ABSTRACT
We propose a method to improve the quality of preschool teachers’ daily observations in child-care, even during hard daily activities, and to make use of it in counseling and guidance. The proposed observational method uses numerical data of active masses recorded by pedometers, and from the active masses of each child, we calculate the correlation coefficient. In addition, we employ Nearest Neighbor Clustering and visualize the result. According to the results and a conference with teachers, we could confirm the high coincidence between the results and remarks of teachers about the children. Finally, we could confirm the effectiveness of this method via an experiment.

KEY WORDS
Childhood Education, Observation, Pedometer, Nearest Neighbor Clustering, Correlation, Infant

1 Introduction
While conducting activities in preschools, preschool teachers need to carefully observe children at all times and monitor each child’s own developmental stages. Preschool teachers must assist in the growth of children’s social progress and support the development each child’s personality according to their developmental stage.

Only experienced teachers can watch over children while providing high-quality guidance, because each teacher usually takes charge of up to 25 children, and their teaching content in daily activities covers a wide range. Moreover, children’s conditions or feelings often change, and teachers are required to monitor each child’s development in such situations.

In recent years, new social situations have appeared that make observations of children more difficult. This refers to the increase of “a difficult child.” These are children who 1) cannot establish friendships with his/her peers, 2) cannot adjust to groups, or 3) left underdeveloped parts for his/her age. Practicing teachers strongly feel that the number of these children and that of “pre-difficult children” is certainly increasing, although there are no formal statistics to support this claim.

Although the importance of observation in infant education is being increasingly augmented, the time of teachers can spare for the observation is limited. In addition, the number of teachers with little experience is increasing in Japan, mainly in private preschools. Therefore, a support tool that for carefully observing the developmental stages of each child to the end, even by inexperienced teachers, is needed.

To resolve the problem outlined above, in this paper we propose a support tool that assists teachers in observations of children. First, we fit commercially available pedometers to children and statistically process their active mass. The process we adopt is Nearest Neighbour Clustering, which is based on Pearson’s correlation coefficient. We conduct evaluation experiments focusing on 23 infants, and as a result, confirm an auto-abstraction function of difficult children. Moreover, we identify a child who was not supposed to be a difficult child at preschool age, but became one in elementary school.

The remainder of this paper is organized as follows. In Section 2 we mention problems with a conventional observational method. In Section 3, we elaborate on the outline of the proposed method, and in Section 4, show the analyzed data results gained from the experiments. The conclusions are drawn in Section 5.
2) providing support for children to develop their own individuality. However, grasping the characteristics of each child is difficult because there is an infinite number of characteristics, depending on the children’s growing processes.

Mizuuchi[2] continues to observe a particular difficult child identified by that child’s home-room teacher, and explores similar cases. The child is also suggested to be displaying signs of “learning disability(LD)” in the diagnosis evaluated by the teacher. However, from the results of the K-ABC (Kaufman Assessment Battery for Children) psychological test, there is no bias in recognition ability and acquisition from him. According to the recordings of observers and the results of tests, the diagnosis is that it is possible that the child is experiencing emotional problems stemming from his lack of involvement with his peers.

The above case in Mizuuchi is abundant in suggestions. That is, the danger of affirming difficult children only by subject. For example, there is a danger of diagnosing that discriminative action by children such as “restive” behaviour is linked to the style of nurturing at home. When there are children who exhibit discriminative behaviour, it is very difficult to evaluate whether their characteristics come from natural impediments or environmental factors. Therefore, to provide appropriate support for the teachers, there is a need to collect objective data about children over a set interval and judge them both subjectively and objectively by synthetic utilization.

2.2 Existing Observational Support Method

Some methods for objectively observing children already exist; however, it is difficult to find an appropriate method for evaluating daily classes. The most general tool is videotaping by observers. Video observation is comparatively easy to apply if the number of target objects is limited. However, when objects include a whole class or school, the recording range has large limit. Negayama[3] points out that video recording is a tool to cut out a phenomenon from circumference and it would be a restriction against free view points. Therefore, using video recorders every day seems inappropriate and irrelevant as a method that completes teachers’ class activities.

There is also an approach that focuses on children’s active mass. Yonetani and Fukuyama[4] focus on measurement of children’s active mass by using pedometers. Their method aims for feedback in child-care to achieve better physical and mental development by explaining the change of active mass.

There is another approach that uses veteran teachers’ and experts’ experiences and knowledge as a knowledge database. We have already developed a support system for creating observational records using those data, but it has not yet led to practical use [5]. Moreover, it is difficult to capture daily actions of children quantitatively with this system.

As was stated above, no techniques that can gain objective data and can be used in daily activities have yet been developed. Therefore, there is a need for a method that does not interfere with teachers’ work, but is small and powerful.

3 The Observational Method using Active Mass

“Action” is greatly focused in “Class Record” which is obliged to create in preschools in the law[6]. Action of children is also focused in the preceding research about “difficult children”. To best meet the legal requirements, we propose a method that extracts the strength of actions of children at preschools as quantitative data, and visualizes their relationship. The approach is explained in this section.

[Approach of the Observational Method using Active Mass]

STEP 1 : Each child put on a pedometer, which can measure the strength of a human’s action. The pedometers used in these experiments were LifecorderEXs (Suzuken, Japan) [7]. They feature a data-compressing function by using PC and can record strength of action every 2 min taking a numeric value from 0 to 10 in increments of 0.5.

Figure 1. LifecorderEX used in the experiment (72.5 mm×41.5 mm×27.5 mm, 60 g)

STEP2 : After regular observation, the correlation coefficient can be solved for each child. In the case where the number of children is n, \( \sum C_2 \) correlation coefficients can be gained. This time, we made two target terms for calculating the correlation coefficients: 1) a term for the entire observation period, and 2) a term for a predetermined specific fixed class.
STEP3: Taking those correlation coefficients as the mutual distance between children, Nearest Neighbor Clustering was used for connecting each child in close order. Classes were categorized in two ways: 1) whole class, 2) boys and girls (to search for clear friendships). The condition precedent for clustering was 20% of the children at this time. The transaction program was written in Perl 5 (Active Perl) and ran on Windows.

By adopting the analyzed results from the steps described above to our observations, we were able to perform the following actions.

- Include references when teachers made recordings
- Make complementary measurements of observations when teachers found it too difficult to watch every child
- Acquire new “notices” and “angles” for children from the data
- Extract children whose active mass was low during dynamic activities, and children whose active mass was high during static activities
- Observe human relationships within the class
- Extract characteristics and conditions of each child

These points above provide opportunities to make innovations based on teachers’ viewpoints of observations and better class activities.

To establish the method, we conducted practical observation experiments at a kindergarten. In Section 4, we explain the experimental conditions, and report and evaluate the results.

4 Evaluation and Results

4.1 Experimental Conditions

- **Experiment location**: a private kindergarten in Osaka prefecture
- **Number of target infants**: 23 5-year-old infants (boys: 12, girls: 11)
- **Term of experiment**: from 2003.11.25 to 2003.12.15

4.2 Evaluation Methods

These evaluations below are carried forward about the approached method.

4.2.1 Adoption of the proposed method

1. **Correlation for 14 Days**: Children wore pedometers on their waist while at school from 8:45 to 14:00. There were cases for which we could not obtain data because of a low number of participants on Saturdays. Consequently, measurements were taken over a 14-day period excluding Saturdays. There were also cases that data from some child was all “0” because of his/her absence. However, these data were included with the whole data set when calculating correlation coefficient. The number of data factors was 2,198 per child.

2. **Correlation in Fixed Child Care Classes**: In a fixed class, there were also cases in which data from some child was all “0” due to his/her absence, though those data were also included to calculate the correlation coefficient. The experiment targeted 20 minutes of a physical education class. In that class, the children were divided into two groups. They were told to dribble balls in one direction and wait for the other group.

4.2.2 Conference with Teachers

Based on the data of 1 and 2 in 4.2.1, a conference was held with teachers. We visualized the experimental data and presented our speculations to the teachers. Finally, they discussed effectiveness of this method as an objective approach.

4.3 Results

4.3.1 Results of Correlation during the 14 Days

Table 1 shows correlation coefficients of each child according to sex. The absolute value of the correlation coefficient is small due to the high number of factors. However, the difference of data among children is high. Figure 2 shows each boy’s average of correlation coefficient over 14 days. Some facts are clear from the results. At first, both minimum coefficients of children M5 and M6 are high, and their friends’ coefficients are almost all over 0.24. From this point, it can be estimated that they have good relationships with others. On the other hand, the coefficient of child M11 is 0.20, which is lower than the others. We surmise that he experiences some problems in daily activities.

Figure 3 shows each girl’s average correlation coefficient over the 14 days. The respective coefficient averages of children F7 and F10 are comparatively high in contrast to child F1, who has very low correlation with others.

Second, we performed Nearest Neighbor Clustering based on the coefficients in Table 1, with Figure 4 illustrat-
Table 1. Correlation by Sex (above: Boys, below: Girls)

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There are also some facts that can be seen from Figure 4, notably that among the boys, children M11 and M2, and among the girls, children F8 and F1, are isolated from each group. In contrast, children M9, M5, F10, and F7 are the central children of each group. Child M10 has low correlation with other children, but strong correlation appears only with Child-M3 and M8.

There are also some cases in which we could not make any judgment from the data; in Figure 4, it is difficult to ascertain the characteristics of children M10 and M4. However, it is reported that these children are regarded as characteristic children by teachers.

Consequently, our proposed method can extract difficult children with high accuracy.

4.3.2 Results of Correlation in the Fixed Class

According to the results of correlation coefficients in the fixed class, the correlation of each child seems high. We suppose this is because the actions of each child are similar in a restricted situation, leading to high correlation coefficients as seen in the P.E. classes.

The correlation in the fixed class is visualized in Figure 5. In this class, boys and girls are together. By Figure 5, it can be confirmed that there were two groups: the group of children M5, M6, F6, F10, M7, and the group of children M2, M1, F8, and F11. In addition, according to the numerical values of the correlation coefficients and Figure 5, a group comprising children F3, F5, and F7, and one of F7, F4, and F9 displayed similar movement outside the group.

Children M4, M10, and M11, who existed outside the group, were those whose correlations are low in Figure 4. Children M2 and F8 show high correlation with other children even though they are not in the group in Figure 4. Above all, we estimate that there are children who have the possibility to cooperate with their peers, depending on their condition.
4.3.3 Conference Based on the Evaluation

A conference was held with teachers to discuss the analysis results presented above. As a consequence, there were some children who were recognized again by the teachers. There were also some children who gave the teachers a new perspective.

1. The Case in which the Teachers could Reconfirm the Known Characteristics of Children

During the conference with teachers, we could reconfirm known characteristics of children. Judging from the large amount of exercise done by child M4, we can estimate that he has specific characteristics exceeding cheerful and active; in fact, teachers take him as a restless child who tends to be hyperkinetic. It is said that he has a short concentration span and lacks full control over his movements.

The results indicate that in the fixed class, children M4, M10, and M11 had low correlation with others even though they were supposed to have high correlations. According to the teachers, those three children are considered as difficult children who cause some concern in the teachers due to the children’s delay in language and emotional development and difficulties with forming friendships. Above all, even the experimental data suggests that those children find it difficult to maintain cooperation during group activities. Consequently, we could see evidence of this method’s effectiveness at confirming the high coincidence between the result and what the teachers said.

2. The Case that the Teachers Gain New Perspectives for Children in Observation

In addition to the above, we also noticed that the teachers could gain new perspectives about the children through the conference. In the case of boys in Figure 4, the existence of Child-M2 was reconfirmed by teachers. The teachers had thought he had no specific characteristics, but during the conference they discussed the data on him. The teachers described him as a child who does not make a special effort to do things he could not do before. There is a big difference in his attitude between the things he can do with confidence and the things he cannot. They also reported the child has biased actions. In addition, they said that he cannot express himself well; for example, he varnish over himself when he has to understand difficult things.

In the case of girls in Figure 4, children F8 and F1 were not in a group, and they had not been discussed in particular before this analysis. However, during the conference with the teachers, they described Child-F8 as a quiet child who often spent time alone; she merely acts with friends, but the teachers do not think she feels lonely. Therefore, she seems to be a quiet child who can happily play by herself.

In Figure 5, Child-F8 shows a high correlation with her peers even though the correlation of Child-F8 is low in Figure 4. From that fact, we can suppose that she can join and stay in the group, depending on the conditions. Lastly, the teachers reported Child-F1’s life is in disorder and she often comes to school late. Her teachers also said that she finds it difficult to join the group make stable friends because of her situation. This is a case in which the child’s domestic circumstances are considered to have a strong effect on her character.

The result of the conference was that the teachers
could reconfirm the actions and characteristics of children, and they also gained opportunities to discover other sides to the children.

4.4 Possibilities of the Proposed Method

The experimental results of the proposed highlighted the following future possibilities.

1. As a result of the conference with teachers based on the data gained from clustering, the relationships and conditions of isolated children show higher coincidence than what the teachers say. Above all, we considered this method effective at supporting new teachers’ observations.

2. Even experienced teachers gained fresh perspectives this time. It is difficult to monitor the whole class evenly and completely, even for them. What is more, it is inevitable that some bias will occur. Our method is also effective at reducing such bias.

3. It is difficult to determine the quality and content of a relationship, even though this method can estimate such factors in relationships of children. For example, there may be a child whose correlation is high because he/she follows friends, but he/she cannot positively participate in the group. Such information should be brought to the notice of teachers, who can then develop new perspectives and help the children through continuous careful observation of them. This method should be utilized as a barometer to augment and complete the observational strengths of teachers.

5 Conclusion

In this paper, we proposed a novel observational method using pedometers and clustering. Using an experiment to evaluate the proposal over 14 days, we were able to confirm that our method can effectively act as an objective barometer for teachers. A particularly good outcome was that teachers can reconfirm understanding of conditions of difficult children about which they were only vaguely aware.

Moreover, the method could provide opportunities to give teachers “new awareness.” For example, this time, teachers could also have chances to reconsider the triggers of low amount of active masses about the children who look quiet. This indicates the proposed method’s effectiveness as a tool for considering the support and behavior of children.

However, the proposed method does have its limits; only the method can’t distinguish them in quantitative aspect. In addition, observation by teachers is also necessary.

To conclude, children’s conditions should not be judged by only the results of this method; the tool should be used together with teachers’ own instincts. Using this tool and instincts together should, however, strengthen teachers’ powers of observation.

Further work will involve developing the method as a tool to keep an eye on condition changes in children via a longer experiment. Furthermore, we will investigate how to make use of this tool in counseling and guidance.

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References


