

Philosophy and Methodology of Clustering in Pattern Mining: Japanese Anthropologist Jiro Kawakita's KJ Method

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This paper describes the methodology and philosophy behind a pattern mining process known as “clustering.” This holistic approach to pattern language creation is referred to as the “KJ method” by Jiro Kawakita (Kawakita, 1967). Pattern mining is a process used to extract the knowledge of practice (rules of thumb and tips) from individual cases and experiences, with the aim of creating a pattern language. Clustering is carried out to discover and organize the common points from the extracted knowledge. We have used the KJ method as the foundation of our pattern language clustering method. Invented during the 1950s and 60s, the KJ method has been widely applied in Japan, particularly in the areas of industry and education. We seek to deepen the understanding of this method and its underlying intentions by quoting Kawakita's explanations in an English translation. In particular, this paper elaborates on the following factual statements: the method was developed via field science; the method uses a bottom-up approach to generate order from chaos; the method requires that the data be viewed outside of any existing concept or framework; the method prioritizes feelings over reason; and at the conceptual level, the method is consistent with the essence of creativity. We expect this paper to provide readers with a clear understanding of the KJ method with a view to using it effectively in the practice of clustering in pattern mining.

Categories and Subject Descriptors: **[Social and professional topics]**: Project and people management—*Systems analysis and design*

General Terms: Human Factors

Additional Key Words and Phrases: pattern language, pattern mining, clustering

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1. INTRODUCTION

When creating a pattern language, it is first necessary to go through a “mining” process to gather the contents (seeds) of what will go on to become patterns. Pattern mining is a process of collecting knowledge from individual cases and experiences. There are various methods of pattern mining (Kerth and Cunningham, 1997; Akado, et al., 2015; Iba and Yoder, 2014), many of which suggest mining and noting a few patterns at a time, the gradual addition of which combines to constitute an entire language.

The Iba Lab, however, takes a holistic approach, mining around 30 to 40, or sometimes even 120 patterns in an organized collection from the initial stages (Iba and Isaku, 2012; Iba and Isaku, 2016). We call this approach “holistic mining,” as it aims to grasp the wholeness of the language at the mining phase, with a view to subsequently elaborating it. Since our publication of *Learning Patterns* in 2008 (Iba et al., 2009; Iba and Iba Lab, 2014a), we have created more than 1,000 patterns using this approach (Iba, 2016).

In this holistic approach, it is necessary to cluster and extract many pattern seeds from the fragments of data acquired through mining dialogs (Collaborative Introspection or Mining Interview). To do this, we use a method developed by Japanese anthropologist Jiro Kawakita (the “KJ method”) in the data-clustering phase. This method has proved to be effective in our practice and has become part of our standard pattern creation process. Recently, this mining method has been adopted by other communities such as EduPLoP (Bergin, et al., 2015; Warburton and Bergin, et al., 2016; Warburton and Mor, et al., 2016) and has been a topic of interest for researchers in the pattern language field.

However, there are no English-language publications about the KJ method, and hence there are few opportunities for non-Japanese speakers to learn about this approach.¹ Furthermore, as feelings rather than

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rational thinking play a significant role in this method, it can be a difficult topic to understand. However, the emphasis on feeling and quality is consistent with ideas put forward by Christopher Alexander (Alexander, 1979; Alexander, 2002), suggesting that this method makes sense in terms of the consistency between the pattern language methodology and its underlying theory. This paper presents a discussion of the pattern mining methodology via an examination of Jiro Kawakita’s description of the KJ method.

2. OVERALL PROCESS FOR CREATING A PATTERN LANGUAGE

There are three main phases in the process of pattern language creation (Iba and Isaku, 2016): Pattern Mining, Pattern Writing and Pattern Symbolizing (Figure 1). The Pattern Mining phase is used to extract knowledge of practice (rules of thumb and tips) from positive experiences, which are then noted in a specific format that summarizes the Context, Problem, and Solution (CPS). We call this unit a “seed of a pattern” (Iba and Isaku, 2016; Sasabe, et al., 2016). In the next phase, Pattern Writing, a full description of the patterns (Context, Problem, Force, Solution, Action, Consequence) is written down based on the seeds of patterns. This description is then subject to a detailed collaborative revision process. In the final phase, Pattern Symbolizing, a Pattern Name and Pattern Illustration are added to express the essence of patterns symbolically (Iba and Isaku, 2016; Shibata, et al., 2016). During these processes, certain phases are revisited/repeated as the language develops, as necessary.

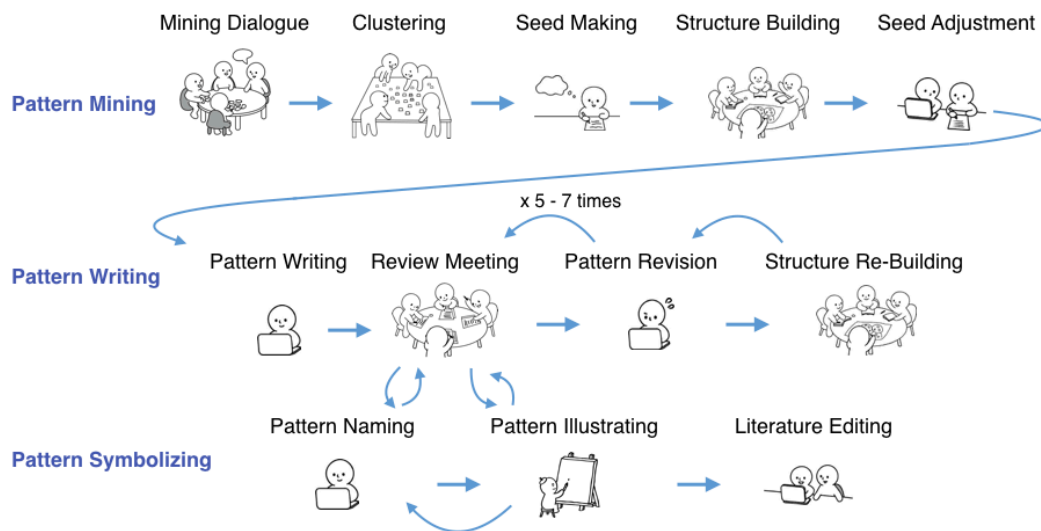


Fig. 1. Overview of the process for creating pattern languages

In this paper, we focus on the clustering phase—a key phase in the pattern mining process. This phase occurs after the collection of experiential data and plays three important roles. First, it helps us to discover the common patterns drawn from individual experiences. At the end of the clustering process, we are left with multiple groups of sticky notes with similar contents. Simply stated, these are the patterns lurking beneath the multiple experiences and cases. In a similar manner to the “rule of three” used in software pattern analysis, seeking common points between these experiences and cases is an essential part of the process by which ideas become patterns.

The second important role of clustering is to adjust the level of abstraction and granularity of the possible patterns. Fragments of information extracted from the mining dialog usually differ in terms of the level of

¹ It is said that the Affinity Diagram, which is known in the English-speaking world, was also devised by Jiro Kawakita. In this sense, this method was derived from the KJ method; however, it is uncertain whether the underlying theory and methodology have been translated adequately. Furthermore, it is argued by some that it is similar to the Grounded Theory Approach (1967). However, the two methods, although invented at around the same time, were created separately and have different core characteristics. The analysis of commonalities and differences between the two may be a topic of interest for future works.

abstraction and the scale of contents. Were a full description of the patterns to be written at this stage, the output would be discrete in terms of abstractness and granularity. However, clustering in this phase allows for a consistency in the set of patterns by comparing every sticky note and group generated.

The third important role of clustering is the support it provides for our exploration of the essential group message. The clustering process involves deep reflection about the meaning of every single sticky note. It demands that we go beyond the superficial meaning of the words. The opportunity for discussion provides the opportunity to obtain a common understanding of the patterns, which becomes the foundation of the next activity, Pattern Writing.

Our activities have revealed that clustering is an effective and essential step in the creation of pattern languages. The KJ method, which is the basis of this clustering method, is well-known in Japan and frequently applied to various fields, including industry and education. It is also significant that this method came out of field science. As such, it is a method that sums up knowledge of practice via observation and dialog.

We will now give an overview of the clustering phase process. This begins with writing down knowledge of practice (rules of thumb and tips) collected from the mining dialog sticky notes and placing them on the craft paper on the table at random (Figure 2: Starting from Chaos). We then attempt to work out the essence of the contents of the individual sticky notes (Figure 2: Hidden Meanings) by bringing together those notes with similar contents. It is important to bear in mind that simply moving notes with existing classification standards such as “-ish” and “-related” is not the purpose here. Rather, the idea is to grasp the true meaning of what is written on the notes, and to compare pairs of notes individually (Figure 2: One-to-One Comparison). Clustering should be done using a bottom-up approach involving every single sticky note, and should never be performed to fulfill a preexisting categorization. This is the most important aspect of the KJ method, which we discuss in greater detail later in this paper.

Clustering is usually carried out by multiple people talking to each other and moving the sticky notes (Figure 2: Talking while Moving). While some groups of sticky notes will be generated gradually, doubt may remain about what has been clustered, and it is important to check the clustered notes repeatedly. In the initial stages, it is normal that some notes do not fit the group in which they have been placed (Figure 2: Doubting Clusters). But when it appears that the classification of the sticky notes makes sense, each group should be circled to clearly show the “islands” on the craft paper (Figure 2: Discovering the Islands). Each island then becomes a seed of pattern.

The creation of *Presentation Patterns* (Iba and Iba Lab, 2014c) involved seven hours of clustering. As the time required for clustering depends on the number of sticky notes, *Collaboration Patterns* required 20 hours to classify the 360 sticky notes (Figure 3).

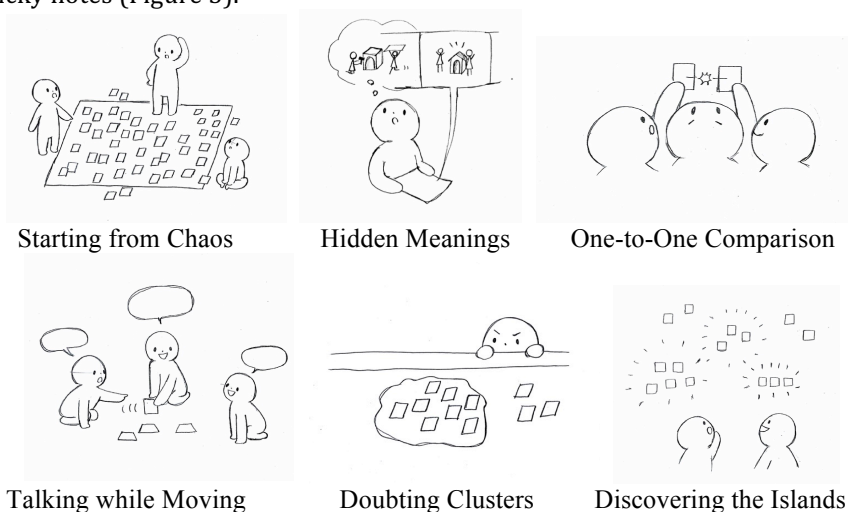


Fig. 2. Patterns for clustering in pattern mining (Sasabe, et al., 2016; Iba and Isaku, 2016)

3. THE KJ METHOD INVENTED BY JIRO KAWAKITA

The KJ method was originally invented by Jiro Kawakita, a cultural anthropologist who was searching for a method to organize data collected from various cultures. Kawakita, whose work took place in the 1960s, a time before modern methodologies such as ethnography were developed, believed there are three ways of

conducting research: “armchair science” (which consists of theorization and speculation), “experimental science,” and “field science.” Of these three, he states that field science is an area that has received very little attention over the years and is methodologically underdeveloped.

Due to the lack of viable existing methodology, Kawakita invented the KJ method as a way of organizing data collected through fieldwork. He wanted to understand foreign cultures from their own perspectives rather than perceiving them through the conceptual framework of their culture. Furthermore, he wanted a method that would derive meaningful discoveries from a diverse and miscellaneous collection of data.

“In organizing data, it is sometimes insufficient to simply go through the process of summarizing and analyzing the contents with similar quality. Why is this the case? When talking about organizing, it means as a process of collecting data that have completely different properties and are incomparable with each other, and deducing some sort of sense from their combinations. It is also a process in which there is a discovery made from a combination of miscellaneous data. In order to ‘organize’ data in this sense, a mere process of categorization is insufficient.” (Kawakita, 1967, p.53)

This insufficiency comes about because, “intrinsically, categorization is a process of grouping that occurs within a single-category data set, which focuses on similarity; some sort of common property” (Kawakita, 1967, p.52). The KJ method was thus invented out of the necessity for “a method to integrate miscellaneous data” (Kawakita, 1967, p.53). It is the product of a search for a way in which “significant integration can be discovered from a set of miscellaneous data that cannot be compared with each other” (Kawakita, 1967, p.53-54).

Kawakita describes the KJ method’s process as follows. First, a large sheet of craft paper is spread onto a table. Much smaller pieces of paper (containing individual data) are then placed on the sheet and spread around (Figure 1). The smaller pieces of paper are placed at random and appropriately spaced.



Fig. 3. Clustering using the KJ method for creating a pattern language

“Once all of the paper has been placed, it is then time to read all of them, patiently and calmly, starting from the ends or the center or anywhere. It is not really necessary to read all of them; it is more about gazing over them. A discussion of three hours can produce as much as two or three hundred pieces of paper, and this may be overwhelming to some people who are impatient. However, there is absolutely no need to panic. Just gaze through the entire sheet starting from anywhere.” (Kawakita, 1967, p.73-74)

At this point, it is natural to get “a feeling of anxiety that ‘such a scattered mess may never become organized’” (Kawakita, 1967, p.121). The Iba Lab’s experience is that a small sense of despair when faced with two or three hundred scattered sticky notes is normal. However, the KJ method has never failed to reach a conclusion, as long as sufficient time and effort are invested in the process.

“After a while, a feeling of familiarity will appear among the pieces of paper. There will appear noticeable connections between the papers, such as that ‘this paper is saying the same thing as that paper’ or ‘these papers are highly similar.’ Once such connections are found, move the pieces of paper next to each other. In this way, groups of paper will begin to appear throughout the entire table. Small teams of individual pieces of paper, in a sense.” (Kawakita, 1967, p.74)

When implementing this process, it is important to feel rather than to think logically. What is most important is to “genuinely listen to the essence of what each piece of paper is saying. Cluster them based on the affinity of their essential meaning. They should not be clustered based on resemblance of what they superficially look like” (Kawakita, 1970, p.58). Kawakita stresses that human feelings outweigh rational thought.

“What should be given the most attention is to cluster pieces of paper that feel similar to each other, and when doing this, the power of feeling must come first. However, those with little experience are inclined to cluster based on reason more so than by listening to their feeling. Namely, they think such that ‘paper A and paper B should be clustered together for this and that reason.’” (Kawakita, 1970, p.58)

From another perspective, “the feeling that it is all coming together naturally is more important than to focus on clustering the pieces of paper” (Kawakita, 1970, p.59). This bottom-up process of thoroughly comparing and arranging the individual sticky notes will allow them to settle into clusters.

“As many small teams gradually form and there are many clustered, take a close look at one of the teams. Let’s say that there is a team consisting of five pieces of paper. The reason those five pieces of paper were gathered together is because there was some sort of feeling of affinity. However, now looking at them for the second time, it is now necessary to read into the five pieces of paper in detail. Read thoroughly, and reconsider logically ‘why these five pieces of paper should be clustered together.’” (Kawakita, 1967, p.74)

“During this process, there are sometimes mistakes found in the initial clustering. There may be times when an irrelevant piece of paper had been added to a team by mistake. Generally, the contents of the five pieces of paper will communicate ‘the reason why those five pieces of paper must be clustered together.’” (Kawakita, 1967, p.75)

Kawakita stresses that “group formation” must “always proceed from smaller scale to larger scale”. In other words, it must be done in a bottom-up rather than a top-down manner (Kawakita, 1967, p.77). However, he says that some people, while understanding this, will still want to begin working from a larger scale.

“This occurs because people already have in their head, a dogmatic principle of how to group the data; such that based on their knowledge, ‘all of these pieces of paper should be divided into three large categories: market research, quality control, and labor management’ and so on. In other words, what they are doing is merely applying their dogmatic framework for categorization, and sorting and arranging the pieces of paper under that pre-established framework. With this sort of approach, the creative significance of the KJ method is completely lost.” (Kawakita, 1967, p.78)

Those people are “merely imposing their categorization framework upon the groups of pieces of paper. They are letting their preconceived ideas, their dogmatic framework be the master, under which the pieces of paper are subjugated” (Kawakita, 1970, p.59). If the process were conducted from the smaller scale, as ought to be the case, the product would be “a natural formation resulting from genuine attention to the opinions given forth, the suggestions from the information themselves” (Kawakita, 1967, p.78). This is the most important aspect of the KJ method, and one that is commonly misunderstood.

In Kawakita’s own words, this can be rearticulated as “speaking for the data” (Kawakita, 1967, p.203). “Thoroughly pay attention to what the clusters of data is saying, and if the data has something to say, listen to it. Listen to what the data says and understand it” (Kawakita, 1996, p.11). In the KJ method, the contents of the

pieces of paper are the main subject, and the people are merely a media to help organize this content. Consequently, group formation is not an artificial result. Rather, it comes about in deference to the “voices” of the sticky notes.

“As the group formation proceeds, the person taking part in the process will begin to experience a new, refreshing sensation. The most important point of this sensation is to be able to feel that he/she genuinely listened to the voice of truth, and followed a moral principle void of disagreeability.” (Kawakita, 1967, p.121)

“When the map has been completed, the refreshing sensation will reach its climax. It is a feeling that ‘the chaos has long passed.’ Furthermore, that will be accompanied by a feeling of completeness for ‘creating something significant.’” (Kawakita, 1967, p.122)

This statement, which is by no means exaggerated, aligns with our experiences as authors of this paper. As seen in his use of the term “create” above, Kawakita’s thoughts on creativity lie at the heart of the KJ method.

“What the KJ method shows is that in order to truly exhibit creativity, one must go through a state of selflessness once, before insisting on the self.” (Kawakita, 1996, p.28)

The fact that order comes about via the chaotic beginnings of the KJ method is not simply a matter of technique. Rather, it is the very essence of creativity.

“‘The chaotic beginning’ is essential. In that state, there is no distinction between the subject and the object. I believe that first, there is chaos, and then a sort of impulse that something must be done, appears. I believe that this is born out of a chaotic state. Therefore, people who use the KJ method try to do something about the chaos, and observe and create labels to make decisions or find a solution. That is, they intentionally find them out of a chaotic world with no barriers. Once they take them and label them, data is born. I believe that only after data is created in this way, the ‘I’ or the self is born to encounter that data. Therefore, I believe this is where the separation of the subject occurs for the first time. I don’t believe that ‘the separation of the subject occurs first.’” (Kawakita, 1996, p.154)

In his book on creativity, Kawakita also states the following:

“A creative act involves the creation of the object itself, but also generates change within the individual who is engaging in the creation. In other words, the subject is also being created. A creation that is done one-sidedly is not truly a creative act. The more creative the act is, the more remarkable the change within the subject will be.” (Kawakita, 1993, p.86)

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For this reason, the process of pattern mining makes it possible to discover something other than that formerly believed. And this discovery also entails a change on the part of the individual responsible.

“The series of emotional experiences that occur with the practice of the KJ method is an important issue in addition to the obvious end product. This is because they account for a significant part of the creative experience, and because such creative experience has the power to change the self.” (Kawakita, 1967, p.122)

An experience such as this is also extremely important in the context of creative learning. It forms the basis for our use of pattern language creation and clustering methods such as the KJ method in the educational setting.

4. THE KJ METHOD IN THE CASE OF *PRESENTATION PATTERNS* (2011)

Here, we examine how the KJ method was used in creating *Presentation Patterns* (Iba et al. 2012; Iba and Iba Lab, 2014b) in 2011. *Presentation Patterns* describes the secrets to giving a creative presentation. It

contains 34 tips on the methods, viewpoints, and mindsets needed to design a creative presentation, which are explained in 34 patterns (Figure 4).

Presentation Patterns, a pattern language for creative presentations, was created by project members using holistic mining techniques. The KJ method was used to cluster the ideas that came out of these mining sessions.

The project, led by Takashi Iba, was a collaborative work involving 14 students at the Iba Laboratory. Participants were recruited according to their different experiences of presentations, including public speaking, musical performance, drama, and dance. The original pattern ideas were mined from the project members' own experiences. Mining dialog between members with a broad variety of presentation experiences elicited ideas for what constituted a "good" presentation.

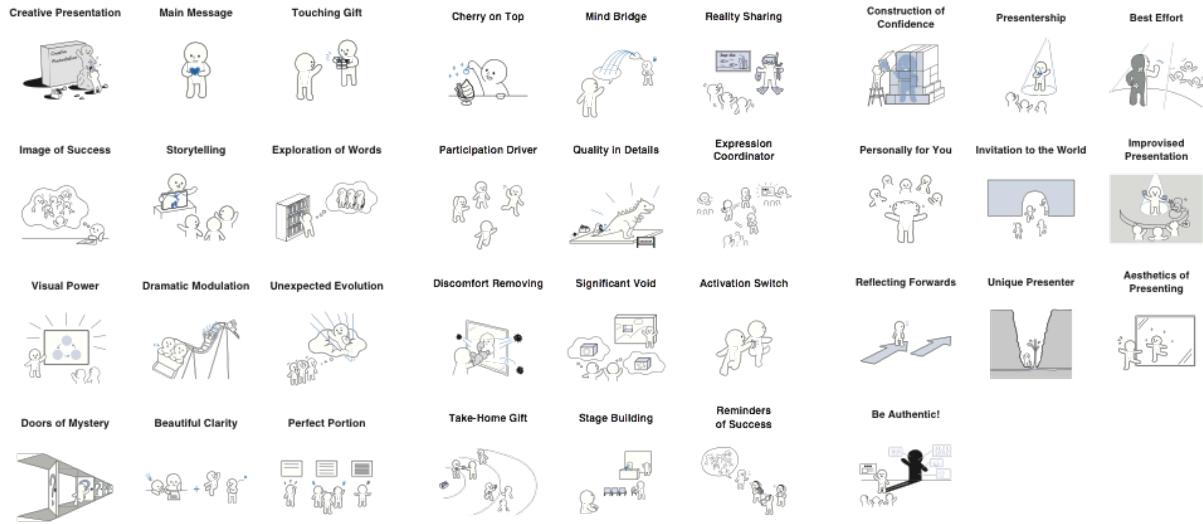


Fig. 4. 34 Patterns in *Presentation Patterns*



Fig. 5. Clustering phase for *Presentation Patterns*

During the mining dialog session, members jotted down attributes they considered important for attractive presentations. Each member wrote down their ideas on sticky notes, gave a description to the whole group, then placed their notes on the table. Members cited specific episodes related to their prior experience so that everyone was able to understand the significance of the individual notes. The goal was to glean as many ideas as possible for potential patterns. Repetitions, add-ons and opposite opinions were welcomed, and nothing was excluded. Selection and grouping were postponed until later. These two mining dialog sessions generated 207 potential ideas for patterns.

These ideas were organized using the KJ method. In the clustering phase, ideas that are thought to have similar attributes are grouped together and placed close to each another (Figure 5 & 6). However, these similarities must not be mere superficial resemblances. Core traits and functions must be observed and discussed before a connection between two notes can be made. Another important aspect to bear in mind is that notes must be moved as pairs.



Fig. 6. Starting from Chaos: example of clustering for creating *Presentation Patterns*

Once the process starts, clusters of notes with similar ideas begin to emerge. The temptation arises to connect an idea to a group of ideas; however, this would once again be superficial. Categories of ideas emerge as a result of connecting pairs of ideas. The KJ method is complete when group members believe that all ideas have been mapped into the correct relations. At this point, the notes have formed emergent clusters, each of which is a potential pattern. Some of these clusters contain dozens of notes, while others contain a few. In the present example, the 207 ideas emerging from the mining dialog phase formed 40 clusters.

Our focus here is on two patterns from *Presentation Patterns*: “Presentership” and “Touching Present”. We will examine how the individual sticky notes were clustered to form the basis of these patterns.

The first example, “Presentership”, is a pattern relating to audience considerations in presentation design. This pattern was created from five different ideas from project members, which were written down on individual sticky notes and clustered (see Figure 7). The following is a sample conversation from the discussion that surrounded the clustering.

- Group member A: “‘Look at the entire audience’ is definitely an important part of a presentation.”
- Group member B: “I agree. I think this is very similar to ‘be aware that there is an audience watching.’ I think these two ideas stress the importance of having a good stage presence.”

- Group member C: “Okay, let’s put those two together. Hmm, I think ‘don’t look down at your notes’ is an important part of being aware of the audience!”
- Group member A: “Yes, those should be placed side by side. So should ‘Don’t hide behind the podium.’”
- Group member D: “Ah, I also think that ‘look at the person who is speaking when you are not the speaker’ is similar to not looking down at your notes. I often take note of this when presenting as part of a group.”



Fig. 7. Cluster of sticky notes for “Presentership”, *Presentation Patterns*

The second example is “Touching Gift”, a pattern about considering the audience when designing a presentation. The concept for this pattern came from a cluster of seven sticky notes (see Figure 8). As shown here, the seemingly unrelated sticky notes come together as a result of one-on-one comparisons. Each “island” represents the multiple elements that come together to create the concept of the pattern.

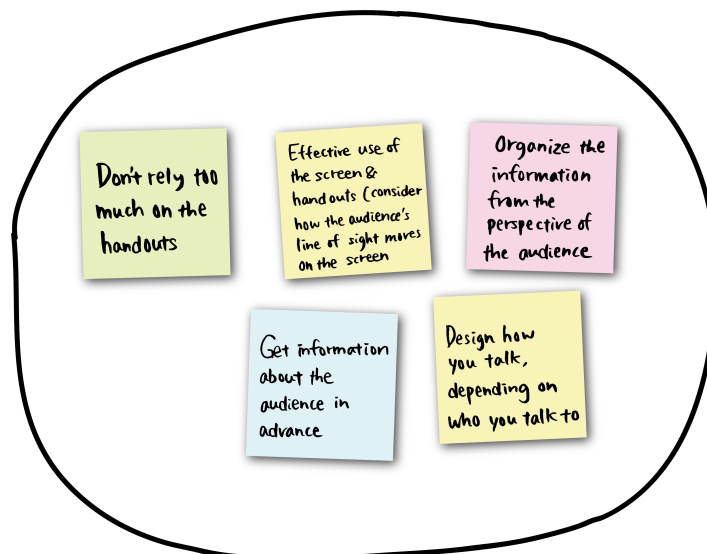


Fig. 8. Cluster of sticky notes for “Touching Gift”, *Presentation Patterns*

5. CONCLUSION

Jiro Kawakita believed that the KJ method was both a philosophy and a technique. These two elements are generally differentiated, with focus generally given to one or the other. For Kawakita, however, the KJ method was an approach in which “the philosophy and technique must not be separated” (Kawakita, 1996, p.153). In this sense, this paper has introduced not only the KJ method itself but also the philosophy behind it.

According to Kawakita, “it is not sufficient for people to know about the KJ method intellectually; it is only fully understood when it is experienced” (Kawakita, 1967, p.127). The authors of this paper encourage interested readers to put the KJ method into practice and experience the process. In so doing, patterns derived from clustering may prove themselves to be a valuable resource (Sasabe et al., 2016; Iba and Isaku, 2016).

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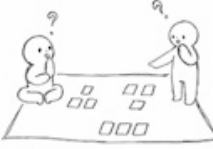
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Appendix: How to conduct clustering in pattern mining using the KJ method


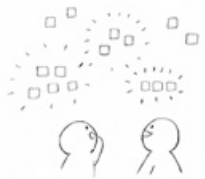

A) Grasping the Mined Elements... Form a shared understanding of the information available to the group.

<p>Environment for Focusing Coordinate an environment where you can spread several sheets of craft paper on a large table and focus for long periods of time. The sticky notes should be placed at random to create a chaotic start point.</p> 	<p>Element Comprehension Carefully but dynamically comprehend the true meaning of each note. Summarize the essence of the information written on the note in your own words, and discuss whether your understanding is correct.</p> 	<p>Element Pairing Place two elements that are semantically proximate near to each other. Look over the whole table and consider the proximity of notes in a <i>one-to-one</i> manner, without getting caught up in any superficial similarities.</p> 
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B) Group Thinking... Go through the process together. Think of the group as one large brain, and talk through any thought processes so that they can be shared with other members.

<p>Talking while Moving Always talk to the group when moving a note. Consider one topic at a time, as a group, and have each person share their thoughts.</p> 	<p>Essence Digging Look for the essence of each note by recalling the kind of episode it came from, and the way in which this seemed important.</p> 	<p>Iterative Questioning Even if a note was moved just once, question the process and repeatedly consider its relationship with other notes, adjusting its position accordingly.</p> 
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C) Finding Overlaps... Find the common meaning among several notes and notice any overlapping patterns.

<p>Active Inquiry When clustering, both the notes and the participants should be constantly on the move. This allows for the notes to be considered from different perspectives.</p> 	<p>Discovering the Islands Find the “islands,” or the groups of notes. Persist with the clustering process until the notes find their proper resting place.</p> 	<p>Mapping Islands Organize and confirm the “islands” formed by semantically proximate notes.</p> 
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