**Trial Use of Robotic Pet in Class Work of Kindergarten for Early Childhood Education**

Ryuhei Kimura, Satoshi Yamamoto, Toshiro Tetsui, and Mitsuru Naganuma
Teikyo University of Science and Technology, 2525, Yatsusawa, Uenohara, Yamanashi, Japan
E-mail: kimura@ntu.ac.jp

**Abstract** - Robotic pet was introduced into kindergarten class work for 4-6 aged children in order to investigate the capability of the robotic pet as the performer equipped with the human interface function of multimedia educational materials using various multimedia digital devices, and find the keys for developing the multimedia education system to enrich early childhood education. The final goal of this study is to help a child wholesome mental and social concern development by enriched moral education and intellectual training as the early childhood education using various digital multimedia devices, and robotic pet as the interactive performer equipped with human interface function. In this work, robotic pet, “AIBO” (ERS-311B; SONY-ERC) was used alone for the first step of this study in order to evaluate ability, fascination as the performer to child. Child's interest, which is important to derive the earnestness and the concentration to the education program, was evaluated by counting of the number of raising their hands as affirmative respondent to question about robot. Videotaping by DV-camcorder was also applied to find any problems during session. Most of children were much interested in robot, but some problems of using a robotic pet in classroom environment of kindergarten were found. We propose the model of multimedia education system using robotic pet to enrich moral education and intellectual training as for early childhood education.

**I. INTRODUCTION**

**A. Requirements of early childhood education**

In recent years, unfortunately, moral hazard is becoming an increasingly popular topic in Japan society. In everyday, media reports of increased violent juvenile crime have caused many to declare a moral crisis in Japan. The disheartening signs are everywhere: the breakdown of the family; the deterioration of civility; rampant greed at every time in everyday. It can be said that our society is in deep moral trouble.

While, there is a claim that “the impact of video games on children's brains” caused the disability of wholesome mental and social concern development. The young gamers, who played frequently, were hardly using the frontal regions of their brains, which are important for emotional processing, planning and self-control, would become to be emotional and quick-tempered personality. It cannot be deny that the disability of mental development caused the increasing of violent juvenile. But child would have essentially intellectual curiosity and fun doing about not only “video games” but also all of widely various his/her belongings; natural phenomenon, all of living things, toys and playing together, in other words, child can spark curiosity at every moment everyday so that if we could gave proper intellectual stimuli, we could enhance child’s natural curiosity. Curiosity is the sense of wonder that inspires child to ask "Why?" leading to often become the primary motivating factor for learning, and they would not play video game only so long time and frequently.

Therefore, wholesome mental and intellectual development could be assisted by stimulating child's curiosity. Giving quality education using enriched material in their early years is one of the ways to the future well - being of our society, nations, and also the global community.

As for early childhood education, parents are their children's first teachers, play an important role for child’s development. Parents create important learning attitudes and build essential skills. But, in Japan, most of family, both mother and father work hardly everyday for living well, and they have not sufficient time at home. Then, outside the family, early childhood professionals are the key to giving quality education for child’s development. While, as for intellectual training, our aim is to stimulate the child to think, analyze, discover, and explore, don’t give literacy (reading, writing …) as for getting "ready for school". Kurata reported the possibility of the improvement of kindergarten education curriculum by introducing and using PC. [1] They reported that the using PC helped children practice basic cognitive and social skills, and play and learn about various things more actively in daily life, leading to assist increased communication and the establishment of social interaction in all of their life. While, there were a lots of study focused on “Child - Robotic Interaction”. Kojima et al developed both a child-like robot and a creature-like robot to observe and analyze how human children interact with robots. [2] Tanaka et al reported the toddlers - social robot interaction and behavior analysis using humanoid through 3 months in unconstrained daily-life classroom environments. [3]-[4] Kaneda et al conducted experiments to investigate robotic - school aged children social interaction using humanoid joined an elementary school society. [5]

In this study, realization of quality educational...
environment to assist wholesome mental development long before children enter school by using multimedia system with interactive robotic pet as the performer equipped with human interface function is final purpose. In this paper, for the first step of this study, trial session using robotic pet, which installed some behavioral contents, in the kindergarten class room environment was performed in order to consider that how to use interactive robotic pet as performer and instructional tool, how about the ability of attracting children, and find the problem of using robot for 4-6 aged children in a classroom environment.

B. Robotic pet using session

Until today, there are many types of robotic pet in Japan. AIBO is most famous dog type robotic-pet designed and manufactured by SONY ERC. AIBO equipped several features such as touch sensors on the head, bottom of feet and tail that respond to stimuli as well as sound, voice and image recognition from embedded stereo microphones and image sensor (CCD camera) capture. AIBO at times can recognize and respond to as many as 50 - 100 simple voice commands, such as "sit" and "stand up". Able to walk, "see" its environment via CCD camera on the top of nose, and recognize spoken commands, they are considered to be autonomous robots, since they are able to learn and mature based on external stimuli from their owner or environment. In autonomous mode, AIBO walks fluidly, plays soccer with its Pink Ball (ERS-7 & 300 series), plays with its AIBOne (ERS-7 only), sits, lies down, and lights itself. Some type of AIBO (ERS-7, 210A) can recognize owner’s face and voice.

C. How to use robotic pet

Recently, Robot Assisted Activity (RAA) has been attracted much attention. Various kinds of robotic pet and animal type robot as artificial emotional creature are used in RAA. We have been investigated RAA for child and elderly since 2002. RAA has been carried out for child inpatient in playroom, outpatient in waiting room at children’s hospital, [6]-[7] and for elderly at nursing home. [8] In those works, it was found that robotic pets could provide some measure of social companionship, emotional satisfaction and also some kind of bonding instead of companion animals, and these many mental benefits could reduce mental poverty of child or elderly by manpower shortage of nursing staff at hospital or welfare facilities.

While, the skillful teacher should be engaging friendly, talking interactively, and have to establish positive personal relationships with each children. It is very important especially in the stage of early childhood.

In view of these facts, applying an interactive robotic pet as performer with human interface function for multimedia education system is expected partly the same mental benefits of RAA for child. Robotic pet like an artificial emotional creature could engage and develop relationship with child interactively. Its cute puppy face and charming motions would expect to excite child's interest and positive attitude toward class activity. It is very important point for 4 - 6 years old child that their primary communication or interaction is not perfect verbal (most of them can not read), and physical activities are dominant. Therefore, realization of easy interactive operation for little child using robotic interface is quite important. Child can select the choice in multimedia material, “Yes/No” by only touching puppy head for example.

II. SESSION DETAILS AND ITS EVALUATION

Trial was carried out 2 times at TAMA - Miyuki kindergarten (Tokyo) for 15 minutes with each class shown in figure 1. Number of children is 45 aged from 4 to 5 years old is listed in Table 1. Robotic dog; AIBO (ERS-311B, SONY ERC) was used as shown in figure 2, which is installed three behavioral programs, one is the “story teller”...
“Yes” and raised their hands (Fig. 3) are listed in Table 2, indicating that AIBO has factors that attract most of children’s interest. It is note worthy that the number of affirmative response decreased from 100% (N=5) to 64 - 76% (N=25) with increasing the number of participants in a class from N=5 to N=25, indicating that the utterance or volition of the adult (teacher; demonstrator (our stuff) in this case) may force children to say “Yes” (and raising hand), especially in the case that a few children in a room. Figure 4 shows the change of affirmative response of class A (N=25). It can be seen that there are a few raised hands just after children were asked question by demonstrator as shown by figure 4 (a). But number of hand was significantly increased after the teachers’ confirmation by repeating question and asked children to reply as showing fig.4 (b).

Table 2. Results of questions after session.

<table>
<thead>
<tr>
<th>Class</th>
<th>Number of participant (N)</th>
<th>Q1 (%)</th>
<th>Q2 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>25</td>
<td>64</td>
<td>76</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
<td>67</td>
<td>80</td>
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<tr>
<td>C</td>
<td>5</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 4 Situations when children were asked question in the case of class A (N=25), (a) just after question, (b) after teachers’ asking children to reply question.

B. Child’s behavioral analysis by video observation

Child’s behavior during session was observed by videotaping in order to find any problem of using robotic pet in class room environment. At the beginning, all children watched closely both demonstrator (our staff) and AIBO as shown figure 5 (a). But, some of children gradually became bored and lost their interest as the session proceeded (Fig. 5(b)). It is obvious that AIBO was too small to demonstrate in classroom environment and it seemed to be hard to see detailed motion for child sitting backward of room.

Figure 5 Situations during the session. Children much concentrated AIBO at beginning (a), but some of children gradually became bored (b).

Many problems were observed about “story teller” AIBO. Figure 6 shows situations during the “story teller” performance. AIBO performed actions related book story, and demonstrator turned over pages to see pictures for children. As showing by the figure, both AIBO and book were too small for large class including over 20 children (Fig.6 (a) & (b)). Normal reading speed was too fast to synchronize turning over pages, and it was too short to watch picture in detail during each page period (Fig 6 (c)). Finally, three supporters were required to execute “story teller” as shown in fig. 6 (d). From this result, use of LCD projector and presentation software with large screen are highly recommended, and use of two or three AIBO is prefer for large class use if synchronized performance will be employed.

Child had much interest in AIBO and responds well to AIBO when “rhythmic dance behavior” was executed. Someone began impromptu dance in time with their well known music which is played by AIBO (Fig.7 (a)). But if an unfamiliar music is played, they suddenly lost their interest. All children did not watch robot and demonstrator, talking with each other, or watching outside of room (Fig 7 (b)). Therefore, if this behavioral program will apply as music emphasis (singing, dancing …) for class work, it is important employing well known music for child.

Figure 6 Class room situations when AIBO executed “story teller” (Class A). (a) and (b) Picture book and AIBO’s voice is too small for large class use. (c) Turning over pages is much troublesome. (d) Finally, many adults gave support to execute “story teller” performance.

Figure 7 Children are much interested in AIBO’s dance, (a) well known music case, (b) but they lost interest when AIBO play with unfamiliar music.

Figure 8 shows the change of child’s concentration level derived from the number of child who watched demonstrator or AIBO at each step of the session in each class. Normal axis represents the percentage of the number of child who
watched demonstrator or AIBO. Horizontal axis represents session steps; “A” is just before the session and “F” is the end of the session. From the figure, boys maintained higher concentration than girls in class A and B. These results are quite reasonable because most of boys prefer mechanical toys and machines such as train, car, robot, and so on. If we apply video material with cute AIBO’s behavioral program, girl would expect to have more interest. Perfect concentration was observed in smallest class C (N=5). We suppose that class room atmosphere is dominated by adult person (teacher; demonstrator in this case) when number of child is few as shown by figure 9. This tendency is the same as described before. On the whole observation of session video, it can be said that preferable interactive talking with children and interpreting about robots behavior or its inner states are essential at each step of the session. Relationships with talking children help children be more interactive and it is very important to make child to understand the content of material and lead to prefer goal of the session.

In summary of this section, trial use of stand alone robot in a large class is not recommended because of its small body (= small motions and sounds), but robot itself showed strong fascination for child as shown by figure 10. Then, if we introduce robot property, robot would be powerful instructional tool for class work.

![Figure 8](image8.png)

**Figure 8** Change of child's concentration level derived from the number of child who watched demonstrator or AIBO at each step of the session in each class.

We are going to next trial using LCD projector with an AIBO performer for “story teller” and 2 or 3 AIBO dancers for “rhythmic dancer” behavioral program. Using many robots is very important because every child should experience richly at every time in everyday especially in early childhood. Therefore, every child should experience AIBO closely, such as touching, talking, and playing interactively. These experiences help child to wholesome develop various mental perceptions.

![Figure 9](image9.png)

**Figure 9** Children were more affected by the existence of adult in the case of small class (b) than that of large class (a).

![Figure 10](image10.png)

**Figure 10** Basically, children were much interested in robot. (a) Child came together closely around robot after session. (b) Other classmate watched session through window.

C. Enriched education model using digital multimedia devices for pre-school aged child

Figure 11 shows the schematic diagram of the multimedia educational AV system for class work use (Fig. 11(a)) and for personal use after class work of kindergarten; especially we expect the use of nursery school at morning or evening in the case of long time nursing (Fig. 11(b)). Interactive video educational material is executed by AV system in a daytime, which consists of LCD projector connected with PC to execute video based educational material. It is expected that they can give various kinds of experiences to child.

For easy to use, robotic pet is applied as the human interface which is able to utilize sound effects, voice commands, and various touch sensors to operate. Robotic pet will use not only as “human interface”, but also as “robotic performer” such as “story teller” and “rhythmic dancer” as described above section. Its cute puppy looking, lovely motion and charming voice, all of these are very impressive and attractive for child. In recent years, the concept of “Motion Media” has been attracted much attention in Japan. [9] Robotic motion would be recognized as new media, and would be able to affect to human perception. This idea is consistent with our “robotic performer”. Robotic performance by fluidly moving, voice guiding, and lighting LED’s, which synchronized with video material, can help child to perceive and understand visual contents of material.

Video material consists of digital video file, PC multimedia software and slides of presentation software. Child will spark curiosity and have opportunities to learning,
exploring, and increase understanding of their world as well as a source of pleasure inside material.

We can find various kinds of subjects for proper educational material content; many activities of kindergarten; i.e., outdoor playing and exercising, sports events, seasonal festivals. For example, famous TANABATA festival gives us folklore with good taste for moral education, and some of scientific knowledge about “milky way” for intellectual training.

Figure 11 Schematic diagram of multimedia educational AV system for kindergarten or nursery school.

Russian psychologist, Vygotsky stated that teacher would be able to give child stronger motivation to learn or train if teacher can catch child’s “zone of proximal development (ZPD)” with prefer “level of aspiration”. [10] ZPD means the thing or the area that child is most interested in. Therefore, material content should deal with every child’s ZPD with high aspiration level. Final goal image of our educational system is shown by figure 12.

Figure 12 Final goal image of our multimedia education system to enrich early childhood education. It is very important to catch the “Zone of Proximal Development” of child for education material.

Increased juvenile delinquency caused by an immature idea, a mental breakdown, or emotional upsets is forced us to take prompt measures, and this is our basic motivation of this study. Mentally and physically development started at baby’s first year and basic personality is almost grown after babyhood. While, in recent years, role of the preschool education of kindergarten or nursery school have became to play more important because many kinds of social problems have been came along; the increasing “nuclear family”, “two income family”, “thinned community-based human relationship” and the increasing of “a motherless or fatherless child” caused by a high divorce rate in modern Japan society.

Basically, child should be educated by parents first with their special love in a happy and warm atmosphere at home, and secondary, early childhood educational professionals support family by giving every possible help, give various experiences to help child’s social and self develop outside family. But, these partial responsibilities of early childhood education basically presuppose that the family can educate their child at home.

Today, many kinds of digital multimedia techniques have been developed and we are able to use many fruits of high phonic) and “robotic performer” would make child to fill with the excitement and wonder of learning. Interactive teachers’ talking, questioning, and discussing about content in order to lead children to proper goal are keys to obtain proper education purpose. Many impressive graphical figures; beautiful illustrations or pictures with audible guides are used in question part, and the answer is showed children by a few choices after that by the same method. Child can make a choice by using “robotic interface”. For personal use, compact video materials for install portable digital video player, proper short summarization video is added instead of interactive question part.

Multimedia material is based on today’s modern digital technique, especially PC. Then, it is important to consider how virtual world inside computer and computer itself impact child’s mind and affect to mental development.

Papert stated that computer can interact to children and give many opportunities to discover and learn in a virtual world. Papert named “microworlds”. [11] In that world, child can explores anywhere freely as he/her like it and increase understanding of his/her own world as well as a source of pleasure.

While, B.Reeves, and C.Nass presented the novel ideas, which derived from numerous psychological studies, that people can treat computers, television and new media as real people and places. They proposed “The Media Equation” that interactions with computers, television, and new communication technologies are identical to real social relationships and to the navigation of real physical spaces. [12] Then, it can be said that people (including child, of course) can always compare and translate everything in virtual world presented by media to real, physical world where we live. This process coincides with cognition of virtual world. In other word, everything in virtual world can reflect the real world in which people personally live.
technology. These technologies can give us enriched and impressive experience inside virtual world. Child in Japan faces serious social circumstance; some of them can not be educated well by their parents at home, so that education outside family have to give many experiences as rich as possible for their wholesome growing up. Therefore, we should apply multimedia (included robot as “Motion media” described above) into educational application as soon as possible. Multimedia material would be able to support educator by giving enriched experience in many fields; fine arts, personal, social and physical development, and also early literacy. We must introduce these methods much carefully, discussing guideline with educator. Many reports [1], literature [13], and guideline [14] will give us important information about use of multimedia resources based on PC. Multimedia and related technology would expect to enhance learning. Children will use multimedia to enrich their learning of curriculum content and to extend their knowledge. Finally children would expand their ability. These technologies also serve as important learning tools and are integrated throughout the instructional program in early childhood education.

IV. CONCLUSION

Robotic pet was introduced into kindergarten class work in order to develop multimedia education system for realizing enriched early childhood education. Robotic pet, “AIBO” was used alone for the first step in this work, and we obtain basic affirmative results for using robotic pet in classroom environment. Multimedia education system, which consists of LCD projector connected with PC, and the robotic performer equipped with interface function for the class work use, and handy digital video player for personal use after class work, and basic considerations about using multimedia resources based on computer technique are presented.

Now we are going to prepare another project for the next step of this study which collaborate nursery school for 4-5 aged 25 children using LCD projector, personal video player, and robotic pet (AIBO) as robotic performer equipped with human interface function. AIBO and mental commit seal robot (Paro [15]-[16]) will also use as artificial emotional creature for robot assisted activity at evening. We will report this project elsewhere near future.

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REFERENCES

[14] National Association for the Education of Young Children; “A position statement of the National Association for the Education of Young Children Technology and Young Children Ages 3 through 8” (1996).