How can the ‘Zeigarnik effect’ be combined with analogical reasoning in order to enhance understanding of complex knowledge related to computer science?

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How can the ‘Zeigarnik effect’ be combined with analogical reasoning in order to enhance understanding of complex knowledge related to computer science?

MASTERS THESIS

by

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Abstract

Many people face difficulties in remembering knowledge, which is complex and abstract. This is especially important when the descriptions of knowledge are to be stored in searchable knowledge bases. But if complex knowledge can be transferred through real life stories, it is more understandable and easier to retrieve for the knowledge acceptor. Moreover, if the stories follow a certain pattern like ‘intentional suspense’ it may be more useful. This study investigates how far a story with intentional interruption is helpful in transferring complex computer science knowledge through processing of information that compares similarities between new and well-understood concepts.

The data collection was done by applying framework analysis approach through the interview of 40 students of Stockholm University.

Results of this study is assumed to help organizations to design, store and retrieve complex knowledge structures in knowledge bases by using a specific pattern of the stories used in the narrative pedagogy known as 'Zeigarnik effect' which is a form of creating suspense.

Interviews with managers showed that they are positive to using the type of knowledge transfer as is proposed in the results of this thesis.

Transcribed interviews with students show that the students appreciate and understand the use of analogies in combination with the ‘Zeigarnik effect’ as is described in the result of this thesis.

After analysis of the data collected from the experiments, it was confirmed that ‘Zeigarnik effect’ has a small positive effect for a group of people as better results have been found in most of the time when ‘Zeigarnik effect’ was used as compared to when the ‘Zeigarnik effect’ was not used. The participants that experienced the ‘Zeigarnik effect’ answered in a better way which proved that their understanding and memory regarding the subject have been enhanced using it.

Keywords: knowledge retrieval, knowledge sharing, complex knowledge transfer, knowledge transfer in university, programming concepts idea distribution, analogical reasoning in computer concept.
Acknowledgement

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Chapter 1: Introduction

As information technology continues to grow the world is becoming more and more knowledge oriented (Linkedin, 2012). In every sector, managing knowledge has emerged up a crucial factor for successful management of organizations. Nowadays the key success factor of any institute depends much on effective knowledge sharing, particularly complex technical knowledge sharing (Carvalho, Santos and Soares, 2012). A number of researchers like Marcotti and Niosi (2000) believed that although industry and academic institutions have been able to transfer simple knowledge, they failed to transfer complex knowledge with a high success rate.

In modern organizations, knowledge is regarded as an important resource for the organizations and acknowledges the certainty to leverage on it for achieving success in dynamic business environment (Gan, Ryan and Raj, 2006). But senior managers have found it difficult to increase productivity in their firms through programs of knowledge management (Gold, Malhotra and Segars, 2001). They describe the main reasons for the failure is due to lack of visualization or absence of familiarity or the abstractness of the knowledge.

Many researchers formulated different ways to increase knowledge visualization (Bai, White and Sundaram, 2012). Many theorize about narrative pedagogy to fulfill this desire. One such researcher was ‘Bluma Zeigarnik’ who proposed ‘Zeigarnik effect’ as an effective way to comprehend and remember ideas (Zeigarnik, 1927).

The ‘Zeigarnik effect’ mainly theorizes that the tension that is associated with unfulfilled goals persist in mind. Our brain signals our conscious mind which maybe busy with new goals that a previous activity was pending. This theory of ‘experience dissonance’ has been proved in various ways and areas of interest by many researchers such as Baumeister and Bushman (2008). Findings by Mantyla and Sgramella (1997) suggest that interruption in a current task produces positive memory activities thus escalates the person’s sensitivity to pinpoint the desired affair and that is how it helps learning by creating as well as resolving suspense.

This study is aiming at identifying and analyzing the success rate of narrative pedagogy that how well it succeeds in transferring complex knowledge related to computer science. The specific method for storytelling which will be investigated is the ‘Zeigarnik effect’ as well as it will provide the reader about the partial fulfillment of the problem i.e. how the mystery
was solved and in turn the reader will gain the internal knowledge of the story through ‘Zeigarnik effect’. Zeigarnik effect is a method of storytelling using unsolved mystery; suspense with twisted ending which theorizes that unfulfilled goals persist in mind and then when there is a description of how the mystery is resolved or the goal is reached the constructive part of the story is better remembered and is better suited for being reused.

1.1 Background

Knowledge management involves the series of activities and techniques used to get the most from an organization’s tacit and explicit knowledge (Teece, 2000). Knowledge management generally tells us the ways in which organizations constructs, withhold, and contribute knowledge (Argote, 1999; Huber, 1991). A key assumption in the collected works of knowledge management is that an organization will have a foundation of economical lead if it has an effective way to administer its knowledge (Schroevers and Hendriks, 2012). Many experts believe that the key standpoint of knowledge management is the distribution of specific knowledge. Knowledge sharing inside teams and across teams in an organization enables organizations to expertise knowledge-based resources (Cabrera and Cabrera, 2005). Researchers like Collin and Smith proved that knowledge sharing promotes an organization in multiple and multilevel ways such as faster performance, sales growth, superior product and service (Collins and Smith, 2006). Thus, although knowledge sharing has positive effects on long term organization output, but many individual factors hamper this sharing (Wang and Noe, 2010).

The presence of a gap between knowledge producer and knowledge user is considered as one of the key hindering factor behind knowledge transfer. Those who are decision makers and those who are researchers reside diverse domains based on varying belief systems, values and practices (Caplan, 1979). So if the knowledge donor transfers the knowledge with associated facts, motivations, other humane factors and his personal recounting of events involved with the knowledge i.e. he describes it through a story it could produce a better result on the knowledge acceptor.

1.2 Problem statement

Software industries as well as educational institutes have managed to formalize and transfer knowledge through descriptions of user experiences or personal stories. On the other hand, how the ‘Zeigarnik effect’ aids in
transferring more abstract forms of computer science knowledge by telling it through simple, everyday stories and then by relating stories to analogical reasoning, has not been investigated so far.

1.3 Goal

This thesis aims at investigating how a specific method of narrative pedagogy named ‘Zeigarnik effect’ can be combined with analogical reasoning for enhancing the transfer of very abstract knowledge related to computer science.

1.4 Research question

How can the ‘Zeigarnik effect’ be combined with analogical reasoning in order to enhance understanding of abstract knowledge related to computer science?

1.5 Target group

Knowledge transfer is considered as one of the extremely underestimated but one of the critical success factors in modern day IT, R&D companies as well as academic institutions (Betz, Oberweis and Stephan, 2010). In organizations, project managers and further technical managers may use the procedure used in this study for successful transfer of complex computer science knowledge so that critical knowledge gets shared among the team members. This study can also provide significant inputs to academic institutes to provide better knowledge transfer for complex knowledge related to computer science (Savita, Hazwani and Kalid, 2011). Some researchers belief that story telling is an effective way of transferring knowledge (Wende, Philip and Dubberke, 2009), but how far that is effective in transferring abstract knowledge related to computer science among the students and IT employees will be investigated in this study.

1.6 Disposition of the report

The disposition of this report is mentioned below which consists of five sections.
Section one: It is about the introduction of the research topic. This section consists of background, description of the research area, purpose and significance, research question and limitation, which provide a general impression of this paper.

Section two: This section is about the literature review related to research topic that gives an idea about knowledge sharing reasons and way among faculty members and their personal characteristics.

Section three: It involves methodology, background study analysis framework as well as the limitations for the research topic.

Section four: Data collection process, analysis and result are deliberated here.

Section five: Finally a discussion, conclusion and future work are offered in this section.

Moreover, references and appendices are added after section five.

Chapter 2: Literature review

This study claims that complex knowledge related to computer science can be transferred and remembered in a much more effective way if narrative pedagogy namely ‘Zeigarnik effect’ have been used i.e. if it was told using suspense stories with unfinished ending. Online research publication libraries like ‘Springerlink’, ‘Wiley online library’, ‘ScienceDirect’ have been used for searching similar related research papers as well as to find evidence to support our claims. These online databases namely ‘Springerlink’, ‘Wiley’, ‘ScienceDirect’ were chosen as they indexed papers from multiple domains as our research is loosely related with human psychology and closely related to computer science. Also these are well known, reliable and authenticate publications that support academic purpose and no further justification is required. All sources contain publication date and we tried to choose most recent papers for our research topic. Numbers of keywords are used to search literature that is closely related to the topic e.g. ‘knowledge sharing’, ‘narrative pedagogy, ‘Zeigarnik effect’. After this, the summery have been read and if that resembles connectivity to the present research it has been analyzed and references have been checked.

Past researches by Paniagua-Ramirez, Barone and Torres (2004) claim that telling abstract knowledge i.e. knowledge which is difficult to comprehend in real life can be shared by exemplifying it to a real life approach as
humans remember stories well. Former studies like Greist-Bousquet and Schiffman (1992) also suggest that people generally remember stories, which follow some specific pattern like twisted ending and incompleteness. These theories are also supported by Bruner’s (1965) study ‘In search of pedagogy’ where the author demonstrated that certain knowledge delivery patterns amplifies knowledge transfer.

2.1 Knowledge Sharing and transfer

Hooff and Hendrix (2002) proved that willingness of individuals to share knowledge is the biggest success factor for knowledge transfer. However, Szulanski (1996) examined that the personal relationship between organizations and knowledge provider or seeker matters for positive or negative outcome of a knowledge transfer. Dixon (2002) and Nonaka (1994) proved that individuals or a group of individuals that have invested resources in making an advance, complicated knowledge may be unwilling to contribute to knowledge seekers with a fear of losing ownership of the knowledge, often demonstrates negative behavior such as lack of motivation, unless they are given good incentives to do so. However, if the knowledge manager who is facilitating the process of knowledge transfer, follows some pattern for codify the knowledge in a readable form and use a common language (Gourley, 2003), and if there is collective expertise between people that involve in sharing, then it will be easier for the knowledge seeker to captivate the new knowledge (Chang, Huang, Henderson and Bhalla, 2005). A methodical approach with coordination, expertise and supporting behavioral attributes encourages knowledge transfer.

Knowledge transfer is considered as a procedure where the sharing occurs from person(s) having some specific knowledge to person(s) desired the specific knowledge (Decker, Landaeta and Kotnour, 2009). According to Zeid (2005) knowledge transfer can be visualize as a flow between knowledge provider and knowledge seeker, where it appears as a selective push pull process between the provider and seeker. Getting the background of the knowledge transfer it is also possible to estimate other characteristics of the knowledge transfer (Pettigrew, 1997).

2.2 Narrative pedagogy

According to Ironside (2005), narrative pedagogy is an interpretive approach for knowledge transfer, where learning and thinking evolves from
the lived experiences of the people associated with the knowledge transfer process. Narrative pedagogy downplays the seriousness and consequences of moral absolutism and quantifying learners through objective tests (Brna, 2008). Gleeson-Kreig (2006) states that, narrative pedagogy focuses on student participation in the learning process where experimental stories are interpreted to bring out what someone should do. Zeigarnik, in her book “On finished and unfinished tasks” discusses that learning of human brain depends on multiple aspects, of which a failure, unsolved incidents or twist in a tale is a very good facilitator for a story to remember. Jensen in his book “Teaching with the brain in mind” points out that the problems can be described with the help of picture / short films. Based on all these previous researches, we can short out few characteristics of good stories that motivate people and have a long impression are:

- Story should have some motivation. (Lind and Tyler, 1988)
- Story should have some twisted ending (Zeigarnik effect)
- Stories are incomplete (Zeigarnik Effect, Greist-Bousquet and Schiffman, 1992)
- Stories should be resolved to be useful otherwise they will remember as a problem that is not suited for reuse.

Researcher like Reber (1989) describes that while transferring knowledge a good approach is to describe an outline of it and give it a unique name. Management Gurus like Dr. Phil (1999) also describes this as ‘name it before you claim it’ as a successful strategy to gain some motivation as audience may feel about learning some new approaches.

2.3 Zeigarnik effect

In 1927, Soviet psychologist Bluma Zeigarnik, proved that human recall interrupted tasks more frequently than completed tasks. Many other psychologists came forward to find reasons behind this. Klinger (1975) proves primary objective can be abandoned, but in a very costly, time consuming and complex way. Until the time of objective detachment comes, the person remains committed to an unfinished endeavor (Baumeister, Masicampo and DeWall, 2011).

It is a natural tendency of all human being that they focus on unfulfilled goals even they are engaged in other tasks (Martin and Tesser, 2006). McGraw and Fiala (2006) advocate rewarding acts as a negative effect in task completion thus undermines Zeigarnik effect. Mäntylä and Sgaramella (1997) established that performance of a person increases if Zeigarnik effect gets introduced.
All these, implicates that if complex knowledge related to computer science is delivered using suspense and at the end rewarding the audience with a solution of the problem, then they may remember it more than the same knowledge get transformed in a straight forward and normal way.

**2.4 Analogical reason**

Analogical reasoning is considered as an important feature of human cognition which involves knowledge transfer between a relatively familiar domain i.e. source to another less known domain i.e. the target (Vosniadou and Ortony, 1989). Recent researches have proven that a person can recognize and use relational similarity if they know the domain knowledge associated with it (Goswami, 1992).

**Chapter 3: Choice of research approach**

As the goal of this to understand how far a certain pattern of narrative pedagogy helps to transfer complex knowledge, it has been understood that the data type for analysis will be such that:

1. It will define or try to define a general concept
2. It will search for pattern
3. Focus will be on similarities and contrasts in natural enquiry.

From the above understanding the choice of research approach selected was qualitative research approach as it satisfies all the criteria of the data to be analyzed. The data available for the investigation was mainly of a qualitative type. Also, the goal is not to predict and control as well as the focus is not based on prediction or controlled and experimental outcome, quantitative process was rejected. As the goal was closely related to questions concerning how computer science students react when experiencing the ‘Zeigarnik effect’ when it is combined with analogical reasoning when they solve abstract technical problems, it was concluded that a descriptive and investigative approach was more relevant.

Among the qualitative research methodologies, grounded theory, framework analyses have been studied explicitly.

From various notes on grounded theory it was revealed that in grounded theory, concepts from primary stage of data analysis gets compared with subsequently producing data. Grounded Theory’s main aim is to generate
theories using social phenomena which experiments to explain a process (Lingard, Albert and Levinson, 2008). The researcher here constantly compares the theories and groups until they grasp a theoretical permeation. So this method was rejected after considering the following:

Grounded theory may alienate potential recipients from research findings and researchers may not uncover significant theories if conducted under a small amount of time and due to independent data gathering, as the data gathered from different sources may lead to out of boundary for the desired research question. This risk can be neutralize by doing the research over vast number of samples but the time and resources are limited (Jones and Alony, 2011).

After rejecting grounded theory, the framework analysis (Denzin & Lincoln, 2000) approach has been studied as this technique is very suitable for any applied policy research because:

1. Framework analysis is a very similar approach to grounded theory, but it differs in that it is better adopted where the research has specific questions, a limited time frame, a predesigned sample and a particular setting (Srivastava and Thomson, 2009).

2. Also, another reason for choosing framework analysis is that this research talks about user experience and perception and tries to understand the reason behind it. For this kind of research ‘framework analysis’ can be considered as a chosen path according to Aronson (1994).

Framework Analysis approach has 5 key research stages. These are: familiarization of the collected data, ascertaining a thematic framework, indexing and charting and lastly representing and clarification. These can be undertaken in a linear fashion, which implicates all data can be gathered before analysis initiates.

The research approach have been considered as: selection of two ideas related to computer science, construction of stories, pre study involving a limited number of samples, selection of methodologies for gathering data followed by analysis process.

3.1 Ethical aspects of the research
In articles like (Shrestha, Tanaboriboon and Hanaoka, 2007; Yasnitsky, 2011) the authors have not argued for the ethical aspects of allowing teaching methods that may in some cases put students into stress. In this investigation I have similarly not made any ethical investigation of if the methods are in line with the students’ personal interests. If, however, anybody would want to implement the methods I have investigated in a teaching situation, it would be advisable to make an investigation of the students feeling of integrity while experiencing the ‘Zeigarnick effect’.

3.2 Summary of all methodological steps

The research method chosen for doing this study is framework analysis. the framework approach is mainly suitable for analyzing cross-sectional descriptive data, empowering diverse characteristics of the occurrences under investigation to be netted. The framework analysis approach, through its interconnected stages, provides the description of the procedures, which provides the way of analyzing data towards the generation of descriptive to explanatory accounts. Also,

· It is a popular method of analyzing qualitative data where researchers need to comprehend data from a number of interviewee (Tierney, 2012).
· It seeks the answers of specific questions (Srivastava and Thomson, 2009).
· It is a research method for finding out the effectiveness of an applied policy (Walt, 2008).
· Framework analysis method provides flexibility of collecting research data followed by analysis as well as doing collection and analysis of the data simultaneously (Srivastava and Thomson, 2009).

Framework analysis method is composed of these main steps:

1. Data management – This step consists of mainly becoming familiar with the collected data (through reading and re-reading); recognizing initial themes/categories; making a coding matrix; inputting the collected data to the themes and categories in the coding matrix. (Smith and Firth, 2011)

2. Developing stories, pre study involving association between the subjects until the ‘whole picture’ appears; developing more abstract concepts, developing associations within concepts; rechecking the original data and diagnostic stages to ensure the likelihood of misinterpretation at any stage; interpreting/finding meaning and explaining the concepts and themes; discovering wider application within the concepts emerged up (Smith and Firth, 2011).
Following those steps, the present research has been constructed with the following procedures:

1. The first step is the initial short literature survey of the problem type and possible approaches to solve these types of problems (to be able to choose general method). The reason for doing this step is to situate the present study within the area of the research.

2. The second step is the more extensive literature study. This section will provide past researchers that have been done in narrative pedagogy and ‘Zeigarnik effect’. The KTH online library has been searched to gather papers of past researches in the field of ‘narrative pedagogy’, ‘complex knowledge transfer’, and ‘Zeigarnik effect’. This step will provide the necessary information about originality of the research, as well as it will also provide information about already proved points so those can be used as a standard for the present study.

3. This step comes in support of choosing theme i.e. constructing the stories with certain criteria. These are:
   a) The story will describe simple daily life incidents.
   b) The story should have two versions. In one version, the explanation of the incidents depicted will be described at the time of the incident. In another version, same will be told at the end thus suspense will be created.
   c) The story can be easily remembered.
   d) The story should be combined with an analog story from the area of computer science.

4. A pre study will be done with some project managers to know what they feel about transferring of complex computer science knowledge through simple daily-life stories. This step is required to identify initial themes and categories.

5. After that, a round of interview will be taken which is based on technical questions to determine how good they have understood the
internal knowledge. The interviews will be recorded and transcribed for analysis.

6. Just as a final test to secure that the qualitative findings correspond to real test results a minor quantitative study was performed. The aim of this study was to find quantitative indications that verified the qualitative results. As a limited group of 40 students out of 400 accepted to participate in the experiments it is only used as a pilot for more extensive studies in the future that could provide more reliable verifications of the results.

3.3 Implementation of the research method

This section will provide the extensive argumentation about the design of the qualitative approach. This experiment was initiated by doing a background study described at Chapter 2. This was important to know if anyone did the same study before and if yes, what were the preconditions and results. This was followed by an extended literature review researches based on ‘narrative pedagogy’, ‘knowledge sharing’, ‘Zeigarnik effect’ to understand what other researchers contributed in this area so that their contribution can be taken to support the claims in how well complex ideas can be transferred using ‘Zeigarnik effect’. To carry out the experiment, two stories were constructed which will intrinsically deliver complex computer science knowledge. A basic knowledge about computer programming is required to understand the inherent concepts told through the stories, so these stories will be told to computer science / information technology students. These stories were constructed on the basis of analogical reasoning i.e. a story with daily incidents which are known to common people have been formed but the incidents described will have analogical incidents in computer science. So, a person who will go through the stories can visualize how the similar things happen in computer world. These two stories will deliver two different concepts related to computer science. More number of stories would have produce better results but due to time and other limitations only two different concepts will be tested. Each story was made of two different versions- one with suspense where the mystery that lies inside the story would be revealed later, another without suspense where the mystery would be explained as per the story progresses. Before taking tests of this analogical approach a pre study was done with five project managers who work in various IT corporations. The aim of this was to know how the
industry feels about this experiment. Then those stories were be told to 40 computer science students of Stockholm University in the formation of two groups twenty students in each group. The number of the students has been made 40 to gain opinion from a fairly large group of students. Of course larger the number would produce better result but due to time constraints, data collected from 40 students should be good enough to conduct the present experiment. The students were divided into two groups to compare how they react to the stories told to them as the main aim of this study is to know if stories with suspense do a better result than story without suspense. This has been mentioned in details at ‘Data collection and Analysis’ subsection.

For analysis of the collected data, a ‘Qualitative Analysis’ technique was used which is detailed in the next chapter. Based on previous studies, it was clear that the research method was an ‘interpretative study’ i.e. to tell a story to a person and examine how well the subject understood that inner concept from it and how well the subject could apply the insight via an analogical reasoning.

Firstly, interview transcripts will be read to get familiarized with the data. Next step was to identify a thematic framework that is the central component of this approach to data management and interpretative analysis. The thematic framework is employed to order and organize data according to key themes, concepts and emergent categories. As per ‘framework analysis’ method of data analysis, these categories evolve and are refined through the researcher’s familiarization with the raw data. These gets followed by subsequent cross-sectional labeling or ‘tagging’. So, the next step will be indexing, where qualitative data is categorized to identify specific fragment of data for different themes. After that charting will be done so data can be read easily from whole dataset.

Then the matrix will be filled up based on their inputs with 4 choices such as good answer as 3, mostly correct answer as 2, somewhat correct answer as 1, and wrong answer as 0. Then the average will be taken for the final success rate of the knowledge transfer by this process.

3.4 Design of the stories

The stories have been designed by the working principle of ‘analogical reasoning’ i.e. complex descriptions can be an analogy of a simple
phenomenon. The analogy between common everyday situations with suspense can enable a reader or listener to understand a more complex structure. Researchers like Bruner (1965) suggest that a fundamental principle can also provide a model of understanding other things similar to it. Also, Carbonell (1983) theorizes that complex problems can be solved in an increasingly reliable and direct manner using analogical reasoning. Based on these facts, the stories in this research have been developed which are analogy of a complex computer problem. The stories also have another criterion i.e. development of suspense as proposed by Bluma Zeigarnik that suspense promotes understanding in a certain context.

3.5 The need for pre study

In order to allow the ‘Zeigarnik effect’ to work the best, a strict focus on the matter was needed. That’s why a pre study was done to know what industry feels about this kind of knowledge transfer process. In the pre study, five project managers were interviewed and their opinions were analyzed.

Firstly, the project managers were told about the whole idea. Then they were asked about how they feel about the concept, what the audience may think if someone told these stories and does the particular pattern of creating suspense may cause any good effect to them? Based on their answers, a numerical indexing was done to make a further analysis of their answers.

Data collection of the pre study was done by interviewing five project managers. As it is a small pre-study so taking opinions of five different project managers can be considered good enough. The transcripts of these interviews are presented in appendix B. After data collection was complete, a qualitative data analysis process has been followed. Firstly, listening of the recorded interview had been done to get familiarized with the data. Then, the data is categorized and indexed. For example, if the interviewee says “yes mostly” i.e. general advocacy towards certain fact, it has been indexed “agree” but if he says “I very much appreciate it” or something which indicates strong endorsement towards certain fact, then it has been indexed “strongly agree”. If the interviewee’s answer have composed of both positive as well as negative opinions or producing weak agreeable statements then the answer is categorized as “somewhat agree”. Also, if the interviewee refrains from any answer or has an unfavorable view then it
was considered “not agree”. This indexing will help to categorize the data into a particular theme which will help to measure degree of accordance of an interviewee. In the table below, actual citations from the interviewee were inserted in order to provide a better understanding of the classification of the citations done in the later table. Also, there were some improper citations which have been discarded in order to produce credible results.

Table 1 holds the interview extracts:

<table>
<thead>
<tr>
<th>The Interview questions. One question for each column</th>
<th>What are your views about the whole idea?</th>
<th>Do you think the audience can have a good conception after reading the stories?</th>
<th>Do you feel the story with zeigarnik effect can do better than the story without for a group of computer science students?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview number</td>
<td>Answer of Question 1</td>
<td>Answer of question 2</td>
<td>Answer of question 3</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------</td>
<td>----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Interview1 answers</td>
<td>“can be applicable to those who don't understand”</td>
<td>“yes they can remember it through the story”</td>
<td>“It may have some effect”</td>
</tr>
<tr>
<td>Interview2 answers</td>
<td>“great in fact to learn new concepts as well as remembering it”</td>
<td>“Definitely!”</td>
<td>“Yes, for both understanding and remembering purpose”</td>
</tr>
<tr>
<td>Interview3</td>
<td>“Nothing new, but a good way”</td>
<td>“Depends on the stories”</td>
<td>“Yes, mostly”</td>
</tr>
<tr>
<td>Interview4</td>
<td>“very limited. Not applicable to everywhere.”</td>
<td>“better to tell them the concepts simply rather than using complex stories”</td>
<td>“I feel it may have good enough effect.”</td>
</tr>
<tr>
<td>Interview5</td>
<td>“I think it is applicable to many others”</td>
<td>“Sure, it is a good way.”</td>
<td>“Yes, to some extent.”</td>
</tr>
</tbody>
</table>
Table 1 - Interview extracts for managers

Based on their sayings described in the table above, it has been categorized as in the table below.

<table>
<thead>
<tr>
<th>Interview questions</th>
<th>What are your views about the whole idea?</th>
<th>Do you think the audience can have a good conceptions after reading the stories?</th>
<th>Do you feel the story with ‘zeigarnik effect’ can do better than the story without for a group of computer science students?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview1</td>
<td>agree</td>
<td>Agree</td>
<td>Somewhat agree</td>
</tr>
<tr>
<td>Interview2</td>
<td>Strongly agree</td>
<td>Strongly agree</td>
<td>Strongly agree</td>
</tr>
<tr>
<td>Interview3</td>
<td>Somewhat agree</td>
<td>Somewhat agree</td>
<td>agree</td>
</tr>
<tr>
<td>Interview4</td>
<td>Not agree</td>
<td>Not agree</td>
<td>Somewhat agree</td>
</tr>
<tr>
<td>Interview5</td>
<td>agree</td>
<td>Agree</td>
<td>agree</td>
</tr>
</tbody>
</table>

Table 2 - Answer categorizations

Next, their opinion is categorized like strongly agree as 3, agree as 2, somewhat agree as 1 and do not agree as 0. After that the sum has been taken for each perceptions and the analysis for each of them is described below. This analysis is a quantitative analysis to have the priority of cultivated data. This sum will indicate the overall proneness of an interviewee in numbers. The quantitative data has been shown in table 3.

<table>
<thead>
<tr>
<th>Interview</th>
<th>What are your views about the whole idea?</th>
<th>Do you think the audience can have good conceptions after reading the stories?</th>
<th>Do you feel the story with ‘zeigarnik effect’ can do better than the story without for a group of computer science students?</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>interview1</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>interview2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>interview3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
3.6 Result of the pre study

One project manager emphasized both on learning as well as remembering the new concepts while answering to the question one: “what are your views about the whole idea?” His answer was “It is good....great in fact to learn new concepts as well as remembering”. She very clearly mentioned her view about the process as well as depicted the reasons behind it and it matched wholly to the concept of Zeigarnik effect. So it has been understood that the person was ‘strongly agree’ with the concepts described. While answering the same question, another project manager stated ‘May be ok but very limited. Not applicable to everywhere.’ This answer gave a notion that the interviewee was not sure about the work as she talked about a possibility as well as the answer didn’t went to the deep into the theory. So this answer was graded ‘not agree’. In another case, one project manager answered “After hearing the stories I feel that I remember most part of it, so I think it is applicable to many others.” As she told about the remembering things from this story but she failed to mention about the learning aspects, she clearly mentioned about her views that she agrees about the concept but not very strongly, so her answers was graded as ‘agree’.

While answering to the question “Do you think the audience can have a good conception after reading the stories?” One answer was “This I can’t say. Perhaps it is better to tell them the concepts simply rather than using complex stories.” This answer is mainly inclined to not to use the concept rather than stick to the standard way. So the interviewee was classified as not agree to the above question. While another interviewee was ‘Definitely, teachers should try story telling like this to introduce a new topic so that everyone can think about it later on.’ This answer provided the necessary positives that will enable a person to use the idea as it depicted the benefit that will come out from it in a complete manner. So this answer has been classified as ‘strongly agree’. Answers like ‘Sure, it is a good way’ showed that the person was agreeing with the concept but it didn’t provide the
necessary reasoning behind it. So based on the person’s interest to the theory it was classified as ‘agree’ with the concept.

While answering to the question “Do you feel the story with ‘Zeigarnik effect’ can do better than the story without for a group of computer science students?” One project manager answered “It may have some effect. This answer provides a notion that the person was confused about the outcome while he is not opposing it fully. So this has been classified as ‘somewhat agree’ with the theory. Another answer “Yes, for both understanding and remembering purpose” indicated the very eagerness about the theory and based on the completeness of the answer, it was categorized as ‘strongly agree’.

3.7 Conclusion of the pre study

Manager one was confident about ‘Zeigarnik effect’ can do good for learning but was not sure that it can do better to someone without using ‘Zeigarnik effect’. But his overall reaction was positive on this.

The second manager was very positive on the theory and strongly agreed about the benefit of it in case of learning complex computer concepts.

The third manager was not very clear about the whole idea, but acknowledged that trying this may have some positive values.

The fourth manager was not agreed and based on her reaction, she felt that it may not be a good way of learning.

The fifth manager expressed her opinion that it is a positive and depending on the stories, it can have good potential for learning complex concepts.

Based on five project managers opinion, their willingness can be measured respectively as 5/9, 9/9 i.e. 4/9 i.e. 1/9 i.e. and lastly 6/9 i.e. So it can be understood three of the five project managers interviewed were appreciative of the use of the type of stories that were presented to them and were willing to follow the recommended procedure as a method to transfer complex knowledge related to computer science. They also acknowledged that it may be helpful to the students.
The analysis of the results indicated that when we combine a common everyday story with a 'Zeigarnik effect' and use the 'Zeigarnik effect' to focus on what is important in the story then this focus can be transferred via analogical reasoning to a description of complex knowledge from computer science in order to facilitate understanding this knowledge.

Chapter 4: Analysis

Randomly met students of KTH / Stockholm University were asked if they were willing to participate in a technical knowledge transfer session. Then their areas of study were examined as participators for this test should have computer science knowledge. If the participants are agree with these then the whole process were explained to them. They were informed that they will be told a story and after that few questions will be asked based on the inherent knowledge they story describes. They were also informed that the questions would be technical, related to computer science knowledge.

During the interview, a judgment has been done about how positive they are for the process. As some students provided pointless answers and those interviews are rejected. Only those persons’ interview were accepted who seriously listened the stories during the conversation.

Almost 100 students have been approached to for the interviews. Out of them many were not willing to participate and some others didn’t have the computer science background. Some others interview were rejected as it was seen that they were providing falsified answers or not very keen. After everything, 40 students’ interviews were selected for further analysis.

The transcripts of the interview are presented in appendix D. After the data collection was completed, qualitative data analysis process was followed similar to what has been done in the pre-study. The collected data was familiarized by listening to the interviews, then it was categorized an indexed.

After narrating the ‘polymorphism’ story, the students were asked question one i.e. “what is polymorphism?” Answering this answers such as “Polymorphism can by understood by providing same data to different entity or person but understanding of the data will be based on the receiving entity.” or “way of handling different data type using the same name.” covers a clear definition and understanding of polymorphism as the definition is complete and covers the most important aspects of
polymorphism. So answers like these were categorized as ‘very good’ answer. If the answers are like “Polymorphism is 2 or more object with same name. It’s related to object oriented programing. As names are same, so some problems occur.” This has been categorized as ‘satisfactory’ answer. As this answer signifies that the person has understood and remember how polymorphism generally works but still has some unclear vision about it as here he does not know what problem arises in polymorphism. Answers like “It’s confusing but one need to understand the run time type of the data representation.” tells that the interviewee is very less confident about the topic but the answer also provided some correct points. Answers like this have been categorized as ‘partially correct’.

On answering the question “How can you implement polymorphism?” answers like “Like making the method names same in but signatures different, so depending on the data, the corresponding method will be called upon.” can be considered a perfect answers as the interviewee covers all the important aspect of implementing polymorphism. However, if the answers are like “If the method names are same, then parameters will be different, in that way you get to know.” Which is also correct but it lacks the correct keywords and internal view of how to implement it actually, so answers like these have been categorized as ‘satisfactory’. If the answers are ‘It happens when 2 or more things have the same name.’ it has been categorized as partially ok as it fails to deliver the overall concepts and talks about only a particular case of the problem. When the interviewee provided no answer or completely wrong it has been classified as ‘wrong answer’.

For the second story, when the answers for the first question about definition of data abstraction, the answers were like “Data abstraction is making method private and an interface over it, which is public.” Shows the clear concepts of the person about data abstractions the answer covers all the point and minute details of it. Answers like these were categorized as very good. While the answers like ‘Through data abstraction you can have an option to hide something you want to keep secret’ were good answers but the interviewee missed one or two minor points, in this case these has been categorized as ‘satisfactory’ answers.

If the answer was like “Not releasing the whole data to the 3rd party.”, which was correct but covers only one particular case or missed vital points of the definition or keywords necessary to describe it, thereby graded ‘partially ok’.

For the second question of the ‘data abstraction’ story, the answers like “It can be done by making an interface public but then made the function
private, so you have to access it through the interface.” Covers all the necessary points as well as keywords to describe data abstraction. So this answer can be classified as ‘very good’ while an answer like “it can be done by providing security, or developing conditional access” is to the point but lack few necessary features of data abstraction. So it can be considered as ‘satisfactory’ level. On the other hand, answers such as “So one have to make a definite way to access the object, other ways won’t work.” is an answer without necessary details. So this can be regarded as a ‘partially correct’ answer.

Finally the qualitative interpretations of the dialogues were transformed into quantitative values in order to be able to provide an overview of all the answers. If the answer of a particular question is nearly perfect then it was categorized as ‘very good’, if the answer is complete or composed of good logic in it then it was categorized as ‘satisfactory’. If the answer is partially correct then it was classified as ‘partially ok’. For an incorrect answer or in cases where the interviewee failed to provide any answer, it was classified as ‘wrong’.

The categorized data have been indexed as 3 for ‘very good’, 2 for ‘satisfied’, 1 for partially ok’ and 0 for every wrong answers. A Sum for each member has been calculated for further analysis.

Group A table 1 and 2 contains the formatted answer of group A students. The first table holds the answers of the 3 questions asked based on the polymorphism story with suspense. The second table has the answers of the questions asked from the data abstraction story without suspense.

Group B table 3 and 4 contain the answers of group B students. The table 3 holds the answers of the 3 questions of the first story without suspense and table 4 holds the answers of the 3 questions from the second story with suspense.

The stories are presented as below:

**Story one with suspense**
A New York based stock broker, Adam, received a text message from his overseas friend who is also a stock broker. It said "HP's shares will be down tomorrow. Adam decided to sell the shares of Hewlett Packard tomorrow and he went to bed early in order to be at NYSE before 10:00 tomorrow.

Hours later, Adam's wife found a fax document in the office room with the header: “HP is going down” and she gave it to her son.

Next day, Adam sold the HP-shares and to his astonishment he found that the shares did not go down but instead they went up. Adam became furious. He did not understand how he could have been so fooled.

By the end of the day, Adam received another surprise as his son gave him a document of detailed information about the economic status of an Indian company with the title “HP is going down”. Then he understood that he had mistaken HP for Hewlett Packard when HP stood for Hindustan Petroleum.

Above is analog to:
In software programming the feature polymorphism works in the same way. As per the story, different persons used the same data in their own way, in programming ‘+’ can do numerical addition as well as string addition based on the interpretation of the data. Likewise in the story, the word HP created the confusion as different persons understood the term differently, like someone understood HP as ‘Hewlett Packard, Adams Wife interpreted is as ‘Harry Potter’ and another person thought of ‘Hindustan petroleum’.
That is the actual concept of polymorphism.

Story one without suspense

A New York based stockbroker, Adam, received a text message from his overseas friend who is also a stockbroker. It said "HP's shares will be down tomorrow. Adam decided to sell the shares of Hewlett Packard tomorrow and he went to bed early in order to be at NYSE before 10:00 tomorrow.

Hours later, Adam's wife found a fax document in the office room with the header: “HP is going down” and she gave it to her son.

Adams wife thought HP stood for Harry Potter. The result of this was that Adam did not get the adequate information in the subtext of the fax which
said “Hindustan Petroleum” will soon face bankruptcy”. This made him sell the wrong shares the next day since he thought that HP stood for Hewlett Packard.

By the end of the day, Adam received another surprise as his son gave him a document of detailed information about the economic status of an Indian company with the title “HP is going down”. Then he understood that he had mistaken HP for Hewlett Packard when HP stood for Hindustan Petroleum.

Above is analog to:
In software programming the feature polymorphism works in the same way. As per the story, different persons used the same data in their own way, in programming ‘+’ can do numerical addition as well as string addition based on the interpretation of the data. Likewise in the story, the word HP created the confusion as different persons understood the term differently, like someone understood HP as ‘Hewlett Packard, Adam’s wife interpreted is as ‘Harry Potter’ and another person thought of ‘Hindustan petroleum’.
That is the actual concept of polymorphism.

**Story two with suspense**

Stefan had a dream of getting successful in short time by copying a successful business. His idea was to copy MacDonald’s and have a fast food restaurant of his own. To know how MacDonald works he managed to get a job there and worked with making the hamburgers. His manager was very pleased with his dedicated work. So, a happy Stefan left the job after 3 months and tried to implement the knowledge he learnt in this period.

But, to his utter bewilderment, he tried to make a hamburger in his own kitchen but failed to do so! So, how was that possible? In three months Stefan rolled out nearly 10000 hamburgers! He became very depressed because of this.

He understood that he only had learned a little part of all that should be learned in order to make well tasting hamburgers.

Above is analog to:
In computer programming, similar situation happens; programmers can use different methods they only know how to use but not how the method
itself has been constructed. To allow programmers to use hidden methods adds extra security in a project because if the method implementer and user are different persons then data doesn’t get leaked.

In computer terminology it is called ‘data abstraction’. The original method implementers developed the process for creating the hamburgers in McDonald’s HQ. They also created the data abstraction by mechanizing the process where the users only need to put switches at appropriate time. The workers who use these machines do not need to know the actual process, but know only how to use it. So the actual methods with their secret ingredients stay hidden.

**Story two without suspense**

Stefan had a dream of getting successful in short time by copying a successful business. His idea was to copy MacDonald’s and have a fast food restaurant of his own. To know how MacDonald works he managed to get a job there and worked with making the hamburgers. His manager was very pleased with his dedicated work. So, a happy Stefan left the job after 3 months and tried to implement the knowledge he learnt in this period.

But what he didn’t know is Macdonald’s process is hidden for those who make the hamburgers, which made him make bad tasting hamburgers since he could not follow these hidden processes. After having failed he then understood that he only had learned a little part of all that should be learned in order to make well tasting hamburgers.

Above is analog to:
In computer programming, similar situation happens; programmers can use different methods they only know how to use but not how the method itself has been constructed. To allow programmers to use hidden methods adds extra security in a project because if the method implementer and user are different persons then data doesn’t get leaked.

In computer terminology it is called ‘data abstraction’. The original method implementers developed the process for creating the hamburgers in McDonald’s HQ. They also created the data abstraction by mechanizing the process where the users only need to put switches at appropriate time. The workers who use these machines do not need to know the actual process,
but know only how to use it. So the actual methods with their secret ingredients stay hidden.

The questions asked to them were:

From story 1

1. What is polymorphism?
2. How polymorphism works?
3. How can you clear the confusion of polymorphism?

From story 2

1. What is data abstraction?
2. How can you implement data abstraction?
3. How come someone can work with the data and still unaware of internal architecture?

After asking these questions to individual students, their answers were transcribed and later reformatted to make it precise. In table 1,2,3,4 the reformatted answers have been presented.

In the next step, the answers were categorized as ‘very good’, ‘satisfactory’, ‘somewhat ok’, ‘not ok’ depending on the quality of the answer for a particular question. If it was interpreted that the answer is complete as well as producing a clear vision of the theory then it was classified as ‘very good’. If the answer was complete but has some limited drawback or quality of the answer was medium in it then it was classified as ‘satisfactory’. Nevertheless, if the answer was correct but incomplete, then it was classified as ‘somewhat ok’. Lastly, if the answer is wrong or no answer was given, then it was classified as ‘not ok’.

In appendix D, tables 5 to 8 hold the classification of the gathered data. After this, a numeric gradation has been done to the categorized answers. For example, if the answer is very good it has been graded 3, for satisfactory level of answer the grade is 2, for ‘partially correct’ answer the value is 1 and lastly for totally wrong answer or no answer the mark is 0. This is how the qualitative data has been measured. This has been documented in appendix D table 9 to 12.
Chapter 5: Results

5.1 Results from the interviews with managers

When the managers were asked what are their views by asking the question, the first manager described “I think it can be applicable to those who don’t understand by telling it in simple way.” whereas the second manager stated “It is good....great in fact to learn new concepts as well as remembering it.” The third manager described that “Nothing new, but may be good way to transfer knowledge.” and the fourth person told “May be ok but very limited. Not applicable to everywhere.” Lastly, the fifth manager expressed that she feels that the remember part is applicable to many others.

So after hearing the first question, it can be interpreted that the second person emphasized both on learning and remembering process and he is very much in accordance with the benefit of it. The first and the last person also feels about the goodness of the process as they think it can be applied to a large group of people but more likely they want to try it as an alternative way. On the other hand considers it nothing new but acknowledges that it can be good, while the fourth person is not sure about the benefit of the process.

When the managers were asked specifically about the usefulness of the idea, the first manager told about its dependence among the type of the audience, while the second manager emphasized about trying new concepts like this and describes “teachers should try story telling like this to introduce a new topic so that everyone can think about it later on.” The third manager describes it as the process is very much dependable on the specific stories. The fourth manager declared that she cannot agree with the concept as she thinks otherwise. The fifth manager answers that “yes, it is a good way”.

So, from their answer, this can be realized that the first manager likes to try this as a knowledge transfer method. The second person have more clearer idea as he also like to try and thinks other should do the same, while the third manager is not fully agree with the benefit of this and feels it is dependent on the stories. The fourth manager is quite negative with it as she thinks it in other way. The fifth manager agrees with the usefulness without going to much detail on it.
When asked about views if better results can be obtained if this can be tried with a group of computer science students, the first manager seemed unsure and tells that it may have some result, while the second manager emphasized both on understanding of new concepts as well as remembering it by describing “Yes, for both understanding and remembering purpose.” The third manager also agrees with the view without going to much detail of it with a simple and short answer “yes, mostly”. The fourth and fifth manager’s answer were mostly negative as they stated like “Well, as I didn’t used ‘Zeigarnik effect’ previously, I cannot say. But yes I feel it may have good enough effect” and “Yes, to some extent” respectively.

5.2 Results from the interview of the students

The student interviews were based on the two stories which were told to them before interviewing. The first question was “what is the definition of polymorphism?” Some students came up with very good definition of polymorphism including keywords like object, data type, function as well as they included how it internally working like “Polymorphism is two or more object with same name. It’s related to object oriented programing. As names are same, so some problems occur.” Answers like this were graded as ‘very good’. Answers like “Polymorphism can by understood by providing same data to different entity or person but understanding of the data will be based on the receiving entity” shows the users good memory of polymorphism but it lacked how really polymorphism works internally i.e. it lacks understanding of polymorphism to some extent. So an answer like this was graded “satisfactory”. Some other students stated like “it works at real time, its real time interpretation of data to the receiving end” shows that the interviewee’s understanding as well as memory of polymorphism was limited. So this has been graded “partially ok”. Nevertheless, answers like ‘cannot tell right now’ or similar have been graded as “wrong”.

For the second question “How polymorphism works?” some answers like “making the method names same in but signatures different, so depending on the data, the corresponding method will be called upon.” Shows the interviewee’s perception was very clear and correct. Answers like this were graded “very good”. Whereas answers like “making many methods with same name so confusion for the computer to choose upon” shows good amount of understanding of polymorphism internally. Answers like this have been sorted as ‘satisfactory’. Answers which indicated some confusion
among the interviewee or the answer didn’t clarify the internal architecture of polymorphism clearly, have been graded ‘partially correct’.

The last question from the story of polymorphism was “How can you clear the confusion of polymorphism?” Here answers like ‘I do not know’ or remaining silent was graded ‘wrong’, answers like “Need to look at the function properties” was graded ‘partially correct’ as it contains vagueness about the person’s understanding. On the other hand, answers like “Signature of the method will be different” shows the person knows the key points for detecting polymorphism. Answers like those have been classified as “satisfactory”, whereas “The data-type will be different among the same name methods” covers all the points necessary to clear the confusions in understanding and remembrance. So these kinds of answers have been classified as “very good”.

For the second story i.e. the story of data abstraction, the first question was “What is data abstraction?” Students who came up with answers like “Data abstraction is strategically hiding internal program architecture.” Implicates that the person’s understanding and memory about data abstraction is sound, so graded “very good”. Answers like “Data abstraction is hiding development details from 3rd party.” Shows the users have the knowledge of main objective of data abstraction but lacks few technical details of it. So answers like that were graded “satisfactory”. Some other answers like “Not relieving the whole data to the 3rd party” can be treated as a very ‘general’ answer for data abstraction and lacks the internal understanding of it. So this was graded as ‘partially correct’. Whereas answers like ‘data abstraction is hiding something’ was graded as ‘wrong answer’.

For the second question for the same story, few students answered “providing a whitelist so that only definite access”. This answer is wrong for the concept of data abstraction thus rewarded ‘wrong’. Some other answers like ‘I don’t know’ or providing no answer also moved to the same category. While some improved answers like “Using some interface, where data can be hidden beneath it” proves that the student may have some understanding of data abstraction but the knowledge is very limited and not well memorized. So the answer has been categorized as ‘partially correct’. Answers like “Logically not permitting access for unwanted users” shows more clarity and understanding thus rewarded ‘satisfactory’ and answers like ‘using access modifier, function-interface pattern’ can be grouped into ‘very good’ as the answer covers the necessary understanding of all the important points of the theory.
5.3 Results from the final quantitative summary

The main aim of this research was to find the indications of ‘Zeigarnik effect’ from the answers of a group of people and it was not to prove in a quantitative way. But following the results described above in part 5.1 and 5.2, the answers have been categorized and indexed in numbers. Later, these numeric have been compared to identify which group provided more appropriate answers. However, quantitative analysis was never an intension to carry out this study, only to compare which group came up with a better performance, the collected answers were indexed and later a small statistics has been made.

While taking the answers from the participants, their way of answering was carefully observed. If the participant hesitates answering or provides an unclear view or does not provide any answer, then the answer has been categorized as ‘wrong answer’ which later indexed as 0. Answers like ‘cannot tell right now’, ‘it is difficult to say’, ‘I don’t know’ or being silence to a question fall in this category.

When a participants answered like ‘polymorphism is two methods with similar name’, ‘Data abstraction is hiding data’. These kinds of answers were correct but only for a very particular scenario or the answer was not complete so, these were categorized as ‘partially correct answer’. Later it was index as 1.

When the participants came up with an answer with good amount of completeness; resulting a conclusion that the participants have good amount of understanding of the topic, then the answer was categorized as ‘satisfactory’. Answers like 'It can be like making implementation accessible only with objects. Otherwise you cannot see what is inside of a program.' is a kind of satisfactory answer. It was indexed as 2.

Nevertheless, if the participants provide a well-structured answer, which covers all aspect of the topic and also comes up with an example like how one can perform that, then the answer was categorized as ‘very good’. Later it was indexed as 3.

The final result after analysis is presented in the following table:
Results show that when groups were told stories with suspense, they have a better result than stories without suspense.

As per groups are concerned, Group A scored 98 when story 1 was told with suspense and 92 score was achieved when story 2 was told without suspense. For group 2, 99 were the score when story 2 was told with suspense and 89 for story 1 without suspense.

If we count on the basis of individual marks, then for group 1, when they were told the story with suspense, 7 persons scored 6 or more i.e. came up with satisfactory level of answer. When the same group were told another story without suspense, then also 7 persons produced overall satisfactory level of answer. For group 2, when they heard the story without suspense, 5 person scored 6 or more i.e. on the average game satisfactory answers, but
when they heard the story with suspense, 9 of them produced the same result.

As per the stories, when story 1 i.e. knowledge of polymorphism was delivered with suspense, the score was 98. When the same story was told without suspense the score was 89. At the same time, when story 2 i.e. knowledge of data abstraction was shared with suspense, 99 was the score, whereas when without suspense it was told, the overall score was 92.

In group one, 4 persons scored overall ‘satisfactory’ marks and 2 persons scored below 3 i.e. provided overall partial answers. Similarly for group 2, 4 persons came into the overall satisfactory range and 4 other people fallen to overall partial answers group.

If we analyze further the data gathered in the result section, we find the followings statistical measurements:

| Pearson Product Moment Correlation - Ungrouped Data |
|---------------------------------|--------------------------------------------------|
| Statistics                      | Story 1 with suspense  | Story 1 without suspense |
| Mean                            | 4.9                  | 4.5                       |
| Number of Observations          | 20                   |                           |

Table 9: Statistics for Story 1

| Pearson Product Moment Correlation - Ungrouped Data |
|---------------------------------|--------------------------------------------------|
| Statistics                      | Story 2 with suspense  | Story 2 without suspense |
| Mean                            | 4.65                 | 4.6                       |
| Number of Observations          | 20                   |                           |

Table 10 – statistics for story 2

Chapter 6: Discussion, conclusion

6.1 Discussion

From the analysis of the project managers’ opinions, it can be understood that they were mainly positive about using suspense as a key pattern in stories to transfer complex knowledge related to computer science. While interviewing few managers acknowledged that knowledge transfer through stories was an already established way to transfer complex knowledge but the ‘Zeigarnik effect’ was relatively new to them and they were ready to try
it. While a couple of managers expressed concern about the relative benefit of this process over the traditional simplistic way of knowledge transfer. Only one out of the five managers interviewed expressed her negative views and reluctance to try it. Two of the project managers expressed their personal opinion knowledge receivers can visualize and remember in a better way if the knowledge gets embed through stories and with suspense.

When the students were interviewed, it was found that when questions were asked after telling a story with 'Zeigarnik effect', the students used proper keywords and phrases in most of the time. This implicated that their level of understanding as well as the recall of the subject matter was also better.

From the results described above, one can conclude from the performances of both the groups that when they were told stories with suspense, the scores were higher. It was also witnessed that, the result varies widely depending on the person interviewed. Telling the same story in same fashion, and asking the exact same question reflects very different understanding of the knowledge delivered.

Among the students with different ethnic origin, most Asians scored fairly well when the knowledge was told without suspense. This can be a scope for another research where students can be categorized as per various criteria.

The score was highest when story 2 was told with suspense to group 2. Before this, story one without suspense was delivered to the group 2. So, there is an clue that when audience hear something without suspense, they forget it after the incident is complete, then for a new incident containing suspense, it provides better opportunities. From the tables, we see the positive value of correlation in case of story 2 suggests that answering pattern matches among the participants. This finding is also accordance with a study conducted by Schacter(2001) in which they found out that the higher rate of memory recall is due to the answers of completed questions acting as retrieval indications.
6.2 Conclusion

This study was commenced to find out ‘how we can combine analogical reasoning with ‘Zeigarnik effect’ to deliver complex computer science knowledge?’ From the analysis and discussion of the results we found that the test subjects were able to deliver more ‘to-the-point’, well remembered answer while applying ‘Zeigarnik effect’.

After undergoing the whole experiment and understanding the result, these following assumptions can be established:
In our experiments the ‘Zeigarnik effect’ had a positive impact for delivering complex computer science knowledge in most cases. From the statistical tables can comprehend that the mean value of answers after stories were told with suspense are higher for both of the stories. However, this positive impact is varying much among the tested persons and thus the impact cannot be generalized into always having a significant effect.

The effect of suspense in delivering complex computer science knowledge varies widely among the tested subjects.

References


Gleeson-Kreig, J.,(2006)."Using Narrative Pedagogy to Create Evidence Seekers", State University of New York, Plattsburgh,


**Appendix A**

**Pre study:-**
Question asked to the project managers:

(The managers were told about the goal of the thesis, the problem discussion, the stories in detail. After that they were asked these questions)

1. What are your views about the whole idea?
2. Do you think the audience can have a good conception after reading the stories?
3. Do you feel the story with Zeigarnik effect can do better than the story without for a group of computer science students?

Identification of the project managers interviewed:
Manager 1: Erik Hartgers from Logica
Manager 2: Nicklas Hjalmarsson from Logica
Manager 3: Johanna Erlingsdottir from Tele2
Manager 4: Vanessa Eriksson from Telia
Manager 5: Zarmina mangal of Cale Access AB

Manager 1

1. I think it can be applicable to those who do not understand by telling it in simple way.
2. It depends on the audience ....they may like it may not but yes they can remember it through the stories.
3. It may have some effect.

Manager 2

1. It is good....great in fact to learn new concepts as well as remembering it.
2. Definitely, teachers should try story telling like this to introduce a new topic so that everyone can think about it later on.
3. Yes, for both understanding and remembering purpose.

Manager 3
1. Nothing new, but a good way to transfer knowledge. I have used it before and seen many people to do so but yes to remember unfinished part is good and justified. This is new to me.
2. Depends on the stories, stories should be realistic enough as well as it should be attached to the concepts. So it may possible that people remember the stories but even then cannot understand the technical part much, or perhaps that's what you wanted to do, making something understand without telling him what it is...in that case it is a good way.
3. Yes, mostly.

Manager 4

1. May be ok but very limited. Not applicable to everywhere.
2. This I can't say. Perhaps it is better to tell them the concepts simply rather than using complex stories.
3. Well, as I didn’t used ‘Zeigarnik effect’ previously, I cannot say. But yes I feel it may have good enough effect.

Manager 5

1. After hearing the stories I feel that I remember most part of it, so I think it is applicable to many others.
2. Sure, it is a good way.
3. Yes, to some extent.

Appendix B

Student # 1

1. Polymorphism is a way, by which we can represent same data but different representation to different persons.
2. It is based on expectation. Like if you expect data to come as integer it will come as a number, again if you expect it as string then you can say 123 may appear as a string or say float like 123.0
3. Well, one has to understand the run time type of the data to understand how it will appear. It is indeed a little confusing, but if you see the story then you can get an idea.

1. Data abstraction can be considered like hiding program implementation using interfaces.
2. It can be like making implementation accessible only with objects.
Otherwise you cannot see what is inside of a program.
3. An example is we use TV remote control without knowing the internal electronic architecture. We just know which button to press for which function.

Student #2

1. Polymorphism can be understood by providing same data to different entity or person but understanding of the data will be based on the receiving entity.
2. Like + can add 2 numbers as well as 2 letters. From this we can think + can do addition to both numeric as well as textual data.
3. It is a little confusing. But if you think like + can add 2 numbers as well as 2 letters. From this we can think + can do addition to both numeric as well as textual data.

1. Data abstraction is certainly the way of separating the outer configuration and the inner configuration, where generally anyone can see the outer configuration only.
   a) In software, I will use method implementation private, so that other programs cannot take it.
   b) It is possible if they just use it but do not want to change or control.

Student #3

1. It's a software term as stated in the stories where you can reuse a particular data differently.
2. Polymorphism, as I understand from the story, work at real time, its real time interpretation of data to the receiving end, as it can be a variable, a constant or something else.
   3. It’s confusing but one need to understand the run time type of the data representation.

1. Data abstraction is hiding development details from 3rd party.
2. It can be done using interfaces, like implementing interfaces and hiding the method under it.
3. Yes, using layered architecture can do it. Like providing the interface signature only.
Student #4

1. I clearly understand Polymorphism. It is the receiving end's data interpretation. Different data as per object.
2. It depends on inside operation.
3. It is a little confusing but as per the story same word different objects understand in a different manner.

1. Not relieving the whole data to the 3rd party.
2. It can be done as per the inside operations maybe. or like making class structures so that things will be internal to a class.
3. If a programmer hides the operation then it can be possible.

Student #5
1. Polymorphism...no idea.
2. Like some behavior of program can be changed like + sign.
3. Types of data...like number, objects

1. Data abstraction is hiding data from unwanted person
2. I can implement this by making processes hidden to the end user.
3. If processes are made before working then people working will not know from where the things come from.

Student #6
1. Polymorphism is different objects appearing with a same name, in that case how to make it meaningful.
2. Function name is same among the classes, making difficulty that is to choose upon.
3. The name will be same but the type will be different!

1. It is hiding parts of the program and providing some other way to use it.
2. I can make implementation details not accessible to others.
1. I can this like making a hidden function but open interfaces.

Student #7
1. Polymorphism is a way when same name objects try to gain access of a resource.
2. If the method names are same, then parameters will be different, in that way you get to know.
3. You can identify the object by its run time type.
1. Data abstraction is making method private and an interface over it, which is public.
2. If you do not provide direct access to the method details.
3. Only make the interface accessible or like providing read access.

Student #8
1. As the name suggests its one object in many form.
2. Like making the method names same in but signatures different, so depending on the data, the corresponding method will be called upon.
3. If you look at method signatures and the type of data, it will not be confusing any more.

1. Data abstraction is securing details of the data or program.
2. It’s based on accessibility. A programmer can change that.
3. Using private accessibility of the methods.

Student #9
1. Single object in many forms
2. It happens when 2 or more things have the same name.
3. Naming differently can be a solution.

1. It is hiding important details so securing data
2. Not that much sure…. can’t tell now
3. Can’t tell instantly...

Student #10
1. Multiple object but with same name, then how to locate a definite one...for that polymorphism sets some rule.
2. If we make 2 entities with same name in a single class then it could happen
3. Of course inherent data will be different.

1. Hiding implementation details to others
2. Just hide the implementation but make some way so that other can use it but cannot change.
3. Using accessibility it can be done.

Student #11
1. It’s a part of object-oriented programming where you can make same name but different feature objects.
2. Can’t tell right now
3. Data type differs ...so it becomes changed and differ in function
1. Through data abstraction you can have an option to hide something you want to keep secret.
2. If you make it sometime before when no other program can track it or like make it finalize before then hiding it.
3. You can provide privilege to specific persons.

Student #12
1. Polymorphism is simply one object in more than one form
2. Many methods in the same name
3. Some data will be unique like the return parameters

Student #13
1. A single object is appearing to many other objects, that’s polymorphism.
2. Same function name but type is different
3. Depends on the reference type

Student #14
1. Same data but creates more than one meaning.
2. Polymorphism works by making a function name it more than once thereby differ in functionality.
3. There will be some indication that what it will perform.

Student #15
1. Polymorphism is when 2 functions name is same.
2. In this case method names are same, but something else is different.
3. Its not confusing, signature of the method will be different.

1. Abstracting data from outsiders.
2. By using implementation security. In many other ways it can be possible also.
3. Using layered architecture.

Student #16
1. It is a property of different object with the same name.
2. Names are same.
3. Need to look at the function properties.

1. This is like not providing direct access to data.
2. Doing programmatically
3. I will not show the functions, but only through certain ways-

Student #17
1. Which can be things with the same appurtenance?
2. All objects in which naming are identical.
3. You can check other features.
1. Depending on the situation some piece of code can be hidden.
2. --
3. it is like doing email without knowing the internal software.

Student #18
1. Multiple methods with similar names.
2. Although names are same, parameters will be different.
3. One needs to check the method parameters.

1. it’s all about making valuable data secret
2. I will make this like making hidden folders or implementing extra security.
3. If he can access the interface and without knowing the method”

Student #19
1. It is multiple objects specially functions with the same name.
2. It depends on the internal architecture.
3. If we check the function signature.

1. For security purpose, keeping minute details safe.
2. Make programs protected by accessibility.
3. Good user interface, MVC architecture can be a good solution

Student #20
1. Same name methods in the same program.
2. Its like the functions overload.
3. The data type will be different among the same name methods.

1. It is all about abstracting data from outside access.
2. Not making any hardcoding.
3. It can be possible like running something.

Group B

Students #1
1. Polymorphism is 2 or more object with same name. It’s related to object oriented programing. As names are same, so some problems occur.
2. This problem is due to its overloading property and data-type will be the key
3. One needs to check the method carefully to solve this.

1. Data abstraction is carefully hiding precious data.
2. One can make this by doing some clever programming.
3. It’s certainly possible, but will be rather difficult to implement.

Student #2
1. Cannot exactly tell the definition now.
2. Polymorphism is based on function.
3. Method type is the problem...maybe

1. Data abstraction can be restricting unwanted access of function implementation.
2. Adding security or making xml access restriction can do it.
3. They can use it if they know like the interface or whole signature

Student #3
1. Polymorphism ... way of handling different data type using the same name.
2. The compiler will check the method signature; there it will get sorted out among the same name methods.
3. It is based on methods signature and data-type.
1. Abstracting how the function is made of
2. It can be done by making an interface public but then made the function private, so you have to access it through the interface.
3. One can use it, but they cannot alter it.

Student #4
1. By definition it is overloading of methods i.e. much method with same name.
2. So there must be something special among these methods.
3. In some sense it is indeed confusing a little.

1. Something not letting know what is inside.
2. -
3. Its not... not ok

Student #5
1. Polymorphism is one object in so many states.
2. As per the function, formation id will be different
3. So we need to check the formation.

1. Data abstraction is not permitting to change internal stuffs.
2. For that we need to implement certain configuration.
3. It is possible if you know outer access ways.

Student #6
1. Poly is many.
2. Function parameter must be unique that’s the way
3. All the functions are dependent on parameters

1. Data abstraction is providing access restriction for security
2. It can be done by providing security, or developing conditional access
3. Studying its formation, like interface building can do that

Student #7
1. Polymorphism is many method with name same but signature different
2. The data type present in each case is responsible
3. One need to look at the overloading parameters

1. Suppressing how the internal program is made of...that’s data abstraction.
2. One needs to make a public interface to cover up the function.
Student #8
1. Polymorphism is technically the same object in multiple occurrences.
2. It is the program interpreter that checks and detects it.
3. For the person. He has to check the implementation details of the method to see how it occurs.

1. Data abstraction is a way of adding security
1. So one have to make a definite way to access the object, other ways will not work.
2. May ways...like location, method name; usage of object can be used.

Student #9
1. It is originally a way of reusing a function on the basis of various signatures.
2. Polymorphism is dependent on data structures.
3. For that method parameters will not be same although names will be overloaded.

1. This is all about hiding internal implementation.
2. It can be done using a number of ways like certain design patterns...
3. We can use as the whole method by calling its name + parameters.

Student #10
1. This is basically how software handles similar names.
2. About names.... similar name but programmer will make certain
3. Don’t know

1. It is keeping data safe from unwanted access
2. Can’t tell
3. ---

Student #11
1. Polymorphism can be a way of reusing objects whose names are same but data-type is different.
2. For this, the data is same but data-type is different.
3. In the same program the methods will be there

1. it’s a kind of security where other functions cannot change it,
2. we can do this by making a public class and static implementation.
3. using interface as access points not methods.
Student #12
1. Polymorphism is kind of objects having same name but different data type.
2. It depends on the type of the data.
3. If we follow the property of object overloading then it will be clear.

1. Data abstraction is an umbrella term of restricted access to implementation details.
2. Using access modifier, function interface pattern, can create it.
3. Calling with proper accessibility with the key.

Student #13
1. This is all about same method can react with different formation.
2. It is the compiler who checks which method to load.
3. By definition it will be operational.

1. Data abstraction is something to do with software.
2. Maybe using xml based architecture.
3. It is like doing the same program.

Student #14
1. Polymorphism is objects whose names are same but structures are different.
2. It is depending on many external factors and parameters.
3. It is like overloading.

1. Data abstraction is strategically hiding internal program architecture.
2. It can done like providing an whitelist...for limited access.
3. The main aim is the interface to access the program ...that’s the key.

Student #15
1. It can be similar object with similar name.
2. As the name is same, it becomes like twin... difficult to choose.
3. Not sure.

1. It is defining accessibility at lower level.
2. This can be performed using private mode.
   3. Like using accessibility...public private. That can be controlled.

Appendix C
<table>
<thead>
<tr>
<th>Interview</th>
<th>What is polymorphism?</th>
<th>How can you implement polymorphism?</th>
<th>How can you clear the confusion of polymorphism?</th>
</tr>
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<td>satisfactory</td>
<td>satisfactory</td>
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<td>20</td>
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Table 5

Table 6 holds the gradation of the answers for group A for story 2 without suspense.
**Table 6**

Table 7 holds the gradation of the answers by Group B for story 1 without suspense.
<table>
<thead>
<tr>
<th>Interview number</th>
<th>What is polymorphism?</th>
<th>How can you implement polymorphism?</th>
<th>How can you clear the confusion of polymorphism?</th>
</tr>
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<td>1</td>
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Table 7

Table 8 holds the gradation of interviews for group B story 2 with suspense.
<table>
<thead>
<tr>
<th>Interview numbers</th>
<th>What is Data abstraction?</th>
<th>How can you implement data abstraction?</th>
<th>How can someone work with the data but still unaware of internal configuration?</th>
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<tr>
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Table 8

Table 9 holds the quantitative value of the correctness of the answers for Group A’s story 1 with suspense.
Table 9

Table 10 holds the quantitative value of the correctness of answers for Group A for story 2 without suspense.
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Table 10

Table 11 holds the quantitative value of the correctness of answers for Group B for story 1 without suspense.
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<tr>
<th>Interview</th>
<th>What is polymorphism</th>
<th>How can you implement polymorphism?</th>
<th>How can you clear the confusion?</th>
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Table 11

The last table holds the quantitative value of the correctness of answers for story 2 with suspense by Group B.
<table>
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<th>Interview numbers</th>
<th>What is Data abstraction?</th>
<th>How can you implement data abstraction?</th>
<th>How can someone work with the data but still unaware of internal configuration?</th>
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Table 12