
		1	sc						
		1	dc						
		1	1.4						
		1	sc						
		1	dc						
	B	1					1		
		1	1.5						
		1	sc						
		1	dc						
		1	1.6						
		1	sc						
		1	dc						
		1+2	1.7	2				2	
		1+2	sc			3			
		1+2	dc		4				4
		2							
	C	2							
		2	2.1						
		2	sc				3		
		2	dc	4	4	4		4	4
		2	2.2						
		2	sc		3			3	
		2	dc	4		4			4
		2	2.3				2	2	
		2	sc						
		2	dc		4	4			4
	D	2+3							
		2+3	2.4			2		2	2
		2+3	sc						
		2+3	dc		4				

Table 3: Example of the scoring table

The graphing of the scoring data presents identification of a marking pattern behavior for all the students in the group. There are sections of the text which clearly are interpreted as more important by the students, like C, E, F, H, andI were assigned high level of importance by both students and the teacher.

3.2. FURTHER DATAT ANALYSIS

The first part of our study focused on assessing the comprehension levels of the study documents by the student. Patterns of the Known and Unknown elements are obtained and analysed. We recorded both the numbers of Known and Unknown text elements found in the study document. Relating these previously defined discourse units helped us to identify areas of the text where students assigned a high level of importance to the information displayed in the text.

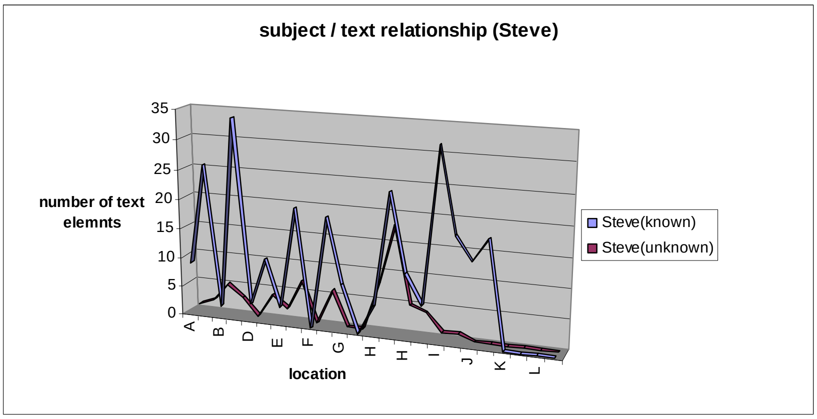


Figure 3: The pattern of known, unknown elements for Steve.

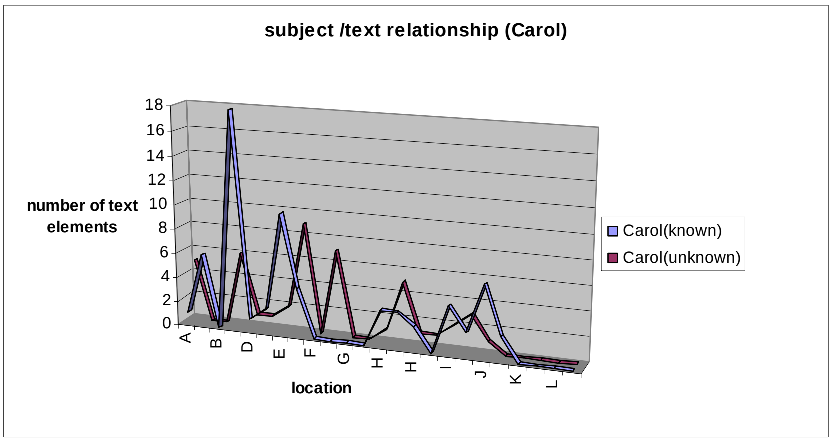
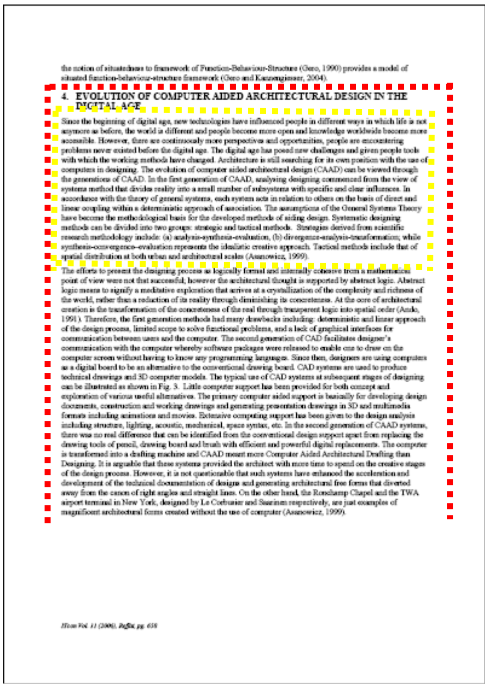


Figure 4: The pattern of known, unknown elements for Carol.

We found two main areas where students showed high levels of comprehension as compared to the instructor highlighting patterns. This might indicate a correspondence on the understanding of the information contained in the text. Although these high level corresponded paragraphs have a similar word count (between 205-228) there is no morphological similarities between the paragraphs. The locations of these paragraphs in relation to the page layout is completely different. The one contained in section F of the document is located almost on the top of the page. Figure 5 shows section F highlighted in yellow. Figure 6 shows section H bounded in red .



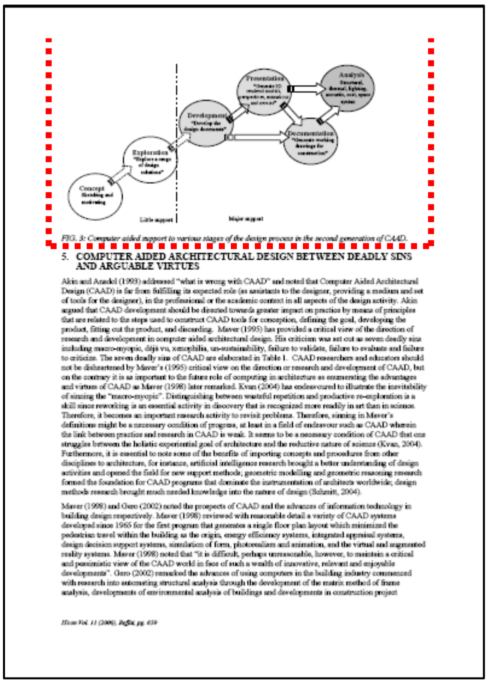
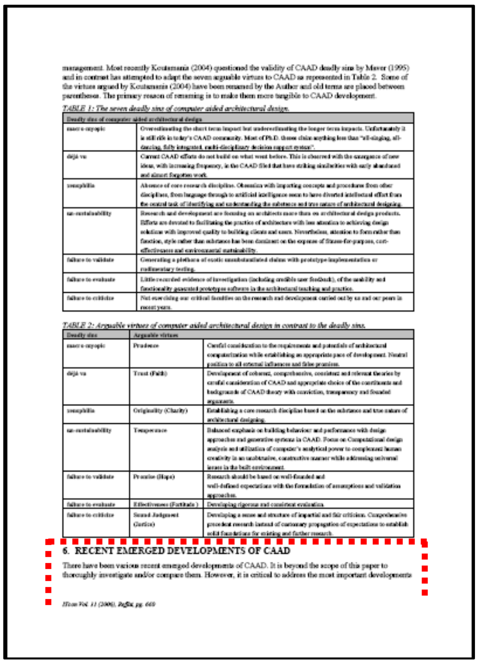
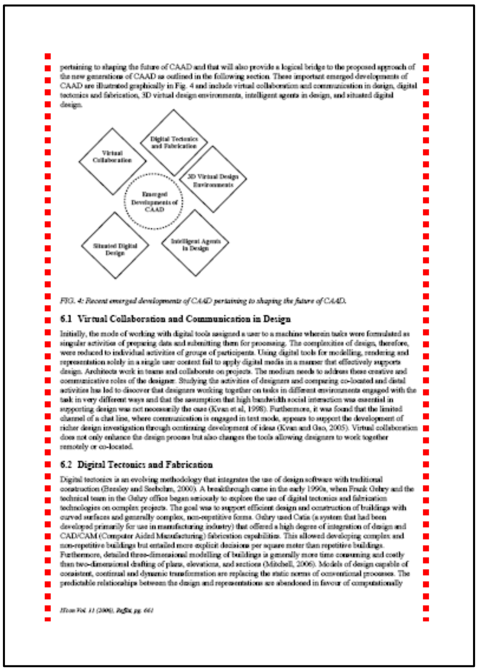


Figure 5: Section F bounded in red.





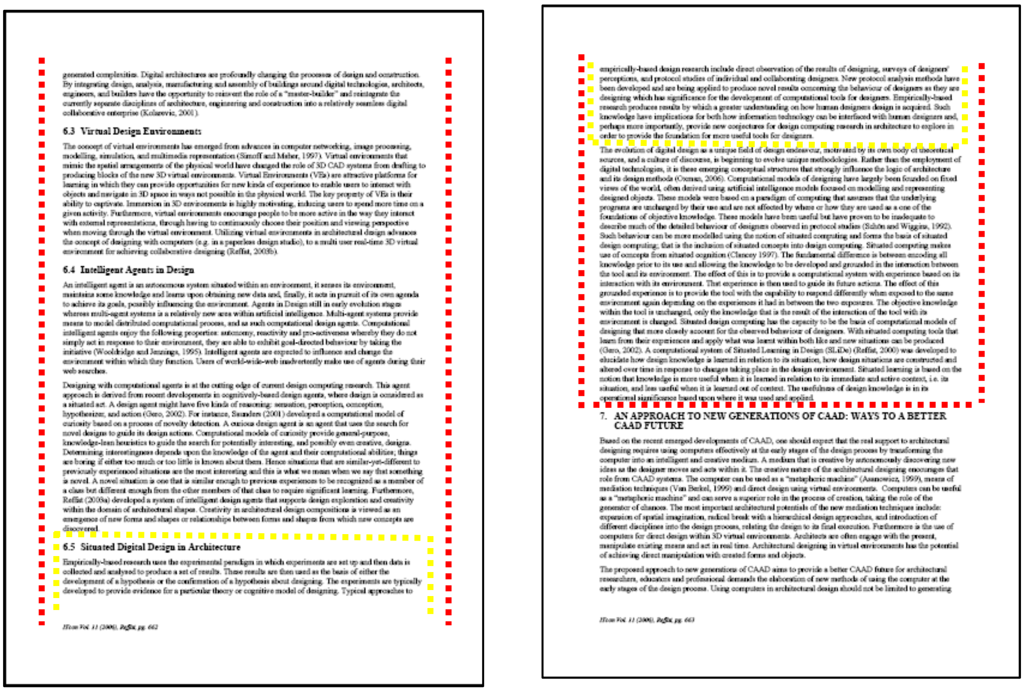


Figure 6: Section H bounded in red.

The high levels of correspondence might be the result of closer match to student's interests. Paragraph F introduces a methodological approach to the development of design aids. Paragraph H refers to future trends in computational environments in architecture. The group may have either previous knowledge or great interest in topics covered by paragraphs F and H. Therefore this results a higher level of confidence about the understanding of the topics covered in the study document.

To evaluate the importance of previous knowledge in the perceived concept importance between teachers and students, we developed a scoring scheme to measure the distance between known and unknown elements highlighted by the students. The intention was to have a mapping of the overall level of comprehension of the text document for comparison.

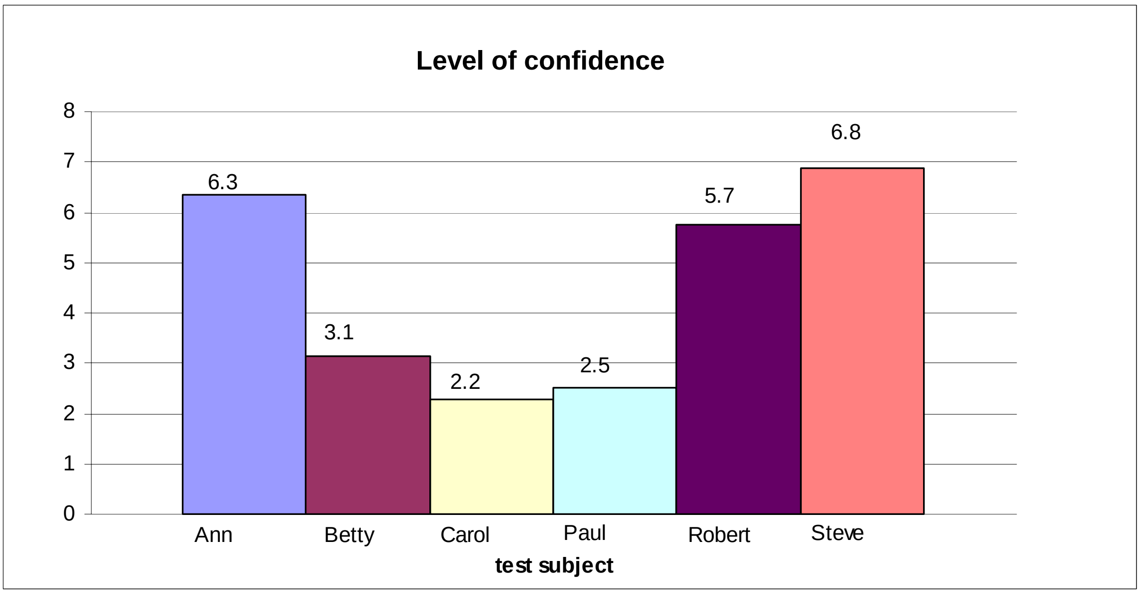


Figure 7: The level of confidence of all test subjects.

The highest level of confidence was produced by the post doctoral fellow Steve. The lowest confidence level was produced by Carol who was a first year PhD student.

The second part of our study analyzed the level of correspondence between the highlights marked by the students and the instructor. We identified areas of the document in which at least five out of six of the test subjects obtained the maximum score possible. Their perceived importance of the concepts match the instructor's perception.

During the study we identified six areas with high levels of correspondence. It is difficult to identify morphological similarities between these six areas. However, similar to what we detected during the evaluation of the data for the level of confidence scoring, the word count for these paragraphs averaged 229.3 words. Two out of six of these areas are preceded by graphical components and 4 out of 6 of them are placed at the beginning of a section. Only one of them is at the end of the section. In this case it is immediately preceded by two graphical components.

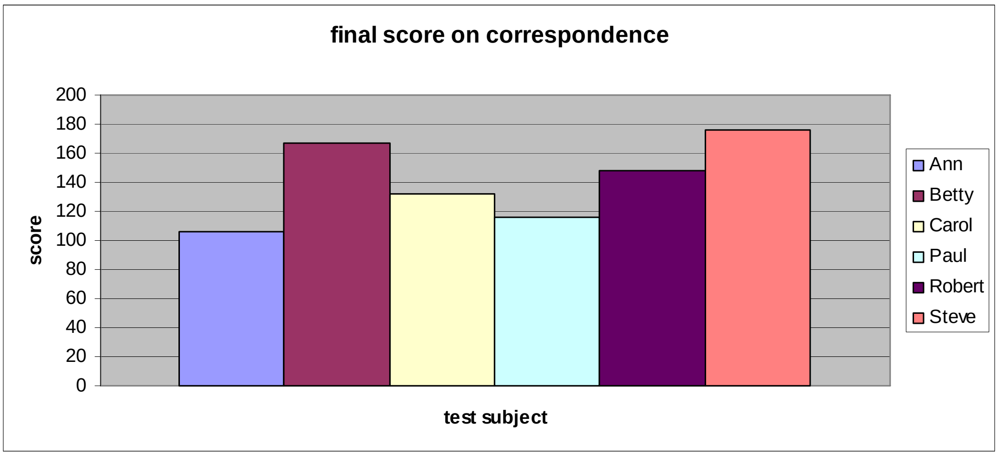


Figure 8: The scores of correspondence on all the test subjects.

The final correspondence score is the addition of all individual scores. The scoring scheme measures the proximity of marking between students and the teacher. The background information provided by the students seems to confirm the pattern produced by the metrics. The highest score (176) was produced by the doctoral fellow (Steve).

3. RELATED WORK AND DISCUSSION

3.1. RELATED WORK

Hsien-Hui Tang (2006) has conducted semester long protocol studies on the level of shared understanding between instructors and students in the studio conversations. Tang's work includes protocol analysis, questionnaires, and ethnographic observations. During the protocol analysis, studio conversations between different students and the same instructor were analyzed to compare their understanding of e ach other. The students and the instructor were requested to mark the important sentences from the transcripts of the recorded conversation. The sentences marked by both the students and the instructor indicated mutual understanding. The percentages of mutual understanding of the conversations of different students were compared. Better mutual understanding seems to correlate to better grades. However, further studio observations were suggested to investigate the correlations between student grades and their understandings of studio conversations. Tang's work analyzed the level of understanding between the instructors and the students in verbal communication in a studio setting. Our study however is interested in the comprehension level of study documents, and the impact that education in reading and writing might have in the level of comprehension of these texts.

3.2. DISCUSSION AND FUTURE WORK

The data collected by the study showed that students' expertise of the subject matter is displayed as their comprehension level, and that the markings are in direct correspondence to these levels. The test subject who consistently performed at the highest level is the post doctoral fellow, Steve. The level of performance might be the result of his academic level. It is possible that in his academic carrer he would have developed a estrategy on how to extract information from these documents.

The metrics also helps us identify students who produced lest amount of highlights but obtained good results at the level of correspondence (Fig 9). Robert recieved the best score (Fig 10). He has worked with the instructor for a number of years. It see ms that his document reviewing behavior pattern might be influenced by years of sha red experience with the instructor. This student not only highlighted the same co ncepts as the instructor, but he only highlighted those particular text elements, refle cting a high level of correspondence at the behavioral level between him and the in structor. It Is worth noting that Robert has the second highest score (148) from our g roup even though he is a first year PhD student .

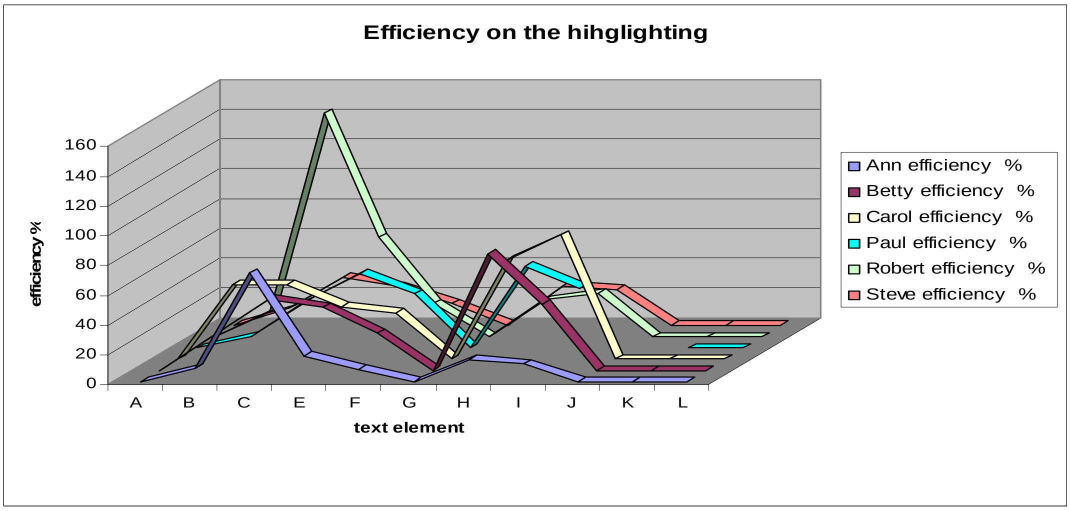


Figure 9: Shows the scores of efficiency in highlighting.

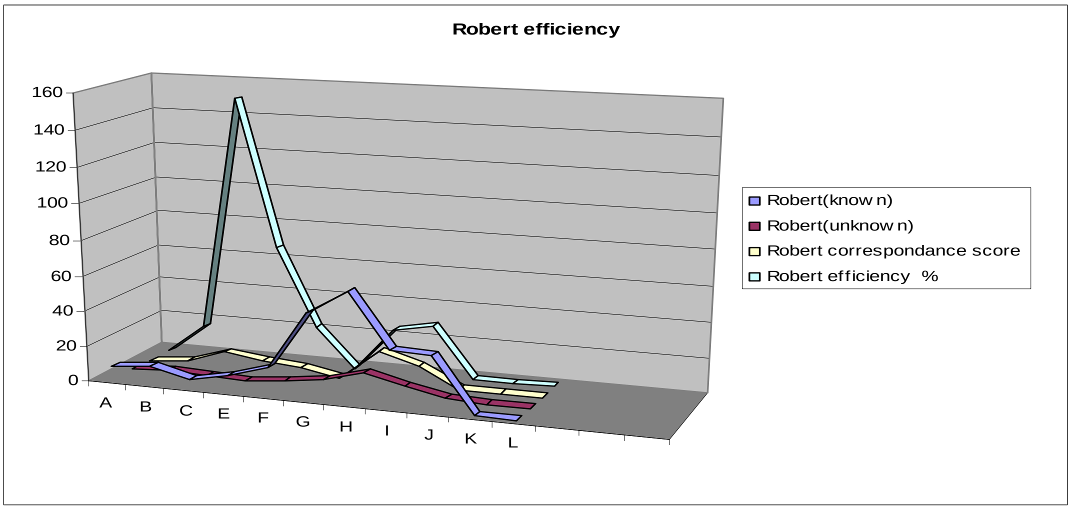


Figure10: Robert's scores of efficiency in highlighting.

Future research would be to further investigate the impacts of the organizational structure of the document on how people perceive the importance of the concepts. It seems that the proximity of supporting elements such as graphical components might increase the comprehension level.

The next step of our research would be to engage with a larger groups of students with different academic backgrounds. We would like to investigate how highlighting behavior evolves over time to verify if students improve their comprehension level of study texts after readiong many different documents in a semester.

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