Montessori Materials as the "Instrument" for Expansive Learning: An Intervention Study of Three Public Kindergarten Classes in Japan

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1. Introduction

In the current guidelines on education targets, methods for preschool education are recommended for all the countries of the world; however, none are required. Based on previous studies of institutional guidelines, *Sekai no Youjikyouiku·Hoikukaikaku to gakuryoku*" (2008)[1], which investigated trends in 13 countries of Europe(Finland, France, Germany, the U.K., the United States, New Zealand) and Asia(Korea, China, Taiwan, Singapore, Thailand, India), including Japan, and *Working with Young Children in Europe Provision and Staff Training* (1997)[2], as well as work on recent preschool education, i.e., EU15(Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the U.K.) from the first *World Survey of Pre-school Education* (1972)[3], we focused on childcare services and childminder training of the country in the global trend of preschool education. We catch preschool education for total, and these are going to reexamine the education from the situation that is macro. Therefore, we are not arrested whether teachers concerned with a child at a place of local practice hold what kind of difficulty with this comprehensive competitive review, and we are going to generate a realistic problem. The present study introduces Montessori materials[4] into Japanese kindergarten classrooms as a means to innovate kindergarten education using a framework of expansive learning[5] and considers the possibility. In other words, this examination further clarifies the process of expansive learning by introducing these materials into public kindergarten classes.

Specifically, in this study, the use of materials developed by the Italian educational theorist Montessori and Engeström's theory of expansive learning is considered. This examination further clarifies the process of expansive learning by introducing these materials into public kindergarten classes.

In general, the materials used in the Montessori system are a component of the overall methodology[6] and have an indivisible relationship with this approach. In contrast, we introduce materials that are separate from the theoretical systems of Montessori education. This is because public kindergarten teachers may have difficulty introducing Montessori education into the classroom and building their own education theory. This was the impetus for our intervention study involving three Japanese public kindergarten classrooms. In addition, there are two intentions behind the separation of the materials from Montessori theory. First, the teacher applies a variety of approaches when introducing the materials and the framework of Montessori education theory, and thus avoids any interpretation of it. Second, Japanese public kindergartens oppose the introduction of Montessori education and its materials.

"So, why adopt the expansive learning theory? Expansive learning theory stems from the cultural and historical theory of Vygotsky in the early twentieth century. Vygotsky conceptualized "the zone of proximal development"[7] in theorizing the cultural formation of higher psychological functions (voluntary attention, logical memory, abstract thought and scientific creativity). However, Vygotsky only considered the individual, and his theory lacked a viewpoint from which to examine the individual in a group. In contrast, Engeström expanded Vygotsky's theory by incorporating the difference between social systems. Engeström's theory applied developmental research[8] that has been a focus in international literature in recent years. The theory analyzes the practice and innovation of study. In a prior study, a group of subjects in a

study by Engeström established "a care agreement"[9] (i.e., a medical treatment agreement) as part of their medical practice. There is also the "new school project"[10], which incorporated this theory into a new educational practice in a study by Yamazumi. In this study, using online methods, school was regarded as "a collective instrument" that included a teacher group.

The present study supports what teachers analyze as an activity system of the self and therefore adopts the above-mentioned expansive learning theory.

First, I explain the expansive development theory proposed by Engeström and refer to an intervention study that applied this theory. I present findings from an investigation into the materials used in this method given the present condition and the demand of the public kindergarten classrooms. Then, I interpret the findings from the viewpoint of expansive learning theory in light of the data from the three public kindergarten classes. Finally, I examine the significance and problems of the materials that became clear during the investigation.

2. Intervention studies of expanded learning

In this intervention study, I apply the expansive learning theory proposed by Engeström, and support innovations in the educational practice of teachers in public kindergarten classes. Following Engeström, this intervention study of expansive learning is based on Vygotsky's method of dual stimulation. In other words, even if we present a practititioner with a problem and the solution (i.e., stimulation) that a researcher has already determined, the practitioner still brings him/herself to the problem as a psychological instrument, not a passive thing (i.e., reaction), analyzes the problem, and finds a solution. That is to say, the researcher and practitioner promote "re-instrumentation" with "re-mediation" for an object. We only offer instruments that may further an understanding of and the solution to the problem for the practitioner. The practitioner cannot remain in the present condition and falls into a double-bind situation where he or she is unable to find a concrete solution. The practitioner recognizes the contradiction of the previous activity when we use a new instrument. We can improve the activity when we analyze factors that obstruct the activity, and thus we improve our development.

The first reason for applying the expansive learning theory proposed by Engeström is hat the process of expansive learning not only brings personal (vertical) change[11] to teachers, it can also promote extensive (horizontal) changes[12] to teachers' relations with their kindergarten classes and communities. The second change affects the condition of the instruments as "artifacts of mediation". An "artifact of mediation" must include the possibility of helping to understand the solution to a problem. What guarantees this possibility? Engeström employs a theory proposed by Bartlett to make this connection[13]. In other words, it is a new method and instrument; however, it is important introduce and develop this new method and instrument to the participating research field in a given scientific experiment in other domains. The materials must include the notion of "the artifact of transmitting". First, because it improves Montessori that the materials have already existed, and she produced her own Materials[14]. In general, the meanings and functions of the materials are determined by

the relations with Montessori education theory. However, developments were made through trial and error at the *Isutituto Medico Pedagogico*, the *Scuola Magistrale Ortofrenica* in Rome, and the *Case dei bambini*[15]. In other words, the Montessori materials benefited from improvement by Seguin[16] and the learning and teaching experiences of teachers and children who used the materials. The Montessori education system was completed after this trial and error by including various elements such as religious thought and peace theory. In this sense, some may say the materials are "artifacts of mediation" for Montessori. The materials have continued to be used in educational facilities all over the world for more than 100 years. In other words, the results of the materials are important as conditions of "instruments".

We thought that we could promote this theory and support the possibility that teachers could build their own educational theories by introducing the materials into public kindergarten classes. We thus decided to analyze the change that occurred when the materials became "instruments" used by the teacher to promote Engeström's expansive learning theory.

3. Background and method

3-1 Kindergarten classes, teachers, and investigation period

The details about the public kindergarten classes we investigated are presented in Tables 1 and 2.

Table 1 Primary investigation

Note1: "older" 5~6years old children class.

	Kindergarten A	**Kindergarten B**	**Kindergarten C**
Prefecture	Okayama	Okayama	Osaka
Infants	130	173	165
Class	Older[1] 2 Middle[2] 2	Older 2 Middle 3 Younger[3] 2	Older 3 Middle 3
Teachers	5	9	9
Key role teacher **Career**	 4 years	S 8 years	K 27 years
Investigation period	2007 July–December	2008 January–March	2008 April–August

Note2: "middle" 4~5years old children class.
Note3: "younger" 3~4years old children class.

Table 2 The second investigation

	Kindergarten A
Prefecture	Okayama
Infants	122
Class	Older[1] 2 Middle[2] 2
Teachers	6
Key role teacher **Career**	H 8 years
Investigation period	June 2009–March 2010

Note1: "older" 5~6years old children class.
Note2: "middle" 4~5years old children class.

3-2 Background of the introduction method

We faced difficulties when seeking cooperation for this intervention study because Montessori education has not been introduced in Japanese public kindergarten classes since World War II[17]. In addition, for the purpose of the investigation, the materials were not connected with Montessori theory that created difficulties prior to the introduction of the materials. The main difficulty was that the teachers should use materials unknown for this intervention study. However, the kindness of the director who thought that an intervention study to introduce materials would improve the kindergarten teachers brought the study to fruition. We did not introduce the materials into all the kindergarten classes all at once. Instead, following the wishes of each director, we began with one teacher. We made it clear, however, that we aimed to construct collaborative activities that would be implemented in the educational practice in all the kindergarten classes, and the director consented. The change may spread to other kindergarten classes even if the introduction of the materials is limited to one teacher. In other words, the possibility exists that the change would expand to the community through a division of labor. When the state of the investigation became clear in the kindergarten A class, the director introduced this intervention study to the kindergarten B director. In the kindergarten B class, one teacher introduced the materials once the director understood the purpose of the study.

The kindergarten C class in Osaka had the Board of Education introduce the kindergarten C director after receiving approval. The procedure for the investigation was similar for all kindergarten classes.

3-3 Experimental materials

We used the following three types of Montessori materials in this investigation: *cubo del binomio* (binomial cube); *incastri di ferro* (metal insets); and *zero è nulla* (lesson about zero). We describe below the characteristics of each type of material, as well as how each type is implemented.

a. *Cubo del binomio* (binomial cube)

This material includes one large red cube, one small blue cube, three red-black cuboids and three blue-black cuboids. All of these items are incorporated in a cube box. After the child separates these items in the box, children back to the original cube by assembling items that have been separated . Configuration of this material is $(a + b)^3$ if expressed algebraically.

b. *Incastri di ferro* (metal insets)

Ten pieces of iron geometric figures appear on a sloping board with five pieces in the frame of the square. Identity alignment is possible when the pieces are removed using a knob in the center of the geometric figure. The frame size is 14 by 14 centimeters. The forms include a square, rectangle, triangle, trapezoid, pentagon, an egg shape, an oval, a curved triangle and a flower cross. Taking edge in colored pencil and put it on the paper of the same size and frame shapes, children will be able to draw the geometric shapes. This activity is an exercise to develop the muscular motion necessary to draw with a pencil.

c. *Zero è nulla* (lesson about zero)

We prepare number cards which made of construction paper from 0 to 10. In addition, we prepare a basket that contains 55 walnuts. First, the children pull a number card. The children then memorize the number and only take that number of walnuts from the basket. When all the children have finished, no walnuts should be left in the basket. The child who pulled the 0 card cannot take a walnut. Children sit down on a carpet and complete this activity in groups of less than 11. The number cards and the number of walnuts changes according to the number of people participating in the activity.

3-4 Introduction method

At the start of the investigation, we performed a basic demonstration for the teachers on how to use the materials. We then had teachers practice using the materials. In addition, we distributed the print reference that explains how to use the materials. Teachers selected the day and time when they would first introduce the materials. The teacher performed follow-up activities every day, and we conducted day-long observations of the children several times over the course of one month. In addition, we interviewed the teacher after each of the observations.

3-5 Date collection

In addition to observing the teacher, we also observed the children on the day the materials were introduced and on a later follow-up day. We also video-recorded any changes that occurred to the children and the teacher who presented the materials. We recorded the children and teacher during the observations in the event there were changes. Recorded video became an opportunity to rethink remembered thinking and action that changes for us and teachers. We interviewed the teachers to understand

any changes in thought that co-occurred with changes in action during the study. We recorded the content of the interview with an audio recorder. The situations in which the materials were used are included in the collected data.

4. Interpretation of the data

This section interprets the changes that occurred as a result of the application of Engeström's expansive learning theory and its materials in public kindergarten A (Teacher N, Teacher H) classes.

4-1 Interpretation of the expansive learning theory

Engeström states that conjugations (i.e., a vertical point of view) are seen in individuals who practice the "expansive learning cycle" (figure 1), and shows five different phases of expansive learning that occur among practitioners. Phase ① is the need state. In phase ②, an object becomes the motive in a double-bind situation and models the instrument in phase ③. In phase ④, the solution is derived by application and generalization of an instrument. In phase ⑤, the activity unfolds through consolidation and reflection, which leads to a new cycle.

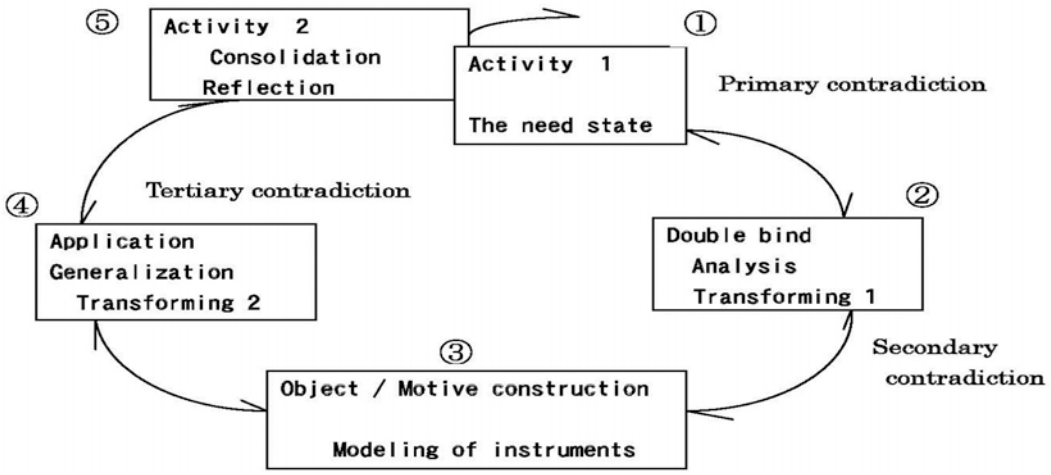

Figure 1 Expansive learning cycle

We can conceptualize the same change that occurred to the individual practitioner by focusing on changes in the relations among the individual components of the activity system. Engeström models the relations between the elements of this activity system as the "structure of the human activity" shown in figure 2

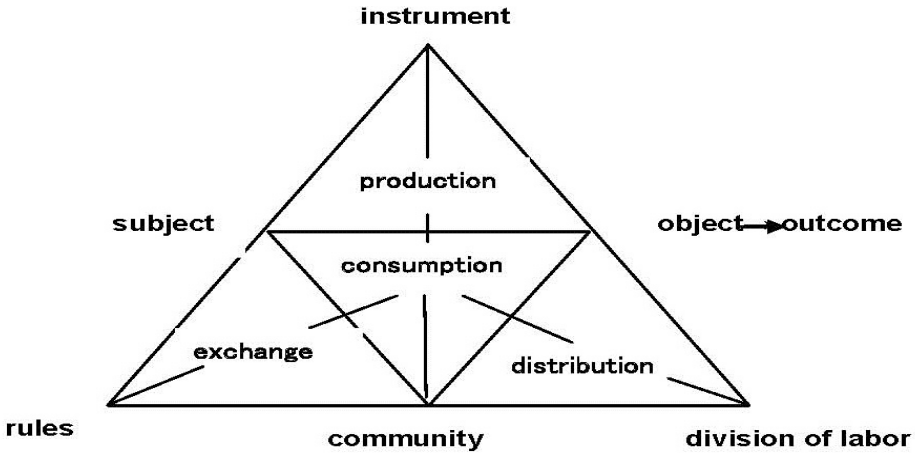

Figure 2 The structure of human activity

I can simplify this by saying the person doing the activity is concerned with an object (i.e., the "instrument") and is also concerned with the rules associated with this object in the community. In addition, the cooperation associated with this object is called the division of labor. All these processes create the possibility of new activity through the double-bind situation without fixing the meaning and function. The changes that occur at any top of the human activity structure spread to all other tops because all the elements of the activity are linked. The person doing the activity thereby brings about new activity through a dynamic process of cooperation.

4-2 The primary investigation (Expansive learning with Teacher N)

In the primary investigation, Teacher N experienced an internal contradiction as a result of the introduction of the materials. This was the case because individual changes (from a vertical point of view) showed various developments. Furthermore, the sign that signaled the change appeared at the spatial social point of view.

First, we identified the changes seen in Teacher N from the interview data. This was the first time she was in charge of an older child. She felt uneasy and stressed, so she reported to me that she wanted to postpone introducing the materials until the next day. However, she was persuaded by the director and subsequently began introducing the materials. She was surprised at the reaction of the child.

> **The children were very concentrated. When the activities would begin, the children's eyes lit up. From their eyes and postures, I could tell that this was unprecedented (9/10/2007).**
>
> **I was surprised to see this concentration. It stimulated me adversely. Through the introduction of these materials, I realized that I always taught the children too much. In addition, I started to be careful not to give lengthy explanations. I started to think different things. It is really different from the first semester because I have had a feeling like "What on earth happened?" for these past two or three days. I understood that**

children absorbed this from my words and manner. I thought …I noticed that I should not say too much with words (9/12/2007).

After this interview, Teacher N learned from the method to present the materials, and subsequently applied the method in her instruction. She instructed children not by words but by movement. The children carefully watched the movement of the teacher and began to imitate it. The direction for using materials was turning into an "instrument" of Teacher N by trial and error in imitation of the method to present the materials. Teacher N then rearranged the materials and changed their location within the classroom. A property called a feeling of abstract done order is expanded in space and other teaching materials newly by materials. Furthermore, teacher N moved the materials in the hallway, for neighboring class children to be able to use the materials freely. The director, who noticed a surge of the instruction awareness of Teacher N, will propose a review of the childcare to all teachers. It may be said that a cycle of new learning was beginning to envelop the kindergarten.

Next, we consider the change that occurred in Teacher N from a spatial social point of view. In other words, what kind of influence would the change have on the elements of the activity system in the kindergarten classes? In this case, we understand that a change in the introduction of the materials (instrument) spread from teacher (subject) to children (object) through a rule to the community (kindergarten).

Figure 3 illustrates these changes.

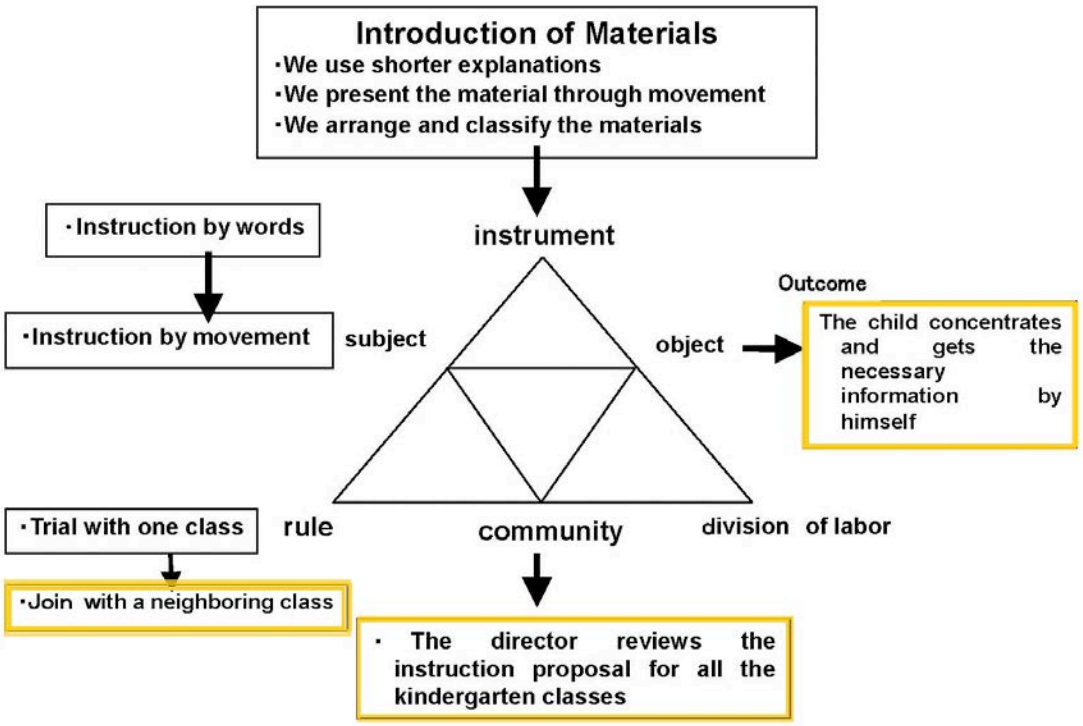

Figure 3 Change in the activity system (Teacher N)

4-3 The second investigation (Expansive learning with Teacher H)

Similar changes happened to Teacher H. Teacher H was busy providing private guidance to a child who needed special support. She was troubled by the fact that she could not instruct the class. In addition, she was required to use the "zero play" materials, but experienced a double-bind because the children did not show interest. However, she finally began the presentation. The children adapted to the "zero play" materials immediately and continued to do so voluntarily. I could tell that she felt surprised and questioned the children's actions in the interview.

Teacher H moved the "zero play" activity afterwards to "the room with everyone (joint ownership space)". This happened because the other children and teachers participated in sequence. Additionally, she set up braided teaching materials in the room. A young child and a boy who had not yet participated subsequently began to participate. The work the children took home became the motive for expansive learning, and the entire kindergarten class was interested in the teaching tools and the materials. When he heard about the interest in the materials having spread to all the kindergarten classes, the director immediately scheduled talks with all the kindergarten classes, including the teachers and us.

I considered the change that occurred to Teacher H, triggered by the introduction of the materials, from a spatial social point of view. In this case, a change caused by the introduction of the materials spread through the division of labor and the rule element associated with the movement of materials. In addition, the change spread through the community and led to new teaching materials. Figure 4 illustrates these changes.

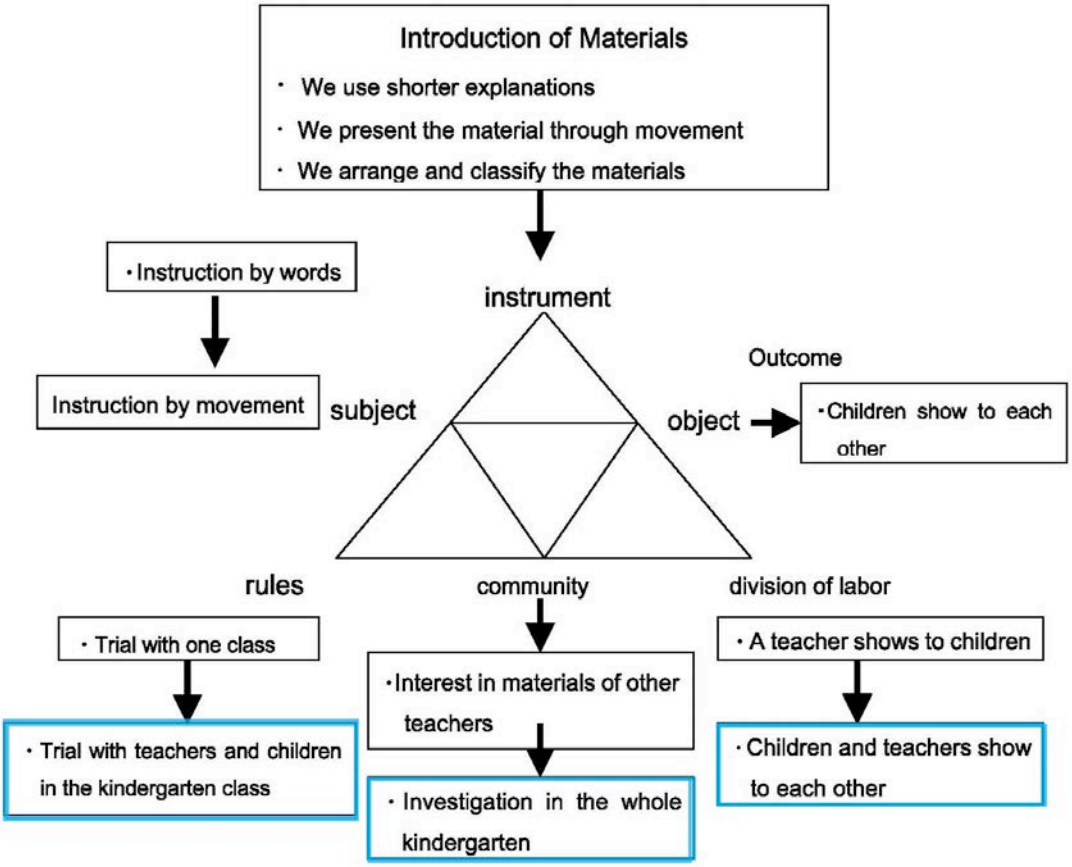

Figure 4 Change in the activity system (Teacher H)

5. Possibility for the instrument of expansive learning theory

I studied the materials before this full-scale intervention study to support and investigate self-innovation in the teacher's activity system in public kindergarten classes. Teachers were perplexed about the materials in the primary investigation and the second investigation when I presented them from the viewpoint of expansive learning theory. This perplexity was caused by being unfamiliar with the materials, their purpose, and their effect while, on the other hand, expecting improvement in the practice. The teachers had to use the materials, but experienced a double-bind when they were unable to find concrete solutions. However, despite this dilemma using the materials, both teachers were surprised at the children's transformation. Furthermore, because we considered the children's transformation, each teacher recognized contradictions in the instruction activity and identified their problems. For example, Teacher N learned from the method to present the materials, and subsequently applied the method in her instruction. On the other hand, Teacher H, in vacant place as a shared space, prepare the (braid) new teaching materials and materials, anyone was able to use freely. In other words, the materials led to an opportunity for self-learning through introspection where each teacher found a solution for their practice and created a new instructional method. This "temporal, personal dimension" represents an important change among teachers. Teachers should develop the idea that by using the materials, they will produce a new "instrument" and create a new "learning" environment. In terms of the development of these new materials, it is necessary to

consider the *zero è nulla* activity. The *zero è nulla* activity involved extremely general materials, with the number cards made using construction paper and the walnuts. In contrast, the kindergarten classes were unfamiliar with the materials comprising the *cubo del binomio* and *incastri di ferro* activities. In other words, the *zero è nulla* materials make it possible to model and generalize the "instrument".

The second type of change caused by the materials represented the social (horizontal) changes; so to speak, relations with their (Teacher N and Teacher H) kindergarten classes and communities. This change happened in one class in the primary investigation. However, this change expanded the teacher's interest in the materials to the whole group, including the participation of children and teachers from other classes and the entire kindergarten class in the second investigation. This happened because ties among the main constituent subject (teacher), the object (child), rules (school year, group), the community (kindergarten), and the division of labor (adult, child relations) made possible new activities with materials (instrument) by a year-long investigation. In addition, I was able to follow the process of the expansive change.

The expansion took place in both investigations and was facilitated by the same director of the kindergarten A class. At that time, there will be a need to consider the differences between the play equipment and materials.

Given the above-mentioned consideration, "any element of materials involves whether the child or teacher brought about a change at the organization" represents a question for the future. In other words, we should have to consider the meaning of the materials that mediate expansive learning. A public kindergarten teacher can improve his or her practice with materials while pursuing this question because it builds an education theory. At that time, there will be a need to consider the differences between the playground equipment and materials.

Will a similar effect be observed if the playground equipment contains elements that are similar to the materials? It is necessary to introduce general playground equipment using a similar method to the presentation of the materials. Alternatively, a comparative study on the classroom materials and other playground equipment without the presentation of directions is necessary. However, the answer to these questions is provided to some extent by the data from one teacher in the primary investigation: "It is difficult just to properly maintain the environment, such as the instrument and the materials in the class room, the puzzle…what if a walnut makes a good feast when playing house" (8/11/2008). This statement is related to the previous experiences of the teacher. Therefore, the materials might not function as an "instrument" if they do not show directions for use. In addition, Teacher N created new teaching tools as a model by herself. Furthermore, as for the *zero è nulla* activity, it is possible to convert it to other playground equipment, following the statement above. Thus, one of the most important elements for the function of the materials as "instruments" is the direction for its use rather than the materials itself.

If the various changes that occurred in the process of this investigation are evaluated positively for a public kindergarten class, the materials could be used, and wider choices would emerge with improvements in teaching practice. However,

directions for the use of the materials may become the key to enacting these changes. Thus, we should treat materials and their directions as one unit when we use the materials. In addition, the method that Montessori developed should be protected, and the directions for the use of the materials should be kept to a minimum. Further, the name “Montessori” should remain. This is the temporary hypothesis offered by the present study.

It will be necessary in the future to make the analysis in the learning process of the teacher individual dimensional analysis of the cooperative creation of an organization, the group level to be able to perform the study that applied an expansive learning theory more in earnest including the inspection of this temporary hypothesis.

However, even if we aim the intervention serious study, in its starting point, and small practices and education being done already in kindergarten side as in this study, in the margins of the training program being carried out already it is a reality that we do so only is not allowed. However, we would not than can not only by a small step in the first, to start this study.

Notes

1. This book introduces trends in contemporary preschool education worldwide and childcare reform, mainly focusing on childcare issues in Europe and America and Asian for each six countries and Japan. It is the following countries to have been surveyed. Finland, France, Germany, the U.K., the United States, New Zealand, Korea, China, Taiwan, Singapore, Thailand, India, and Japan.

2. With this book, today's problem is introduced to be survey by European major country information about the detailed information about the child-care facility, the childminder training course. It is the following countries to have been surveyed, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, the U.K.

3. This book describes the first investigation by Mialaret, who was the chairperson of the world preschool education system in those days followed a global trend of the preschool education by the request of the UNESCO member nation. So, data from 67 countries that replied to a questionnaire are included.

4. Material is the starting point of Montessori education and is said to be a crystallization point coupling the spiritual strength of the child, a catalyst letting you activate it. Montessori was named "concentration of attention" to it (Heiland 1995: 76). Materials are important elements of Montessori education.

5. Expansive learning theory aims at "switching their systems and acts by the originality of the participant group", and doing it (Engeström, 1999: i).

6. Montessori placed emphasis on teacher training to diffuse a method and the educational principle using materials. And she tried for construction, the maintenance of the system (Heiland, 1995: 110). As a result, Montessori education spread globally. However, this regime made the education and research study from a new point of view difficult.

7. Vygotsky defined "the zone of proximal development" as the distance between a potential development standard decided through a development standard of decided reality and an individual solution to the problem under the instruction of an adult or the collaboration with an able friend. In this study, the main constituent of the development is not a child, but the teacher as the cooperator of the materials being introduced.

8. In the 1980s, Engeström began researching participatory action as part of an "educational intervention" methodology. He studied the process of "expansive learning" to create solutions for the problems of a practitioner overcoming an obstacle and the contradictions encountered in team practice.

9. From the studies by Engeström and others on the medical practice activity of Helsinki City,he tried to replace the "care of involvement as" a long-term and continuous, medical isolated and "visit" center. The idea of "the care agreement" originated from a doctor and nurse from different medical institutions(Yamazumi, 2004: 126-129).

10. One of the intervention studies conducted at the Kansai University Center for Human Activity Theory was on a hybrid, after-school instructional activity called "new school (NS)". In NS, a university, an elementary school, home, or other organization performs project learning in the form of cross-school working (Yamazumi, 2004: 285-351).

11. According to Engeström, this "vertical" and "temporal, historic" change is called the development, and the same main constituent means that an object changes along the temporal axes. It has been already recognized in the work by Vygotsky that "a tool" has an effect in this direction.

12. The "horizontal" and "spatial, social" change is called the development, and the change that occurred in an individual and the object means the change along the space axis to spread to the community.

13.*Op.cit.* p. 199

14. Montessori, *IL Mmetodo della Pedagogia Scientifica applicator all' educazione infantile nelle Case dei Bambini,* 1909: 31

15. *Ibit*. pp.132–133

16. Seguin, O.-E. (1812–1880) had thought of the principle of Saint-Simonianism in the 1830–1850 generation for civil society establishment period after the French Revolution. He was one of the first involved with the education of physically and mentally disabled children. He systematized a physiologic training method in practice and aimed at the socialization of disabled children. Montessori materials assume teaching tools of Seguin the origin (Montessori, 1909: 31).

17. Montessori education was introduced in Japan in 1912. At a public kindergarten (Shimane Prefectures Teachers College Affiliated Kindergarten , Himeji Teachers College Affiliated Kindergarten), there is a record that incorporates the education, but it was not a practice adopted materials. The 1930s, by nationalism, militarism, western educational thought faded. Montessori education is being re-evaluated in Japan, it is the 1960s. After the war, in Japan, Montessori education was introduced in Catholic kindergarten mainly. To the public kindergartens, are not introduced at all, a matter of teacher training, class organization, materials cost, and the like.

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