Pattern Language Online, Qualitative-Data-Based Pattern Language Creation System

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In this paper, we introduce Pattern Language Online, a web system that supports the creation of pattern languages based on qualitative data. While there are various ways to create pattern language, the method researched and developed for 15 years by the Iba Laboratory, to which I belong, handles a variety of textual data. The data include narrative texts obtained from mining dialogue, the main points of patterns in the intermediate steps, and descriptions in pattern format. Handling qualitative data involves complexity, and if it is mismanaged without organizing the data, it can directly lead to a decline in the quality of the pattern language. Therefore, we developed a system to support the creation of a pattern language based on qualitative data by making it easy to manipulate, store, and refer to the data needed to create a pattern language. This paper will also discuss how our proposed system relates to qualitative data analysis systems (QDAS) and other systems used to create pattern languages.

Categories and Subject Descriptors: **D.2.2 [Design Tools and Techniques]**: User interfaces; **H.4.0 [Information Systems Applications]**: General; **H.5.1 [Group and Organization Interfaces]**: Computer-supported cooperative work;

Additional Key Words and Phrases: Pattern Language, Cloud System, Pattern Language Creation

ACM Reference Format:

Kawabe, Y. Iba, T. 2021. Pattern Language Online, Qualitative-Data-Based Pattern Language Creation System. HILLSIDE Proc. of Conf. on Pattern Lang. of Prog. 28 (October 2021), 15 pages.

1. INTRODUCTION

For 15 years, Iba Lab has been creating a pattern language about various topics that provide tacit design knowledge of human actions. The topics we have covered include Learning (Iba & Iba Lab, 2014a), Collaboration (Iba & Iba Lab, 2014b), Presentation (Iba & Iba Lab, 2014c), Project Design (Iba & Kajiwara, 2016), living well with Dementia (Iba & Okada, 2015), Cooking (Isaku & Iba, 2016; Akado et al, 2016; Yoshikawa et al,), and Dialogue (Iba & Nagai, 2018) etc. At the same time, we have been researching the process of creating pattern language and what is important to create high-quality pattern language, published in papers and workshops at various conferences. Our experiences and tips have been compiled into a language consisting of 364 patterns (Iba & Isaku, 2016). In addition to us, Christopher Alexander (Alexander, 1979), the inventor of pattern language, Rising (Rising, 1979), Harrison (Harrison, 1979), and others have also studied and proposed methods for creating pattern language. One of the characteristics of Iba Lab's method is that a huge amount of qualitative data is processed in several steps. Different types of data are handled at each step of the process, such as narrative texts obtained through mining dialogue, key points of patterns in the intermediate steps, and descriptions in pattern form. Therefore, if the pattern writers blindly follow the instructions and go through each step, they may not be able to prepare the data in a way that is easy to use in the later steps, or they may edit the data on the surface without understanding the meaning behind the data, which may require significant revisions, and they may have to start all over again. It will not be easy to create high-quality pattern language in such a situation.

In creating a pattern language, as the process progresses, discoveries are made about the subject, understanding of good practices is deepened, and sometimes the creator's own experiences are incorporated into the creation. At such times, if the relationship between the interpretation and the original data is not grasped, it may end up as a pattern that describes nothing more than the author's imagination or delusion. To prevent this from happening, it is necessary to constantly check whether things described now deviate from the information obtained by mining dialogue. However, as more and more operations are performed on the data, it becomes more difficult to trace them quickly. It also becomes less easy to organize and manage the data.

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What tools are used to create a pattern language that involves such complex data manipulation? In the Iba lab, we use a combination of several tools, such as the primitive tool of sticky notes and pen, a general-purpose writing tool, and data organization using spreadsheet software. Riehle proposes a new method for creating a pattern language that combines the grounded theory approach, a qualitative analysis method and recommends using QDAS. QDAS is software for qualitative data analysis.

Is it possible to create an optimal workspace for creating a pattern language by combining tools developed for different purposes? Donald Norman, a researcher in psychology and interfaces, in his book "Things That Make Us Smart," gives the examples of the Tower of Hanoi, the orange puzzle, and the coffee cup puzzle to show that the same problem solving can be made much more difficult by changing its representation. He then describes the need to reconsider the way of representation and pursue optimal design to increase the performance of tasks. We need to think about the design of tools for creating pattern languages. For example, Honíšek is experimentally developing a web system for pattern mining.

Therefore, we have developed a pattern language creation support system that consistently supports the process from analyzing qualitative data to its description in the form of a pattern language. In the following sections, we will first give an overview of the pattern language creation process developed by Iba Lab and explain the difficulties that arise when dealing with qualitative data. Then, we will present the pattern language creation support system along the creation process. The differences between the system and existing qualitative data analysis tools and other systems will be discussed.

2. IBA LAB'S METHOD FOR CREATING PATTERN LANGUAGE

Creating a pattern language can be roughly divided into three parts: pattern mining, pattern writing, and pattern symbolizing. The pattern language of the Iba Lab is called Iba Style, and each pattern describes in forms of context, problem, solution, and consequence. Then, giving each practice a symbolic name, an introduction, and an illustration will leave a lasting impression on the reader and serve as a vocabulary for communication and thought.

The following subsections describe pattern mining and pattern writing, primarily what the developed system would support. Since this system mainly supports pattern mining and pattern writing, pattern symbolizing is omitted. Figure 1 shows the creation process and the data types handled in each step, which is proceeded from top to bottom. The left column contains each step and its summary, and the right column contains the type of data to be handled there. In figure1, the creation process is written as a simple linear process for ease of viewing, but additional dialogical mining and literature mining will be done along the way in an actual project. It becomes more complex as data is added at intermediate stages.

2.1 Pattern Mining

Pattern mining consists of four stages: mining dialogue, key element extraction, pattern seed creation, and systematization.

In the pattern mining process, we start by digging out what is important in practice, how to achieve it, and concrete examples from mining dialogues. In the case of conducting mining dialogues through interview surveys, one to three hours of interviews are conducted with five to fifteen people, and what is said in the interviews is transcribed. In the Mining Dialogue, we will go into depth about what is important in practice, how to achieve it, and why. The interviewer's own experience will also be incorporated into the dialogue to confirm whether his or her understanding is correct. The dialogue transcription that will be analyzed is called mining source data.

From the mining source data, we extract key elements considered particularly important. The key elements will include what is important, how it will be achieved, and why, as well as symbolic examples and concrete actions as supplements. Writing key elements has the side benefit of allowing us to look back at each mining dialogue and get an idea of what they need to ask about in-depth in the following mining dialogue.

Once the key elements are extracted, the potential pattern seeds are created by gathering similar or complementing each other. Typically, potential pattern seeds are created from 100 to 400 key elements. The first step is to look at the key elements as a whole and find the key elements that felt particularly important. Then, using these key elements as clues, we gather those that reinforce each other to form clusters. Each cluster obtained here becomes a seed of a pattern. After the clustering is complete, write a long sentence with a label that clearly describes the pattern seeds to understand them later. At the end of the pattern seed creation, it is helpful to grasp the types of seeds by grouping them bottom-up so that the next systematization will be easier.

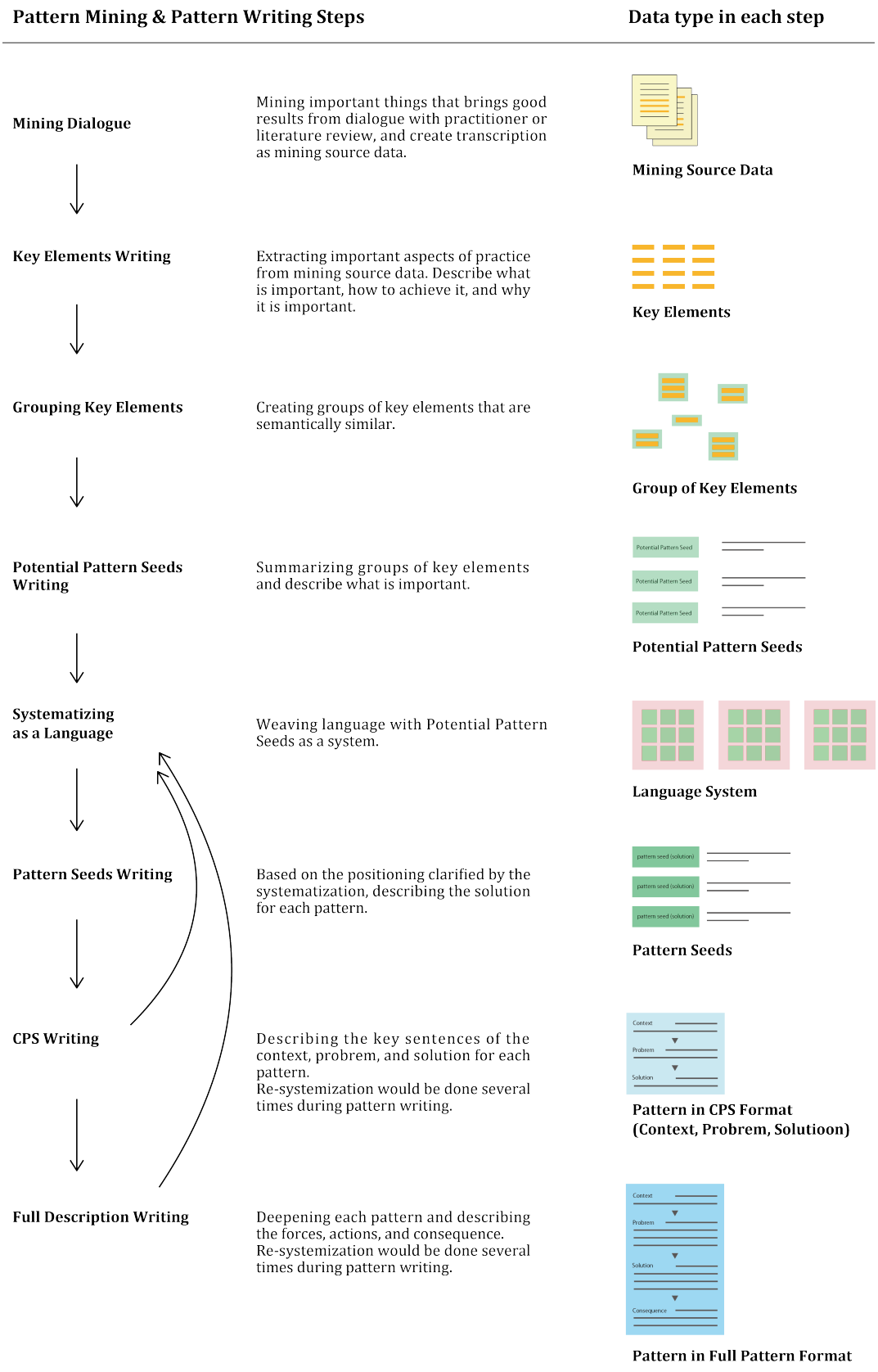

Fig. 1. Steps and data types in Pattern Mining & Pattern Writing

Then, the entire language system is considered using potential pattern seeds. Once we grasp some of the coherencies, think top-down about the major categories that would describe the language as a whole. When considering categories and grouping potential pattern seeds, it is good to group them in threes. By setting the constraint of grouping them into three categories or groups, we can concentrate on thinking about the positioning of each pattern while keeping track of the whole language and expressing the complexity of the practical knowledge. This constraint can effectively encourage creative thinking, but we don't have to set the final number of categories or groups into three. Some of the pattern languages created by the Iba Laboratory have more than three categories.

Once the categories are decided, check that the potential pattern seeds fit into the categories in a well-balanced order by applying the bottom-up approach again. Systematization is a hierarchical structure of categories, groups, and patterns and is refined to the point where we are convinced that no other system is possible as a language.

After the system has been established and the potential pattern seed's position has been determined, the solution of the pattern is described, and it is defined as pattern seeds. Once the core of each pattern is written, we move to the pattern writing phase.

2.2 Pattern Writing

In pattern writing, the first step is to write key sentences of context, problem, and solution based on the pattern seeds obtained from pattern mining. Once the key sentences are established, the causes of the problem are described as Forces, the specific actions that can be taken are described as Actions, and the positive results after practicing the solution are described as Consequences. As the pattern description is deepened, the understanding of the language as a whole is also deepened, leading to the need for re-systematization.

In the actual writing process, after writing the pattern, several people discuss the content of the pattern and deepen the description based on the feedback received. In the confirmation dialogue, the participants discuss whether the descriptions are accurate and whether the sentences convey what they want to say. This process is repeated over and over again to refine the pattern.

When describing a pattern, it is always necessary to refer to the mining source data and the insights from the previous steps. As we describe the patterns, we will discover new connections between the episodes told in the mining dialogue and our own experiences, which will help us understand the patterns more deeply. Moreover, the sentences we write will become more profound. However, if we focus on our own ideas and interpretations in our descriptions, we may unintentionally deviate from original data, so it is necessary to confront the data obtained from mining constantly. In addition, the original data is necessary not only as material for thinking deeply during pattern writing but also as evidence of the pattern itself. In order to be able to handle data in this way, it is essential to clearly state where each piece of data comes from, whether it comes directly from the interview or article, another article or review, or personal experiences.

2.3 The reason why dealing with qualitative data can be difficult

The creation of a pattern language using complex qualitative data can lead to confusion between summaries of original data and interpretation and the writing of things that are merely the assumptions and imaginations of the author. We sometimes fall into such problems in the projects of the Iba Laboratory. One of the reasons for this is that as the process progresses, various types of textual data become intermingled, making it impossible to quickly and accurately refer to the relevant part of the mining source data. Which data are referenced during each step of the creation process are shown in figure2. For example, we deal with potential pattern seeds, key elements, and mining source data in systematization. From figure2, we can see that all the steps use the data created in the previous step. Also, the number of data to be handled increases with each step. In the steps till systematizing the language system, the complexity of the textual data is not very high. However, during pattern writing, it is necessary to refer to the mining source data, key elements, and the language system structure, and since there are multiple operations on the data, It is difficult to remember from which data a pattern was derived. While mining source data and key elements are textural data, the language system is a different type of data, making it more challenging to grasp all the data simultaneously.

Even if a pattern is written based on the original data, if it is not written considering the position of the entire language, the language will not be holistic and powerful. In addition, as the meaning of each pattern and its description changes throughout the language due to continuous re-systematizations during the writing process, if the patterns are not linked to the original data, it is not easy to find where they came from and to refer to them quickly and accurately.

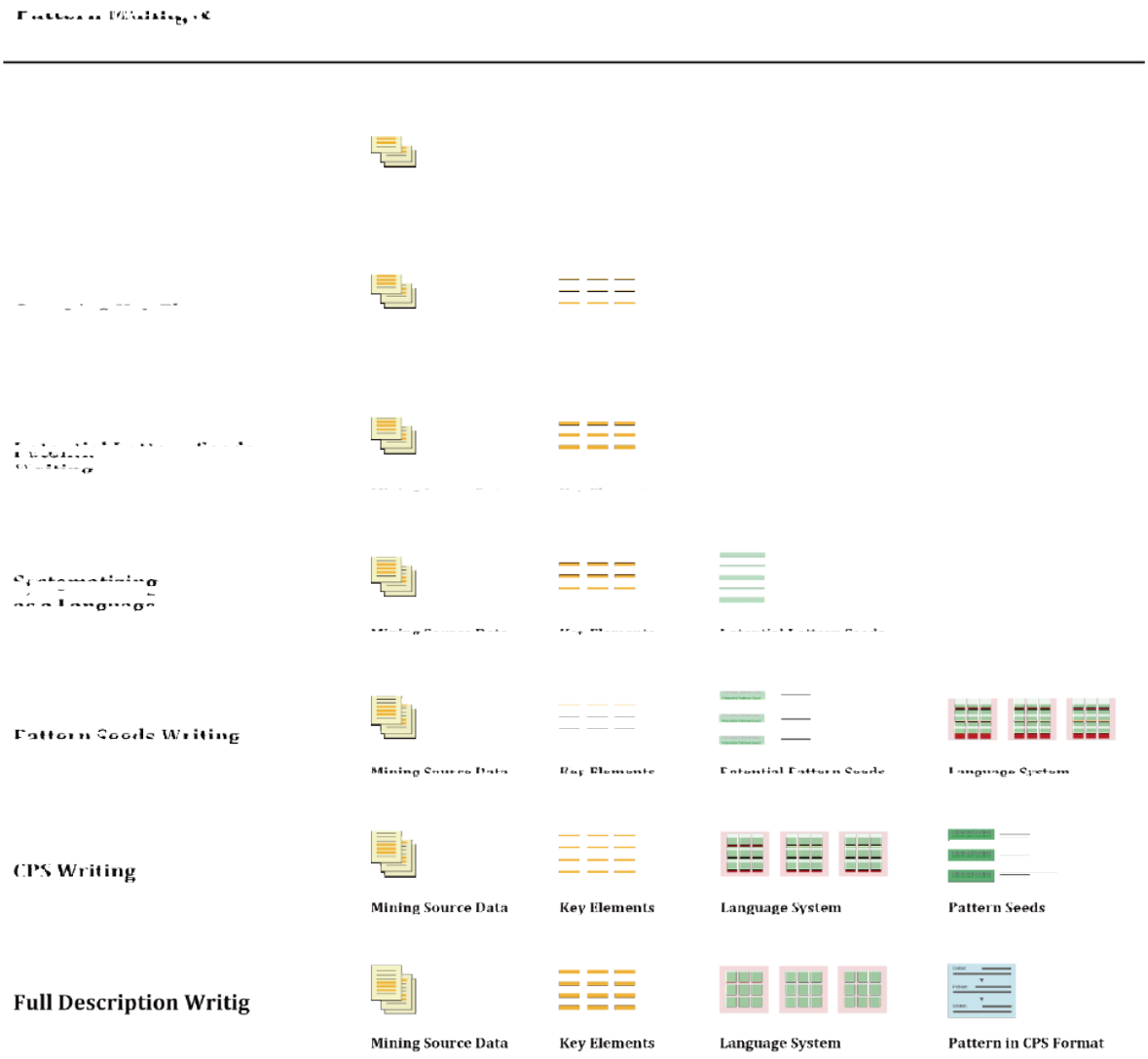

Fig. 2. Data referred in each step

3. PATTERN LANGUAGE ONLINE: QUALITATIVE-DATA-BASED PATTERN LANGUAGE CREATION SYSTEM

In this section, we present Pattern Language Online, a qualitative-data-based pattern language creation system. An overview of Pattern Language Online with screenshots along with each step of the creation process is shown in Figure 3. The main functions of the system, i.e., extracting key elements from mining source data, creating potential pattern seeds, systematizing as a language, and pattern writing, will be described.

We will also explain how each of the functions supports creating patterns, using some patterns introduced in the pattern language for the creation of pattern language proposed by Iba and Isaku (Iba & Isaku, 2016) the parts that are italicized in this section are pattern names. Since this system is web cloud-based, users can work collaboratively in web browsers like google docs.

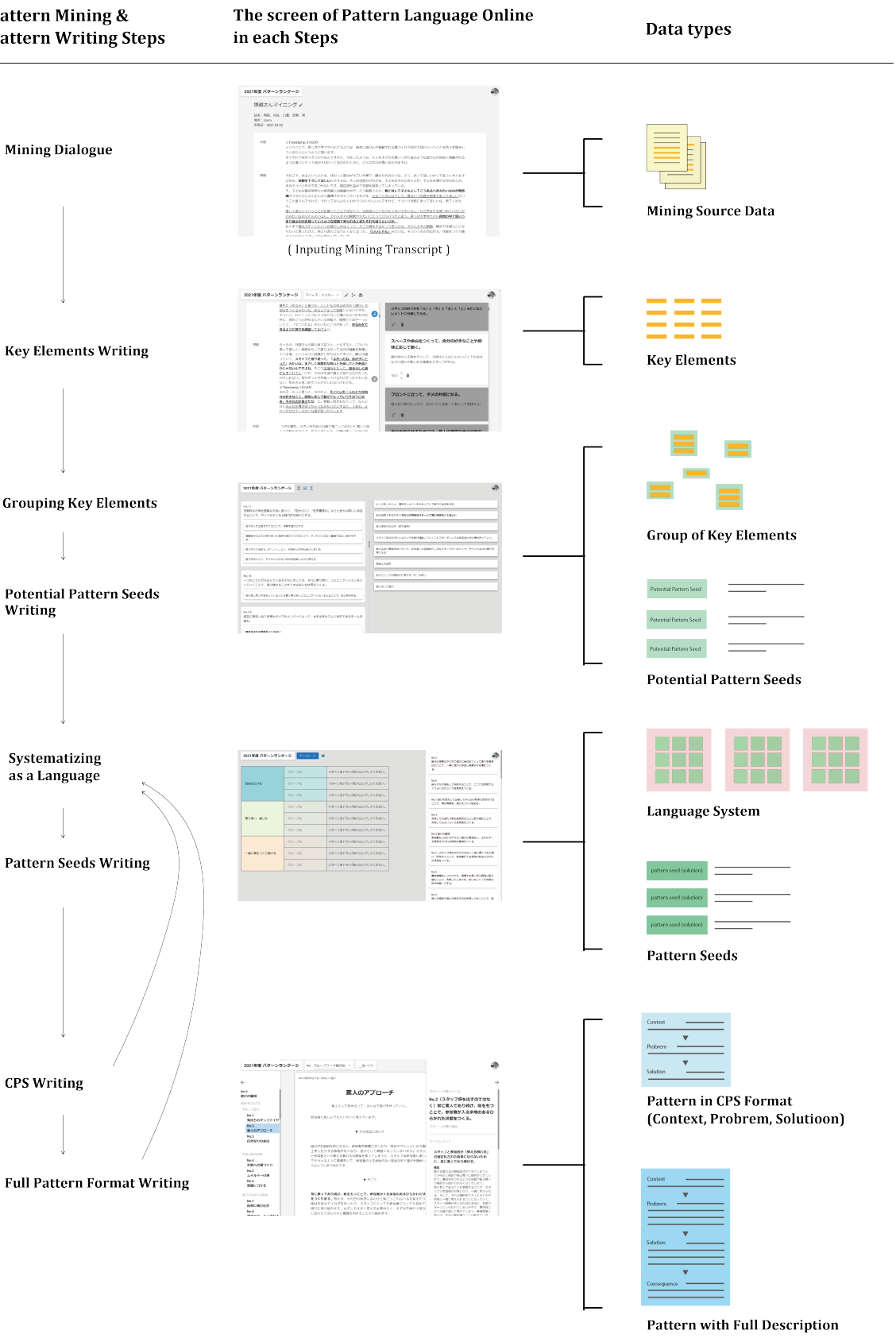

Fig. 3. Overview of Pattern Language Online with Screenshots

3.1 Extracting key elements from mining source data

The first step is to input the transcription data. A series of dialogues is imported as a block, with the speakers and their remarks.

At the beginning of the process, it is a good idea to read back through the interview, adding *Emphasizing Marks* to the parts that you feel are particularly important to collect information for the first clue. In this system, meaningful sentences can be bolded, underlined, or highlighted by changing the text color.

Figure 4 is the screen for writing key elements, with the transcription text on the left and the form for writing key elements on the right. Key elements include key sentences, supplementary information about why they are essential and specific examples. Key elements can be tied to dialogue blocks. By linking key elements to blocks of conversation, it is possible to trace back to the relevant part of the transcription.

When extracting the key elements, it is a good idea to *start where you can*, which is particularly impressive, rather than going through the details right away. If you read all the information in the same way, you will lose sight of the most important things. At this time, it is effective to recall the Mining Dialogue in your mind without looking at the transcription purposely.

For this reason, the system implements three view modes: Normal mode, Reading mode, and Centering mode. These three modes allow you to switch the size of the transcription area and the key element area, so you can switch modes depending on what you want to concentrate your attention on. For example, you can use the reading mode to read the transcription carefully and the centering mode to grasp the points that we felt were important.

However, if we only focus on the parts that made an impression on us, we may miss some potentially important information. Therefore, this system has a function to highlight blocks of dialogue with blue lines that are not linked to any key element so that you can check for omissions.

When describing a key element, you need to capture the *Intent of the Action* from the data and write a *Recallable Summary*. Since it is crucial to keep *Notation of Examples* to make it easier to grasp the intention, you can also input symbolic photos of the scene where the action is performed and figures from the literature. In addition, since the “What-How” format is recommended for describing key elements, the placeholder of the key element form is set to this format as a guideline.

When creating a pattern language with multiple people, bringing in *Multiple Viewpoints* and *Welcoming Duplicates* is good to find particularly important points. This system has the concept of spaces, which allow key elements to be extracted from the same mining source data by multiple people without interfering with each other (figure 5). Key elements described in each space can be merged into a single space, so you can carefully consider key elements by comparing.

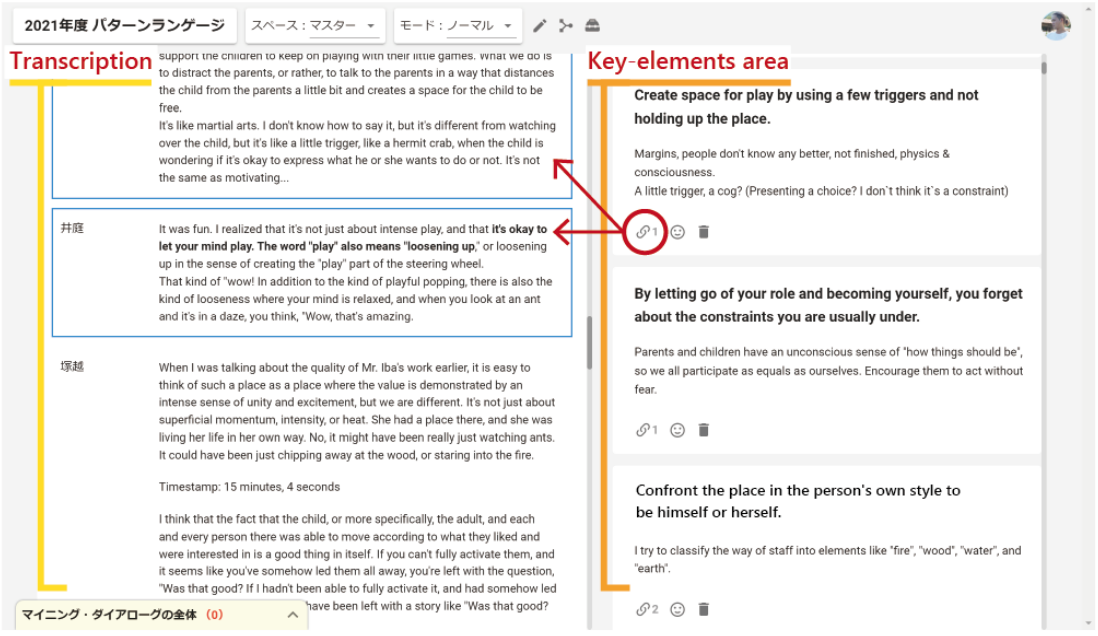

Fig. 4. Extracting key elements from transcript

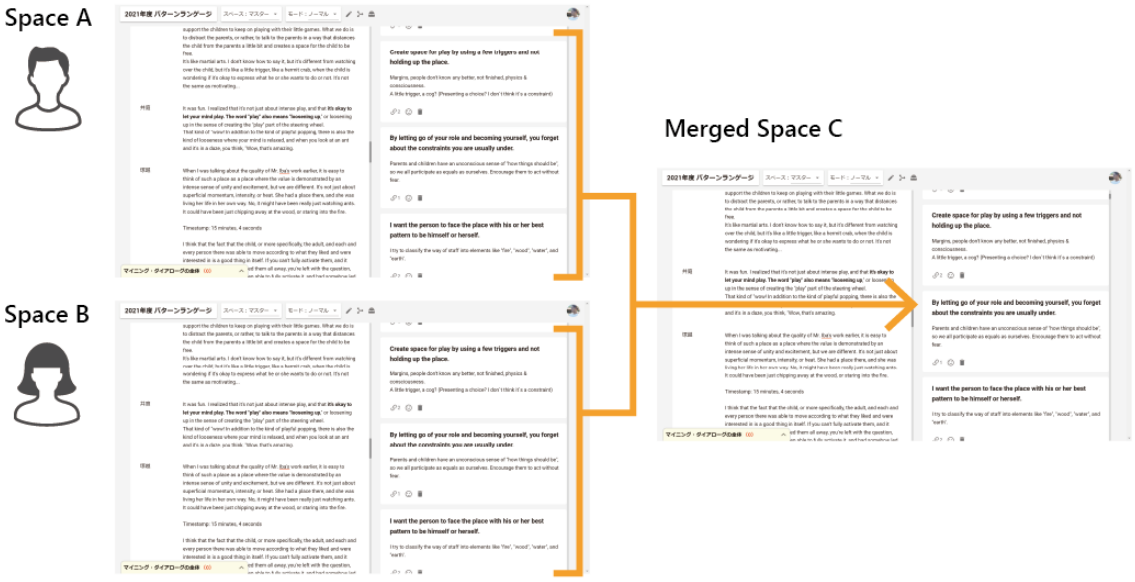

Fig. 5. Users can create own spaces for extracting key elements and they could be merged into one

3.2 Creating Potential Pattern Seeds from Key Elements

Figure 6 shows the screen for creating potential pattern seeds. There is a space for Potential Pattern Seed on the left side, and on the right side key elements are listed. We can drag and drop them into the same group if they are semantically similar. Then, think about what is essential to practice in the group and describe it as a potential pattern seed.

In order to accurately determine the semantic distance between the pattern seeds, it is necessary to consider the essential meaning of each pattern and clarify the differences between patterns by reading original data many times and sometimes taking into account the speculation of *Hidden Meanings* that are not mentioned. For this reason, it is important to *Episode Recap* by checking what is being said in the context of the mining source data. On this page, you can immediately see the original data associated with each key element in a pop-up, and you can refer to them to check the meaning of each pattern and the differences between them (figure 7).

In actual work, the key elements are compiled from hundreds of key elements into dozens of pattern seeds, so the ease of finding the key elements is a critical issue. If we have several key elements that you want to discuss, it will be difficult to remember them, and we will spend much time searching for them when you try to discuss them later. Therefore, elements are listed in one dimension from top to bottom in the main workspace in this system. This will make it easier to track which key elements were located. Online whiteboard tools are helpful as they allow you to arrange the two-dimensional space freely, but it cannot be easy to find what is where.

On the other hand, it is not easy to compare the subtle proximity of meaning between key elements when they are just placed from top to bottom. For example, when comparing ten key elements that are similar, we may feel that we want to place them freely in 2-dimensional space for comparison. Therefore, a pinning feature has been implemented that allows us to place key elements in 2-dimensional space(figure 8). While freely moving the pinned key elements, *Local Adjustments* are performed to identify the best combination. In doing so, we achieve both ease of searching for key elements and subtle proximity of meaning to be verified.

You can leave a note for each Potential Pattern Seeds, and by leaving a *Personal Summary* there, you can *Share Interpretation* with other members. By doing so, you will be able to deepen the discussion of each pattern. If each member does not leave their thoughts anywhere, there will be a gap between what each member is thinking, which will hinder deeper thinking.

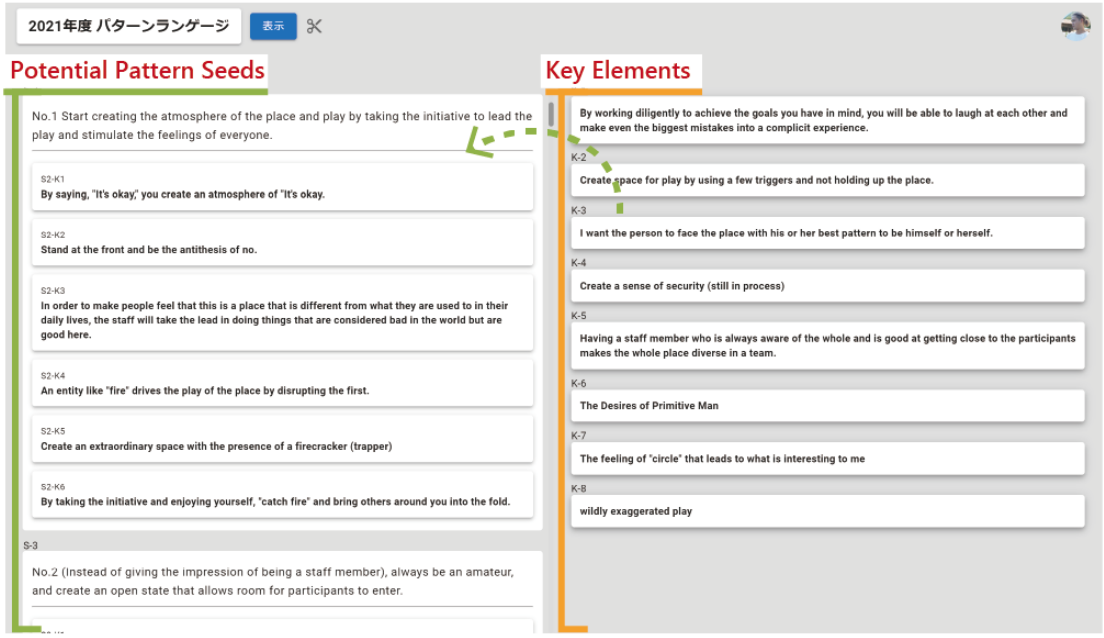

Fig. 6. Clustering key elements and creating potential pattern seeds

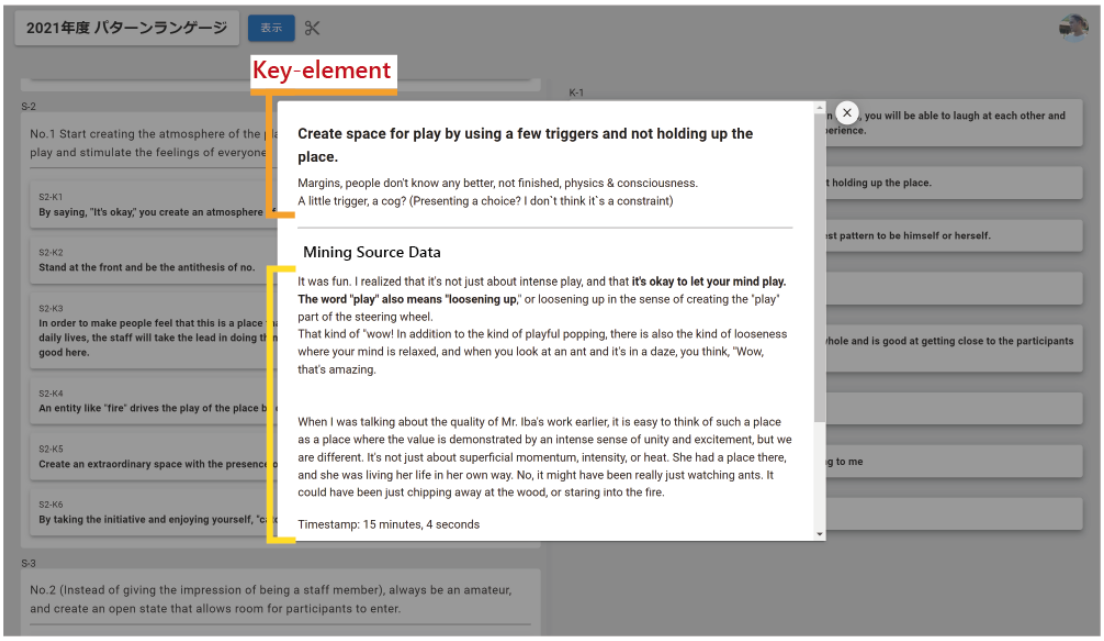

Fig. 7. A popup showing each key element and the mining source data linked with it

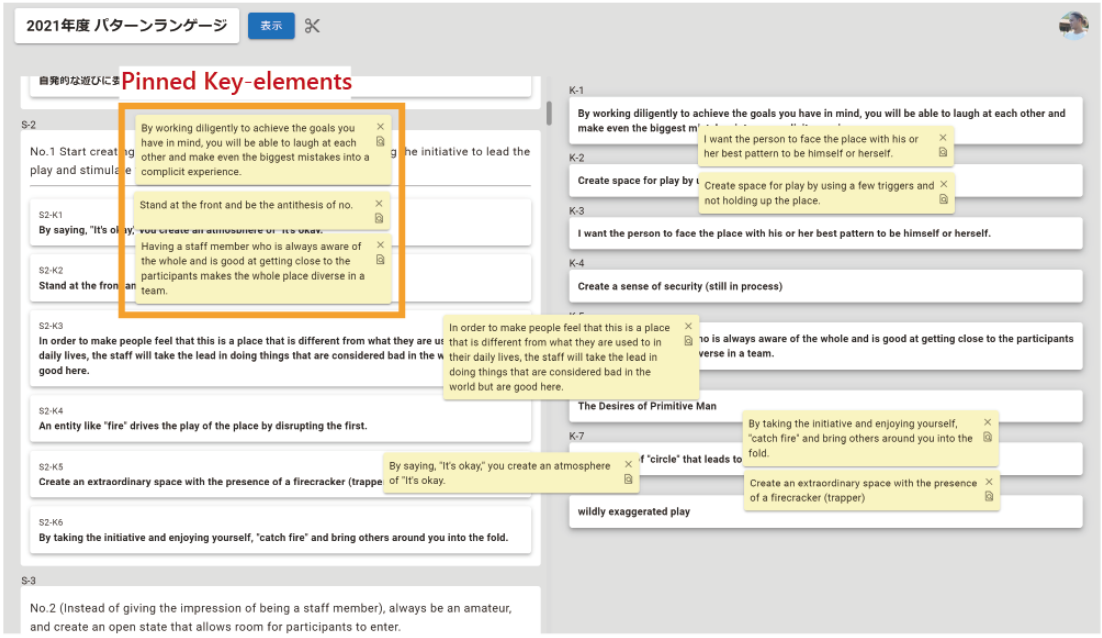

Fig. 8. Pin key elements and place them freely in 2-dimensional space

3.3 Systematization of Patterns as a Language

On the systematization page, first, decide on the major categories, and then drag and drop in the Potential Pattern Seeds that go into each category. The left side of the page shows the scaffold of the language system, and the right side lists the seeds (figure 9). The number of categories and groups can be changed freely, but the default setting is three at a time, as recommended by the Iba Lab's method.

Figure 10 shows the screen with Potential Pattern Seeds applied to the scaffold. Once each Potential Pattern Seeds' positioning is fitted, we will write a temporary pattern name and solution. Again, by making the key elements and original data linked with the pattern available via pop-ups, we can deepen patterns based on their position in the overall language and the context of the original data.

When you weave the patterns as a language, if you feel a missing element, you need to *Add the Missing Element* by conducting interviews or literature mining again. At that time, you will start again with key element extraction, as shown in 3.1. The newly added Potential Pattern Seeds will be automatically added to the list.

Once you have an entire picture of the pattern language and understand the difference between patterns, there are occasions when you want to combine several patterns into one. The system allows you to merge several pattern seeds into one, and when you merge them, the key elements and original data linked with each are also merged.

As you are systematizing, you will better understand each pattern and make discoveries. The system allows you to leave a memo for each pattern to refer to it later. The memos are available in four colors: yellow, green, pink, and gray, and you can use different colors depending on the content. You can also leave memos not only in patterns but also in groups and categories.

3.4 Pattern Writing

On the pattern writing page, you can write each pattern in the format of Pattern name, introduction, context, problem, solution, and consequence of Iba Style in a paper-like interface (figure 11). By using one sheet for each pattern, there are no line breaks in the middle of the pattern text, even if the pattern text becomes long. When writing patterns, starting with the key sentences of Context, Problem, and Solution is recommended and gradually enriching the content. In this system, you can switch to the CPS mode, hiding the unnecessary introduction and consequence part and concentrating on writing the CPS.

When pattern writing, we need to *Grasp the Source* by looking back at the original data from pattern mining and our own thinking. On the right side in figure 11, we can display the pattern seeds and key elements that are

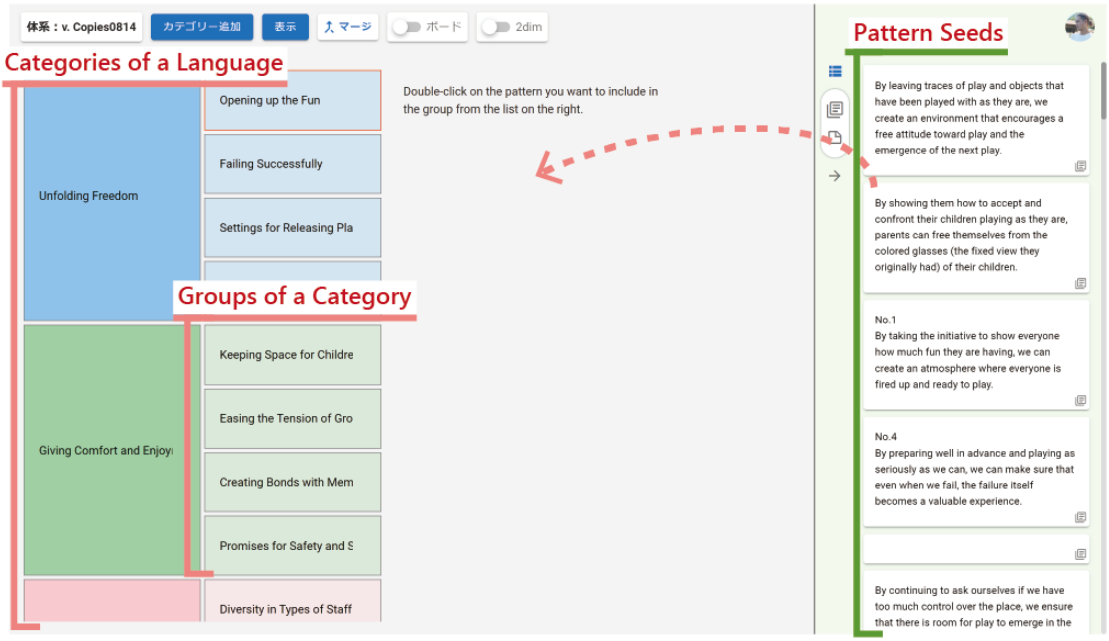

Fig. 9. Scaffold for systematization

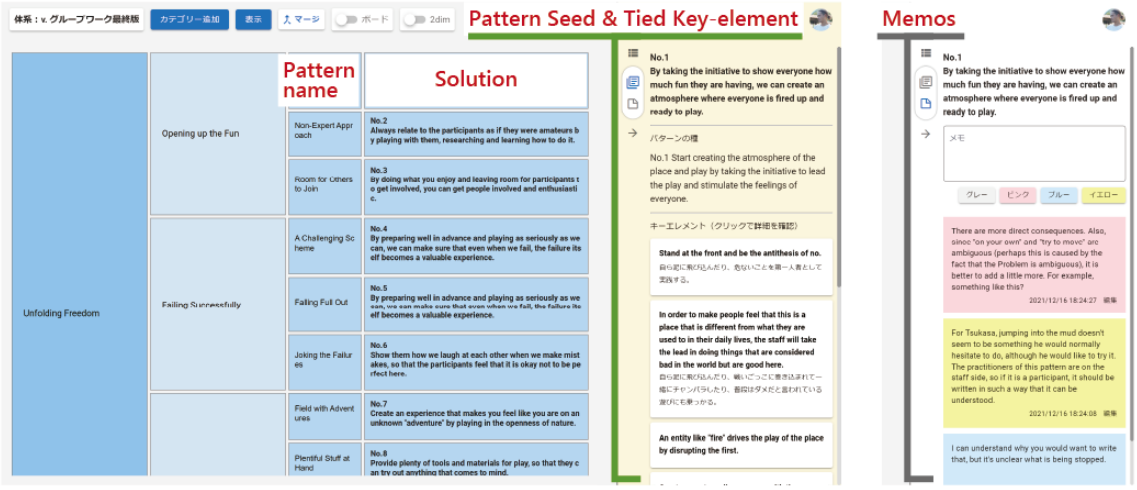

Fig. 10. After potential pattern seeds applied to scaffold and pattern's memo

associated with the currently displayed pattern. By clicking on each key element, you can browse through the interview narratives, literature transcripts, and images linked to that key element (figure 12).

Furthermore, to make each pattern more powerful, we need to check where it stands in the whole language. The tree view of the whole language can be displayed on the left side in figure 11 so that you can see each pattern's position within the whole at any time.

As well as the Key Element Description and Potential Pattern Seed creation functions, you can also create spaces in writing. By creating spaces frequently, we can easily keep a *Record of the Full Process* and *Revision Notes* for your edits. *Keeping a changelog* is useful for new members to catch up on the content. Another technique for deepening a written pattern is *Writer Change*. Switching spaces allows multiple people to write the same pattern and compare them.

Similar to the Systematization page, the Writing page also has a memo function for each pattern. The notes feature allows us to iteratively revise by leaving revision comments, helpful books, lectures, blog posts, and other information. By keeping all the information needed to write a pattern in one system, we can write it without having to use different applications.

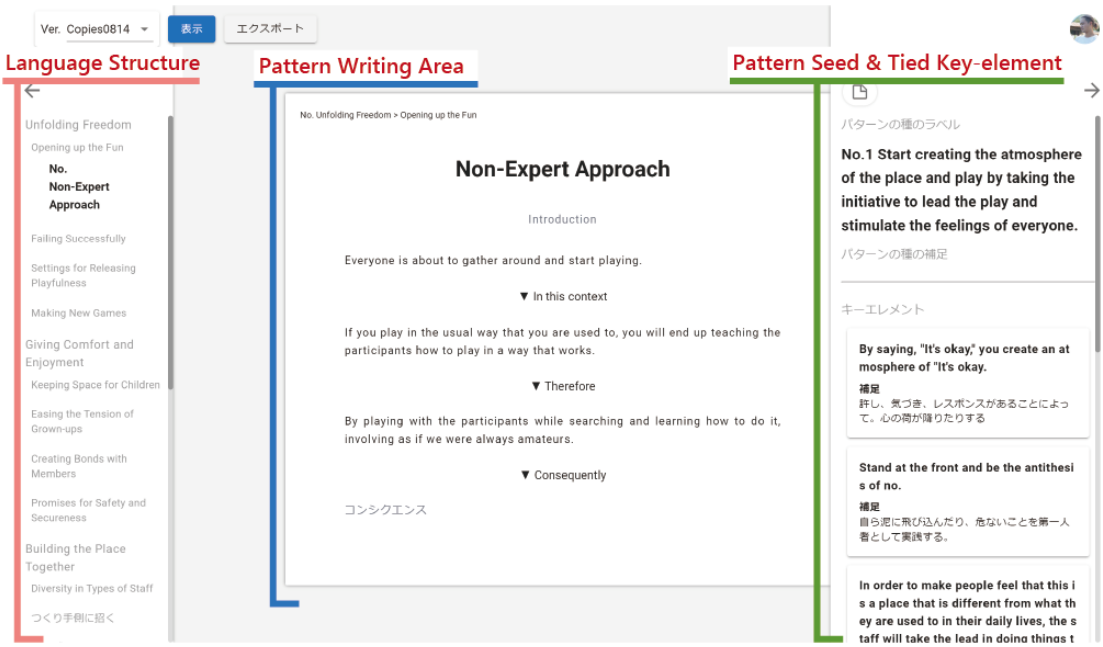

Fig. 11. Pattern writing page

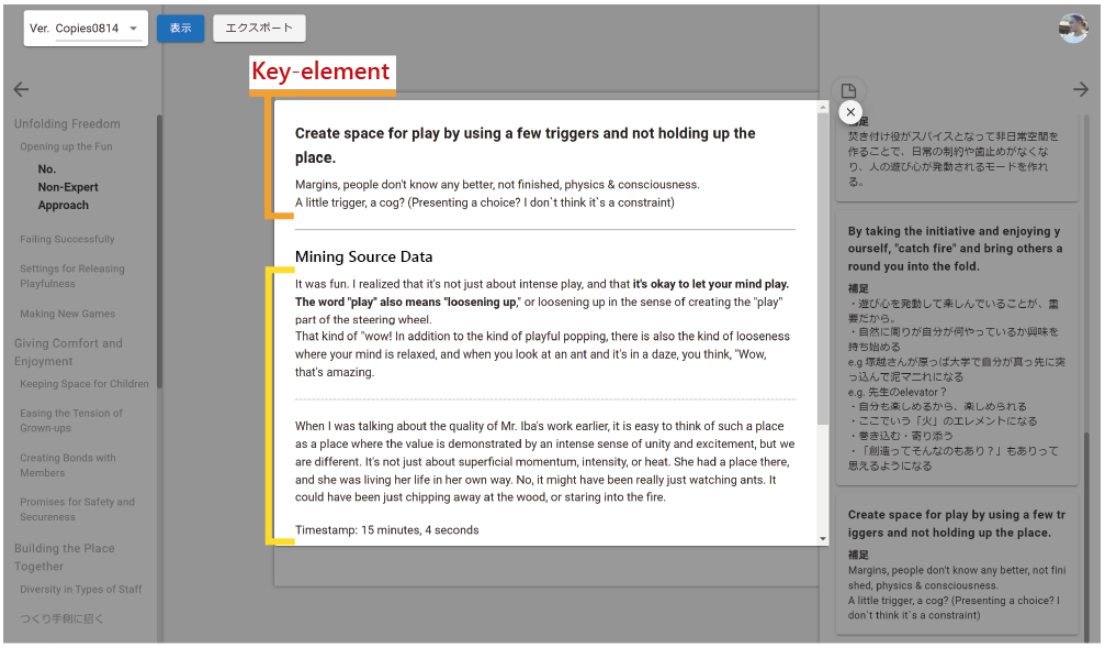

Fig. 12. Mining source data which are linked to key element

4. DIFFERENCES FROM QUALITATIVE DATA ANALYSIS SYSTEM AND ANOTHER PATTERN LANGUAGE CREATION SUPPORT SYSTEM

This section shows the differences between the pattern language creation system and other systems. Comparisons are made with the Qualitative Data Analysis System, the Pattern Repository, and a system that supports pattern language creation through text annotation (Honíšek & Vrani, 2020).

4.1 QDAS (Qualitative Data Analysis System)

Qualitative data analysis has been conducted in various academic fields such as cultural anthropology, sociology, and nursing, but it was first conducted using pen and paper. In the 1980s, a movement to make it more efficient on computers began, mainly in Europe and the United States, and various systems were developed as QDAS (Qualitative Data Analysis System). They have been used by researchers and educators working with qualitative data, and the main positive effects of QDAS on analysis are said to be the following (Gilbert, et al., 2014).

- Become a force to deal with information that grows in volume and diversity as the project progresses.
- Facilitate collaboration among researchers in distant locations.
- Increased efficiency in data management
- Increased portability and durability of data, since digital data is more compact than physical data

In creating a pattern language, it is necessary to maintain a large amount of textual data because more than ten hours of interviews and the creator's own experiences and interpretations will be included.

Pattern mining involves extracting important parts of interview narratives and literature as key elements and segmenting them into manageable units, but at the time of writing, we need to keep track of which specific examples are tied to each pattern. In order to be able to return to the original data quickly, it is essential to improve the efficiency of data management. The systematization and re-systematization of language, which used to be done on paper, can now be completed in a digital space, making it easier to store, manage, and version control of repeatedly updated pattern descriptions and systems. It also makes event tracking when and how the patterns were revised. As described above, the pattern language creation method developed by the Iba Laboratory is compatible with the various effects of QDAS.

Why has the Iba laboratory not used QDAS in the past? We think there are two reasons. (1) The creation method is frequently updated in the research and development stages. (2) Affordances and ease of use, which existing QDAS do not have, are necessary for pattern language creation.

The use of QDAS at a stage when the method has not yet been established is likely to have more negative than positive effects. One of the criticisms and warnings about using QDAS is that if QDAS is suddenly used at the very beginning of the analysis, the various functions and limitations of QDAS will prevent the analysis from following the methods and plans that should be used. In order to conduct a good analysis and get results, it is essential to understand the analysis method itself, apart from efficiency. In the same way, it is not good to use QDAS to create a pattern language when the methods and things to be careful about are unclear. For this reason, it is better to use the traditional pen-and-paper method, which is more flexible when the method has not yet been established.

The standard features of the various types of QDAS can be summarized as follows (Gilbert, et al., 2014).

- We can assign multiple codes to a piece of text/audio/video/photo.
- The relationships between codes can be cross-referenced to obtain constellations and patterns.
- Import nominal, ordinal, and interval data to compare subgroups in the data.
- Use links and memos to track the researcher's ideas.
- Output in a report format that can be used to analyze or present findings outside the software.

These features are beneficial for pattern language creation. However, they do not provide full support for methods specific to pattern language creation. The main difference between our presented system and QDAS is that our system supports the entire process of pattern mining, which analyzes the data, and pattern writing, which describes the insights. When creating a pattern language, the mining source data is most frequently referenced during pattern writing. If we move our workplace to another writing tool after analysis, it can be difficult to get back to the original data quickly. QDAS is a perfect tool for efficient qualitative data analysis. We consider it much easier to create a pattern language if we can seamlessly connect analyzing data and describing insights with the pattern language creation system that takes advantage of QDAS.

4.2 Pattern Repositories

Pattern repositories were developed as a platform to gather many patterns created by various people. It is a funnel for storing and retrieving patterns and a way to refine patterns once they have been registered. There are several types of pattern repositories with varying features, but most have features for the following

purposes: Pattern Writing, Pattern Application, Pattern Evaluation, Pattern Evolution, Browsing/Searching. In other words, pattern repositories are used to facilitate the lifecycle of a pattern language, where it is written by the author, used by the user, evaluated and commented on, and improved based on the feedback. Therefore, the target users are also many stakeholder groups involved in pattern language development, such as Authors, Analysts, General Users, Reviewers, Domain Experts, Domain Novices, Etc. (Köppe, et al., 2016).

To meet these requirements, it can register patterns in a variety of formats, allow users to enter practical examples and improvements for each pattern, link to other related patterns, give credit to the author so that other people know who the author is, and allow users to add category tags for search purposes.

The pattern language creation system proposed in this paper focuses on supporting the initial creation of a pattern language and can be combined with a pattern repository to refine further and improve the patterns once they have been published. At that time, it would be good to store the original data used to create the pattern language together in the repository as supplementary information and evidence.

4.3 Pattern Mining and Writing with text annotating

A tool to support the creation of pattern language using qualitative data is the system developed by Honíšek (Honíšek, et al., 2020) when mining drama patterns from drama scripts. The system they have developed allows users to annotate patterns on imported text data and then describe the contents of the patterns while looking at scripts annotated with the same patterns. Annotation is done in a top-down approach, using the author's patterns. On the Pattern Writing page, users can immediately see the annotated text.

There are two differences between Honisek's system and Pattern Language Online. First, in the Iba lab's method of creating pattern language, multiple interviews are conducted with multiple people. While Honisek's system cannot add several annotations linked to the same pattern across multiple mining source data, Pattern Language Online allows creating a pattern from several mining source data. In addition, since our method of creating a pattern language is not based on describing patterns that the creator has already grasped but on finding patterns from the bottom up based on mining source data, Pattern Language Online is also designed so that patterns can be found from the bottom up, not from the top down.

5. CONCLUSION

In this paper, we introduce Pattern Language Online, a system that supports the efficient creation of pattern languages based on qualitative data obtained through interviews and literature. This system is expected to manage the data more accessible and refer to the original data. We can use more time to refine the pattern description and deepen the interpretations, which are crucial for creating pattern language. We are currently using this system experimentally in several different scales and conditions projects. We want to report on the results and the possibility of further development based on the results.

ACKNOWLEDGEMENTS

We'd like to thank Misaki Yamakage for her generous support. And thank you to Ms. Ando and Mr. Hioki for pointing out improvements and requesting functions in the development of this system. We would also like to thank members of Iba Laboratory for providing us with the opportunity to conduct projects using this system. We also would like to thank Shepherd Michael Weiss for her contribution to refining this paper, Adamar Aguiar, Joe Corneli, Erika Inoue, Sae Adachi, and Mary Tedeschi for their comments at the writers' workshop.

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