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Using the Concept of Serendipity in Education

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Abstract

The word "serendipity" was introduced to the field of science by Merton while studying the progress of science and noticed that accidental discoveries often contributed to its progress.
We have developed a serendipity-card system to increase discovery encounters because we believe the concept of serendipity works in the relations of subjects.
In education, when students experience the satisfaction of finding something by themselves through serendipitous patterns, their motivation for research is raised since they have an interest in and responsibility for particular subjects.
The purpose for using the concept of serendipity is not to obtain high efficiency but to think about "the deepness in events," as suggested by Katai. Consequently, discovery encounters are to be increased in such environments.
We introduce a curriculum called "Serendipity and Creativity" to use serendipity in education with support theories for making accidental discoveries.
In the era when computers and manuals take away the time of consideration from human beings in programmed fields, the practical use of serendipity recovers a habit of observation and consideration.

Keywords: discoveries, serendipity, accidents, sagacity, MOT

1 Introduction

Serendipity was coined in 1754 by Horace Walpole based on a fable called the Pilgrimage of Three Princes of Serendip [1]. Robert K. Merton introduced the concept of serendipity to science [2] after noticing that its progress reflected the contribution of discoveries obtained from unexpected results. While trying to explain this phenomenon, he "serendipitously" found "serendipity" in the E.O.D., and he used the term. This term was widely accepted. Norbert Wiener wrote that this trait of the three princes was very vital weapon in the armory of the scientist [3]. In the Journal of Chemical Education, Ronald S. Lenox recommended the use of this concept in the education for science students [4], writing "Serendipitous or chance discovery is one of the important avenues for discovery in science. As such, it is important to recognize it and to educate students"
We developed a curriculum called "serendipity and creativity" which is ten times of every 90 minutes in MOT education of Toyama Prefectural University. The purpose of the curriculum is to experience encounters with discoveries by making hypotheses. In the curriculum, we also practice correlating themes and articles across different disciplines to nourish small notices into significant ones over long period of times, because serendipitous discoveries show similar patterns.

2 MOT Curriculum

The following are main contents of curriculum:
a. Introduction of serendipity
b. Quasi-experience of cross-cultural community exercised by games of playing cards
c. Theories of Umberto Eco who describes how easily serendipity happens in cross-cultural communities [5]
d. Significance of preparing an hypothesis that may cause encounters with serendipity
e. Practice making hypotheses
f. Characteristics of using serendipity-cards [6]

with the introduction of the "KJ Method" and the "NM method"
g. Characteristics of the externalization of a notice [7]
h. Semantic networks and the meaning of semi-lattice structure in networks [8]
i. The Small World Network [9], the Strength of Ties [10], the Chance Discovery [11] and the Social Network [12]
j. Value of information and how to adopt it
k. Nourishing an hypothesis and discovering significance
l. Verification of an hypothesis using Charles S. Peirce's abduction method [13]
m. Risk management when using serendipity in organizations
Koichiro Hioki wrote that how a solution is obtained often effectively amplifies the uncertainty [14]. Many discoveries and inventions have sprung from experiment failures amplifying uncertainty. He argues that obtaining solutions while amplifying uncertainty is necessary, even though the way doesn't exist.
A curriculum that uses the concept of serendipity is one way of the amplifying uncertainty.

3 Concept of Serendipity

Serendipity meant "the faculty of making happy and unexpected discovery by accident" in the time when Walpole coined it [15]. He wrote in his letter "you will understand it better by the deviation than by the definition." The concept of serendipity last over 250 year, since it has generality and mysterious attraction. In a fable 450 years old since the king of Serendip wanted his three princes to complete their educations from first class masters in his palace. But he had noticed that a significance of practice in the outside, and he sent them on pilgrimages so that they could look at the world by themselves and through the thoughts of others. The king believed that learning extended beyond the desk. He gave his princes an opportunity to see the relations between the world and themselves.
The concept of serendipity consists of three key words: "discovery", "accident" and "sagacity".
Merton, sociologist expanded the concept to academic and scientific fields through a study of the progress of science. A curriculum that exploits serendipity creates more encounters for discovery with the support of the related theories, in which we relate the works of computers and human beings.
Many scientists and literary figures have recognized the significance of the accidental discoveries based on their own experience of learning something unexpectedly. Still they have not openly embraced the practice to increase serendipitous encounters.
We have developed a program that incorporates various theories to utilize the concept of serendipity which can be included in most disciplines to add an additional way of thinking.
Margaret Mead described the concept of cybernetics as a media for exchanging most opinions [16], and we can add that the concept of serendipity provides one view for seeing all aspects.
In the cases shown below, the concept of serendipity sometimes works voluntarily or involuntarily.
a. Loosening the restraints of the current paradigm for making a new idea
b. Holding the conviction up to the time of success
c. Having minds that challenge even the most daring cases
d. Meeting an important person for obtaining solutions
e. Making caution or having interests in different disciplines
f. Noticing even a subject's small significance
g. Nourishing a subject's great significance
Merton pointed out the similarity of the concepts between serendipity and Thomas Kuhn's paradigm shift [17]. The view that normal science does not contribute to scientific advances argued by Kuhn, means the significance of unexpected discoveries like serendipity.

4 Role of Accidents in Discoveries

The role of accidents in discoveries not for only provides an encounter situation, but also frees human beings from the constraints of the current paradigm. How human beings think is usually very limited due to the learning function of the brain that follows precedents. Since an accident loosens thinking, one may have a chance to create an innovative idea. Innovation is often disrupted by a man who succeeded on past jobs demonstrating the difficulty of the loosening constraints of the current paradigm.
Another role of accidents is to make an incorrect

conviction to execute the invention, while the advancing new technology may assist successful completion. Umberto Eco called this the force of false.

Even though in the long term the results of serendipitous encounters are not always positive, a culture that accepts mistakes as challenges to innovation can be properly evaluated to develop serendipity.

We propose the evaluation for using serendipity in three phase times of works, starting, executing, resulting. Because the concept of serendipity lacks steadiness of manual documents, the failure process must be valued in some cases for the following successes. The concept of serendipity has a challenging "high-risk high-return" culture.

5. Serendipity-cards System

The history of science shows that the sagacity makes encounters with a small notice of significance at the first stage of most discoveries or inventions. We obtain two important messages from it.

One is how to detect a small notice in the first stage. The second is how to nourish it into an effective significance in the second stage.

To solve these two subjects, we propose a serendipity-card system that creates relations with many concerns in a semi-lattice structure among notices. Serendipity cards are filled with hypothesis formats when one notices something in any encounter, based on Peirce's abduction method.

Serendipity cards have characteristics for increasing encounters by themselves with information concerning subjects due to responsibility and the curiosity of personnel notices. Serendipity cards which are small enough to be kept in a pocket can be easily used to record a notice in any situations [6].

We value the externalization of notices, because it allows us to process and intentionally keep them. We can also use computers in many phases of works after externalization for making encounters with discoveries. D. Green describes this as combining lots of different pieces of data leads inevitably to serendipity, to unexpected discoveries in the Serendipity Machine [18].

The items completed in serendipity cards include theme, hypothesis, the related articles of 5W+1H (who, what, when, where, why, how), result and date.

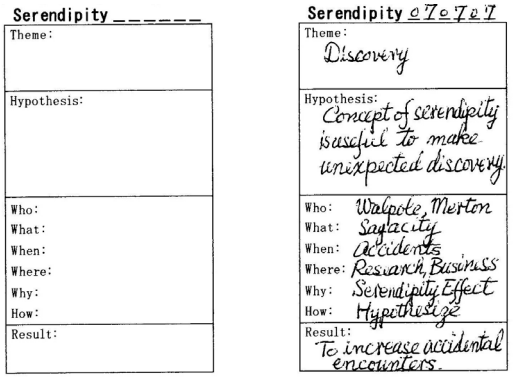

Figure 1. Serendipity-Card

Their role of serendipity-cards is the externalization of notices from our brains. In this stage, an important caution is that a notice to be recoded does not necessarily have great significance, as we spin and weave significance with small notices. In the process of thinking, we sometimes do not evaluate the caution and miss a notice.

An ideal flowchart of the serendipity-cards system is shown in Figure 2.

Figure 2. Ideal Flowchart of Serendipity-Cards System

After externalization, we nourish notices with many concerns in and out of our disciplines. As an hypothesis declaration creates interest in the results, one easily makes an encounter with any information concerning the hypothesis through a long period of time.

The related articles of 5W+1H help compose the semi-lattice structure, which can result in rich relations with hierarchies on themes and articles. Possible case grammar applications of exter-

nalization are expected to be expanded by computers. We are studying articles, but not yet, as Fillmore defined words as agent, counter agent, object, result, instrument, source, goal, and experiment [19].

We designed use of the serendipity-cards system to be simple because human beings must think deeply and holistically about their concerns by themselves, as in the pilgrimage of three princes of Serendip. We are aware that simple pondering without concerns results in simple consideration. Whenever the occasion demands, we review the serendipity cards to seek relations among many concerns. While seeking relations in the cards, their subjects are absorbed into our brains or remembered, and these works may affect subsequent encounters.

For human beings, high work efficiency is not always good for obtaining useful knowledge based on long term. People do not only follow high efficiency to obtain the results. We allow ourselves to repeatedly review the cards to find new notices of relations among them.

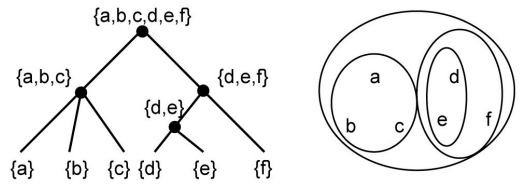

Figure 3. Tree Structure

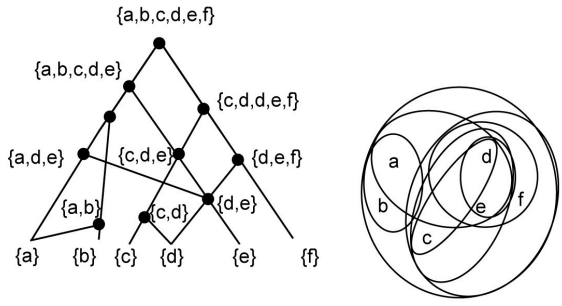

Figure 4. Semi-lattice Structure

We named the work of reviewing relations among serendipity cards "brain inventory", since memory after the work easily evokes subjects [6]. A hierarchy among theme and the related articles of 5W+1H constitutes a semi-lattice structure on relations among the cards. When we apply a tree structure or a semi-lattice structure, articles of "why" and "how" may give hints to produce further hypothesis on the same theme in a different hierarchy of a tree structure as shown in Figure 3 or a semi-lattice structure in Figure 4.

In case of a tree structure, a hypothesis is led to seek solution in a narrow bottom, while in a case of semi-lattice structure a hypothesis may be led to other branch. Semi-lattice structures may expand the possibility for discovering new relations among cards by computer. An application of small world network is one of an interesting study of encounters. As Green called computers "Serendipity Machines", we expect that computers will also play important roles in discovery encounters. Human beings have to play the deep thinking roles in many aspects.

6. Significance of Relations

Since we understand that the significance of most discoveries is in its relations to others, we value the relations among subjects.

O. Katai et al. introduced a novel scheme of eventual structure on individuals called "rhizome of events [8]." In the same paper they also introduced a viewpoint on relationalism and Piece's existential graph. The paper shows that coexistence structures can be represented by networks where the individuals are expressed by the curved line segments and predicates (relations) as nodes (circles). Leibniz defined the relations: space is the "Order of the co-existence of entities" and time is the "Order of Succession of events." In Newtonian conceptions, they have expressed as "Monochronic Time" and "Polychronic Time."

An effective hypothesis is concerned with the subjects by itself in many relations. We make situations where human beings are more concerned with others to make encounters with different disciplines. Since the works of serendipity are implicit, one must concentrate on making knowledge explicit in any phases of the work. Collaboration between human beings and computers may make implicit knowledge to explicit.

The concept of the Small World Network proposed by Duncan J. Watts [9] partly explains the phenomenon of serendipitous encounters. The theory of the strength of weak ties [10] proposed by Mark S. Granovetter explains significance which correlate or makes clusters, nodes and paths among cards, and causes useful encounters with serendipity.

We are also interested in semantic networks and

their spreading activation theory by A. M. Collins and E. F. Loftus [20], which are concerned with the subjects and articles of serendipity cards. "Information visualization and problem finding" reported by Konomu Dobashi utilize hypotheses system to make discoveries with computers [21]. The chance discovery reported by Yukio Ohsawa suggested an important approach that contrasts the viewpoint concerning the effort of human beings. The difference between the serendipity-cards system in discovery and other heuristic system is in the purpose. The former exploits human brainpower while the latter wants to efficiently discover the objects.

The serendipity-cards system stresses improving human beings. We expect that the results of using the serendipity-cards system will be reflected in human behavior. Human motivations may be raised by the system.

7. The Difference of Role between Human Serendipity and Computer

In studies of these subjects, we have recognized that the human serendipity is to cope with unexpected occurrences of events (imagination of relevant events, information or knowledge, evaluation and judgments of processed data by computer), while the computer is to follow pre-specified ways of processing of data or information (combination of data), rearrangements, classification, etc.

As the model and format developed for computer shows the simplified way of human action, it is sometimes useful to instruct human beings with these model and format.

The significance that serendipity-cards is adequate to catch the characteristic of subjects without judging in binary system of “good or bad,” due to the complex relations of other concerns. Consequently, the evaluation of many relevant subjects has chances to be effective in unexpected fields.

Since the necessity of consideration in wide disciplines makes discovery, we give a role to serendipity-card system for seeking correlation with consideration.

8. Reports of Participants and Continuing Research

Most of the reports from 14 participants of the MOT course showed interest in hypothesizing for serendipitous encounters. Even though none of the great encounters were observed during six-month course, they are still interested in hypothesizing about concerned subjects. They realized the significance that observations of circumstance provide as a theme to think deeply concerning with others. One established a research club to continue the work for utilizing the serendipity system.

We are researching the utilization of case grammar for externalization and the assessment of results for making more encounters with the serendipity-cards system.

9. Conclusion

We have recognized an effectiveness of using the concept of serendipity in education by experience, and developed a curriculum. Many theories related to computer, network, informatics, cognitive science and brain science support the effectiveness of serendipity analogically. We need objectivity for an assessment of the effectiveness. Since, the concept of serendipity value ability of brain, we have to consider a weight of them.

Ideally the bridge between human beings and computer would be constructed from both sides. However, currently the construction is mainly proceeding from the computer side. Computer science is progressing faster than such human sciences as cognitive science and brain science. In such situations, we are using computers to increase efficiency, without considering that human beings may lose the ability to continue research. Since human beings are more creative than computers, we must keep this ability in good use.

Based on the above consideration we proposed serendipity so that we continue using our brains. While recognizing the necessity of computers in many fields as support for human beings, we also need time to think deeply to maintain creativity. Requiring opportunities to think deeply and ponder subjects, creativity is nourished by the concept of serendipity.

When we reach the connecting point of a bridge from both sides of human beings and computers, we will recognize that our targets are identical.

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