

**Research Processes and the Use of Research Environment**  
**-Graduate students' evaluation on research settings according to their research phases-**

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**ABSTRACT**

Though there have been significant number of interesting studies on graduate students' research environment, they still seem to lack long-term view of their research activities. The purpose of this study is to grasp graduate students' long-term use of their research environment. We focused on "Research Settings" such as formal research meetings at several scales and informal conversation within students' rooms, where most of the students took part in order to acquire indispensable research information for creating their master's thesis, and conducted investigations (interview + questionnaire) on 22 masters of a department of general systems studies, in which we asked them to evaluate the usefulness of each of these research settings at each stage of their research activity. Consequently, their styles of the use of research settings in long-term were categorized into 3 types: "Balanced Use", "Distributed Use", both, of multiple settings, and "Good Use of Student Room". The students of the former 2 types tended to evaluate formal laboratory meetings as more informative than informal conversation in students' room at the initial stage of their research, i.e. the exploratory stage, but, on the other hand, the other way round at the following stage of execution. The results suggest that the research environment should be examined in long-term view according to at least 2 stages.

**1. Introduction**

Since the responsibility of educating professional researchers are taken exclusively by graduate schools, it is a primary task for the improvement of professional research environment that the research environment at graduate schools be evaluated appropriately from the viewpoint of graduate students.

Much the same as the one in UK with MPhil and PhD programs (Phillips & Pugh, 2000), the education of graduate schools in Japan consists of master's program and doctorate program, which take at least 2 and 3 years respectively. The core of these programs is devoted to prosecution of studies and research for writing each dissertation. For those who expect to be professional researchers in the future, the first effort of studying for and writing dissertation, i.e. master's thesis, has special meaning as the first trial of all the following research activities. And thus, they are more conscious of carrying out the whole research process "under their own managements" than the other who do not advance for the doctorate.

We, thus, focus on the former students' research processes dedicated to the creation of their theses, i.e. of the students who expect to advance to the doctorate program. In this paper, we conduct surveys and analysis on the sort of settings they mostly benefited by in obtaining various kinds of information indispensable for achieving their master's theses.

## **2. Research Background**

Contrary to the approach that so frequently becomes an issue in which research environment improvement is defined in terms of optimum allocation of research funds, human resources, and other resources, much less reported have been the more fundamental issue of the types of sources from which researchers and more particularly graduate students derive their research data that enables them to proceed with their work.

Though, there have been some interesting studies that consider the research environment from the standpoint of graduate student behavior. Some, for example, analyzed actual usage of research labs and other limited spaces over a fixed period of time (Long et al., 1997, and others), while others investigated the degree of overall satisfaction regarding the research environment using a questionnaire (Oda, 1996, and others). The former type of study focuses on how to enhance the physical environment to make it more conducive to research, while the latter seeks to elucidate the opinions and aspirations of graduate students about educational facilities, equipment, the curriculum, and their own research activities.

However, these traditional studies suffer from the following drawbacks: they fail to address how different environments are used during different stages of research activity. Considering that research activity is generally pursued over a fairly long period of time and passes through a number of stages, it is very conceivable that students utilize the environment differently depending on the stage. Thus, we pose the argument: is it appropriate to assume research either as single general process or as continuous process of the similar activities?

## **3. Research Framework**

### **3.1 Research “settings”**

Tanaka (1988) observed that "even if the atmosphere and customary practices of research institutes, discussions with other researchers at the same institute, scheduling of research activities, and so on do not contribute directly to the immediate research issue at hand, such institutional environment nevertheless create an important research environment for all the belonging researchers that can be referred to as a "research site," and "while they themselves contribute to the creation of various research sites, researchers are greatly influenced by these sites in myriad unseen ways." In other words, the overall environment in which social relationships are forged among a prescribed set of researchers in the physical space of a research institute is expressed by the term *research sites*.

This study will focus on one particular research institute and shall seek to narrowly define a number of research “settings”—laboratory meetings, informal research meetings, academic conferences, interactions with other students in graduate students’ rooms—and the direct contributions these settings have on graduate level research. Different “settings” have different constituent memberships; provide for different unique modes of interaction, discussion, and information exchange; and adopt appropriate physical settings. "Settings" in this sense is close to the core of what Tanaka meant in his work by the term "research sites."

### **3.2 Acquiring “Research Data” from “settings”**

Toda (1998) observed that "*research data* defined broadly as information for conducting

research is not necessarily confined just to academic content materials." "While all sorts of information may be included, it is nevertheless different in character from general information." For the purposes of this study, we shall define "research data" as information that is necessary for graduate students to pursue their research for their master's theses. It is through involvement in research "settings" and the acquisition of research data from these "settings" that graduate students engage in creative research activity.

In their classic study on the information needs and the ways in which information is used by scientists and researchers, Garvey et al. (1979) showed that conversations with colleagues and discussions at meetings were at least as important sources of information as the more obvious sources such as the library resource and technical reports<sup>1</sup>. Of course essential information can also be obtained from the relevant literature, e-mail, the Web, and various other sources. However, it is unlikely that the student's project that relied primarily on these other types of sources would go smoothly, especially at the very beginning stages of research. We will be primarily concerned with research "settings" as settings where information is directly conveyed in face-to-face interactions with others, since such sources of information that can be accessed and used by the individual alone—existing literature, the Web, and other electronic media—shall not be dealt with per se. Rather, the various kinds of settings where students might learn about the existence of particular useful information on these other kinds of sources shall be treated a research "settings".

#### **4. Research Objectives**

The target of this study is the effort over an extended period of time to conduct a research project, and will focus on the "settings" from which graduate students derive the "research data" they need to proceed with their research. Thus, our objective is to elucidate the relationship between the research environment and research activities that has not been addressed in previous studies, specifically, by attempting to identify (1) the stages of research that are involved in the preparation of a master's thesis, (2) the "settings" where graduate students obtain their research data as they work on their theses, and (3) whether the use of these "settings" varies for different stages of research.

#### **5. Research Method**

##### **5.1 Survey Method**

This study was conducted on a group of subjects based on an interview (Survey 1) in which the subjects were asked about their recent experience with the research process, and a questionnaire (Survey 2) soliciting information about the use of different research "settings"<sup>2</sup>. Both surveys were conducted between September and November in the year 2000.

##### **5.2 Subjects**

The subjects of the present study consisted of 22 individuals who obtained master's degrees at the Department of General Systems Studies<sup>3</sup>, Graduate School of International and Interdisciplinary Studies, the University of Tokyo, and are continuing on in pursuit of a doctorate. Ranging in age from 24 to 29, 15 of the subjects were men and 7 were women. We deliberately choose to focus on the master's program that lays the initial foundation for

**Table 1 Subjects' Research Fields**

Research Fields	Programming Studies*		Field Studies*	
	Basic Systems Studies	Information Systems Studies	Natural Systems Studies	Complex Systems Planning
Nr.of Subjects	5	7	8	2

\*Programming studies generally involve building a model on the computer, then evaluating or proving the model through simulations.

\*\*Fieldwork studies typically involve gathering external data through some sort of field survey, then analyzing and interpreting the significance of the data.

researchers, and selected the particular department because it encompasses remarkably wide range of different disciplines<sup>4)</sup> all within the same environment. This should help us determine the extent to which the subjects' preferential tendency for particular "settings" is correlated with disciplines they intended to carry on.

The Department of General System Studies is divided into 4 programs. **Table 1** shows the program affiliations of our 22 subjects. The 4 programs can be broadly divided into

programming-related research and fieldwork-related research. The diversity of subject matter dealt with in the 4 programs will be apparent from these titles of our subjects (**Table 2**).

### 5.3 Research Environment of Survey Subjects

Currently as of March 2000, the Department of General Systems Studies has 47 faculty members (including professors, assistant professors, and teaching assistants), and about 30 research labs. The 22 subjects were affiliated with 15 of the research labs. The research labs are typically organized so that 1 or 2 students from each school year (including fourth year undergraduates and graduate students enrolled in master's and doctorate programs) are assigned to a professor or an associate professor. In addition, the graduate students could also receive supervision on their projects from these research assistants. The subjects basically pursued research on independent themes that they themselves selected, and worked under their own management toward completion of the theses.

There were some difference from individual to individual, but all of the subjects made use of the students' rooms. The students' rooms are the rooms accommodating the graduate students while studying and pursuing research at the university. Their basic characteristics are:

- Three to eight students were assigned to each room,
- A particular study place (desk and chair) was assigned to each student,
- There were numerous cases in which students share a room with graduate students from other research labs, and
- Computer terminals were always available for use.

**Table 2 Thesis Titles of 22 Subjects**

SUBJECT	DISSERTATION TITLES
A	The Improved Computational Models of American (Call) Options
B	Simulation of a 3 Players Game Using the Dynamic Cognitive System*
C	Framework of Computer Systems Management Using Log Data and the Development of the Tool for It*
D	Phenomenology of the Busy Beaver Problem as a Dynamical System
E	Quasiequilibrium Structures of Synchronously Rotating Binary Neutron Star Systems in General Relativity
F	GMLS: A Directed Graph Model with Label Sets for Semi-structured Data Management
G	Cutting Neural Networks and Emergence of Modularity
H	High Prevalence of Wolbachia in the Azuki Bean Beetle <i>Callosobruchus chinensis</i> (Coleoptera, Bruchidae)
I	Computer Simulation of the Formation of Visual System Global Topographic Mapping*
J	Bio- and lithostratigraphy of the Upper Permian Seamount-top limestone in Southwest Japan: Paleoenvironmental Study of a Superocean
K	Field Sex Ratio of a Braconid Parasitoid Wasp, <i>Heterospilus prosopidis</i> (Hymenoptera Braconidae)
L	An Efficient Method to Generate Softwares for Reconfigurable Computers
M	Educational Evaluation of Exhibition on Zoological Parks and Aquariums - Behavioral Study on Visitors by Non-participating Observation Method
N	Development of Flexible Production Systems in the Senshu Textile Industry
O	Study on Symbiotic Relation between Fungus-growing Termites and their Fungus*
P	Automatic Acquisition of an Evaluation Function
Q	Computer Reactions - Affirmative or Negative - Affect User's Thinking
R	A Painterly Rendering Method Based on Image Moment
S	Evaluation of Possible Enhancement of Primary Productivity Due to Upwelled Mixing of Deep Water by a Man-made Sea-mount Using Ocean Color Remote-sensing
T	Acquisition of Cooperative Tactics by Soccer Agents with Ability to Predict
U	Study on Growth and Activity Pattern of the Horseshoe Crab ( <i>Tachypleus tridentatus</i> ) Larvae for its Conservation
V	Quantitative Analysis of Bean Plants - Bean Beetles - Braconid Parasitoid Wasps Community in North Sonora Region*

\*: English translation by Yokoyama (originally written in Japanese)

Most of the information exchange that goes on in these students' rooms is in the form of informal and unplanned conversation among 2 to 3 people.

In addition, the graduate students also attend various meetings to exchange research data including informal research meetings, research lab meetings, joint seminars, academic conferences, and so on. These are planned "settings" for exchange of information, and vary in size just 2 to a few people, groups of around 10, larger groups from 15 to 30 participants, and very large assemblies of people. Also, according to the participants' affiliation, these "settings" differ in degree of formality and in terms of the type of information that is exchanged. Thus, physical environments of these "settings" sometimes also vary.

## **6. Survey 1: Interview Regarding the Research Process**

### **6.1 Objectives**

The objectives of Survey 1 were to (1) investigate the research process that is involved in the preparation of master's theses, and to (2) assemble preliminary data for Survey 2.

### **6.2 Methods**

Survey 1 was conducted as follows: (1) first, we read the thesis of each subject, then based on our understanding of the content and organization of it, we (2) interviewed each subject for about 80 minutes. While making specific reference to the contents of each thesis, the interviews focused on the research process that was involved in preparing the thesis. A list of basic questions regarding the research process and research-oriented life was prepared, in advance, to be asked of each subject. Some of the questions were:

#### (1) Research Process (extracted from the list)

- In the flow or process of conducting research in writing your master's thesis, what took place when? What did you do at each phase of the process?
- When and by what process did you determine your research theme?

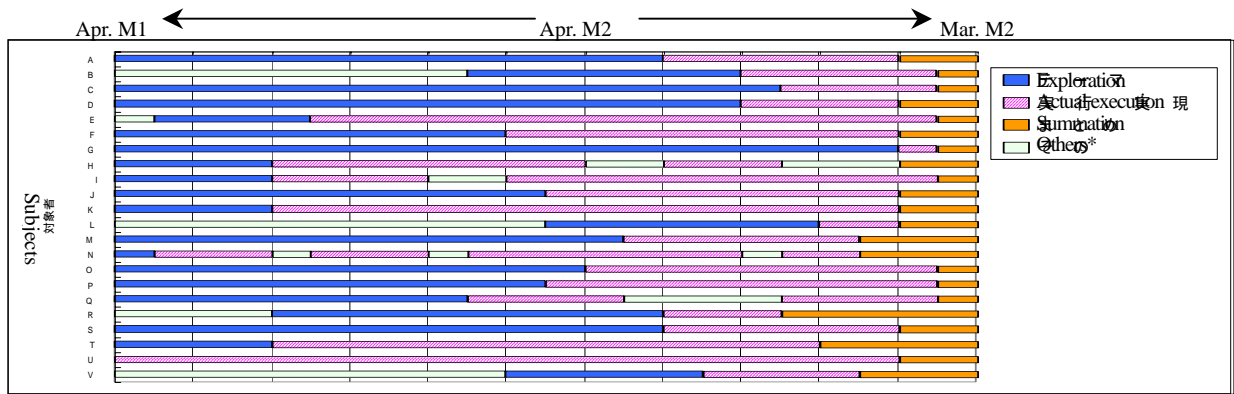
#### (2) Research-Oriented Life (extracted from the list)

- How frequently did you come to the university? To the graduate students' room?
- What sorts of "settings" did you use in conducting your research?
- What were the "settings" where you received the most useful hints or suggestions for conducting your research?

Paralleling the oral interview, we also had the subjects fill out a time-sequence sheet (referred to below as the *descriptive data*) that again asked them to describe what they did at each phase of their research.

### **6.3 Results**

The research process was very much a matter of trial and error and no two of the 22 subjects conducted their research in exactly the same way: some of the subjects were hesitant and did not decide their research themes until the last minute, others settled on their themes right away and made steady progress with their research, and still others ended up choosing research themes that were totally different from what they first thought. Yet despite this variation, the research processes of all of the subjects could be divided into an "exploratory" phase during which the subjects searched and determined their final themes, and an "actual



**Fig. 1 Research Processes for 22 Master's theses Described by the Subjects**

\*The category "others" covers various interruptions such as efforts to find employment, refinement of graduate BSc theses, or other activities that were not directly relating to the research at hand.

execution" phase during which the subjects proceeded with the actual research operations according to the themes they selected. If we include "summation" as the phase in which the subjects write out their theses<sup>5)</sup>, we can segment the research process for all subjects into three phases— "exploration" "actual execution," and "summation" — but beyond this, we could not derive a more detailed breakdown of phases that applied to all of the subjects. Though this segmentation of the process looks rather brief when compared with that of well known creative thinking process, i.e. "first insight", "preparation", "incubation", "illumination", and "verification"(see Lawson, 1990), the former still has something common with the latter when we assume "actual execution" phase as an equivalent to "verification" phase and "exploration" as including the other four phases in the latter process model.

**Table 3 List of Research "Settings" Mentioned by the Subjects**

Research Settings	% *
laboratory Meetings / Joint Seminars	100%
Informal Conversation in Students' Rooms	100%
Course Lectures	100%
Academic Conferences / Workshops	82%
Informal Research Meetings	68%
ut-Campus Training Seminars	41%
nformal Conversation at Laboratory Facilities	18%
Informal Conversation in Computer Rooms	9%

\*The percent figures represent the approximate percentages of the subjects that specifically mentioned each "settings".

**Fig. 1** shows the research process time transition resulted from this survey. In this work we focused mainly on the two stages of the research process that all of our subjects had in common: "exploration" and "actual execution." **Table 3** shows the "settings" which the graduate students mentioned in the interviews as being useful in furthering their research. In the following Survey 2, we focused on the five "settings" with the highest percentages: laboratory meetings / joint seminars, informal conversation in students' rooms, course lectures, academic conferences and workshops, and informal research meetings.

## 7. Survey 2: Questionnaire Regarding the Use of "settings"

### 7.1 Objectives

The primary objective of Survey 2 was to identify the "settings" where the graduate students obtained the research data that furthered their research.

### 7.2 Methods

We developed a questionnaire designed to elicit information about the use of different "settings", which was to be given to the same 22 subjects who participated in Survey 1.

On the questionnaire, the graduate students were asked to rank the overall usefulness of five kinds of settings: (A) informal research meetings, (B) academic conferences &

workshops, (C) laboratory meetings & joint seminars, (D) informal conversation in students' rooms, and (E) course lectures, for obtaining research data for six kinds of research tasks: (1) problem setting, (2) defining one's original viewpoint, (3) determining a strategy for "actual execution", (4) improving one's skills for executing research operations, ex. programming skills and so on, (5) accumulating background knowledge, and (6) approaching to useful sources or references. The students ranked the usefulness of the settings on a scale from 1 to 6. Based on the results of the earlier interview, we assumed that research data types (1) – (3) would be especially essential during the "exploratory" phase, (4) would be most required during the "actual execution" phase, and (5) – (6) would be required generally throughout the entire research process. **Fig. 2** shows what the questionnaire looked like.

We obtained valid responses from 20 of the subjects. Based on the responses, we defined 30 *degree of benefit scores* (6 kinds of information × 5 types of settings), then created a matrix consisting of 30 columns for the degree of benefit scores × 20 rows for the 20 subjects, which we used in the following analysis.

### 7.3 Results

A cluster analysis was performed based on the following procedure to determine if different groups used the various settings differently. First we performed a principal component analysis on the above data matrix (20 rows × 30 columns), and extracted 7 components (cumulative contribution rate of 79.6%). Then we derived a 20 row × 7 column data matrix for the degree of benefit scores that are the attributes of the 7 principal components, and applied cluster analysis (Ward's method) to this data matrix to divide the subjects into three groups: Group I (6 subjects), Group II (8 subjects), and Group III (6 subjects). **Fig. 3** shows the usage of the different "settings" by each of the three groups thus defined. Each point in the figure shows a group average of the degree of benefit (scores ranging from 1 - 6) for a particular "setting."

It will be apparent from **Fig. 3** that, for Group I, the average degree of benefit scores for the various "settings" broken out for different kinds of research data are quite close together, which indicates that several sites are used by this group's members to derive benefit in a balanced manner. We thus refer to the usage of the different settings by this group as *balanced*. **Fig.3** also reveals that, compared to Group I, the average degree of benefit scores for Group II for the various "settings" varied greatly for the different kinds of research data. We will

R* Tasks \ R* Settings	1. Problem Setting	2. Defining Original Viewpoint	3
A. Informal Research Meetings	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. 5. 6.	
B. Academic Conferences & Workshops	1. 2. 3. 4. 5. 6.	1. 2. 3. 4. 5. 6.	

Usefulness Ranking  
 1: not useful at all  
 |  
 6: extremely useful

R\*: Research  
 \*Subjects scored the point (1-6) for the usefulness of each setting in aspects of getting information for the tasks listed above.  
**5 Research Settings** A. Informal Research Meetings, B. Academic Conferences & Workshops, C. Laboratory Meetings & Joint Seminars, D. Informal Conversation in Students' Rooms, E. Course Lectures  
**6 Tasks** for 1. Problem Setting, 2. Defining Original Viewpoint, Making a 3. Determining a Strategy, 4. Improving Skills for Executing Dissertation Research Operations, 5. Accumulating Background Knowledge, 6. Approaching to Useful Sources of References

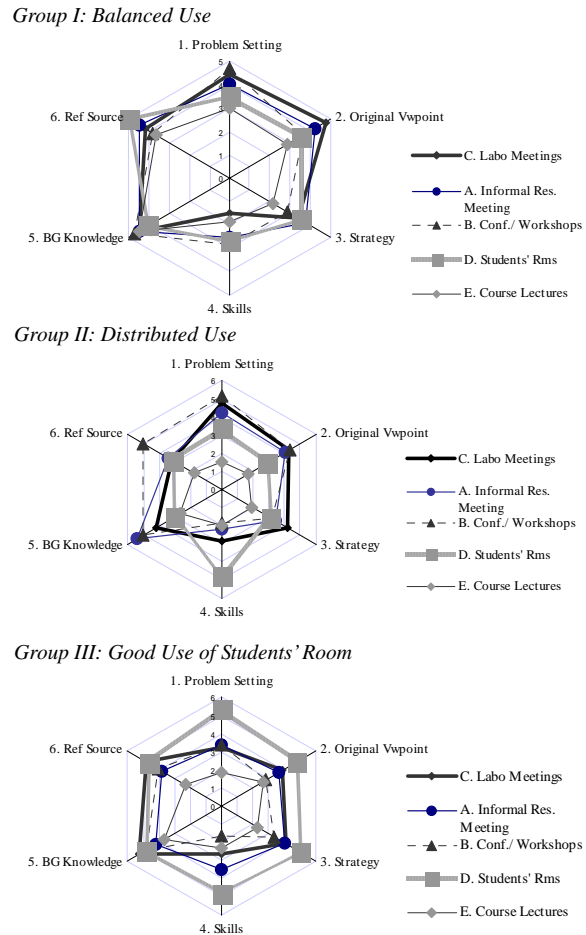
**Fig. 2 Outline of the Questionnaire for Survey 2**

therefore refer to the usage of the different settings by this group as *distributed*. In contrast to the styles of Groups I and II, **Fig.3** shows that Group III derived extraordinary benefit from "informal conversation in students' rooms" regardless of the type of research data. We have therefore labeled the usage of the settings by this group as *good use of students' rooms*. The usage of the settings by the graduate students in our sample can thus be classified into three types: balanced, distributed, and good use of students' rooms.

Next we examined whether the differences in the usage were correlated with particular disciplines (see Section 5.2), and the results reveals that, while the programming oriented students exhibited a somewhat greater inclination toward the distributed styles of research, overall there was no marked correlation between the usage of the settings and the type of research. We would also note that there were 7 subjects who belonged to either the same research lab or same graduate students' room, and out of these, only 2 of the subjects shared the same pattern of usage, while 5 of them did not. The analysis presented here thus suggests that (1) 3 distinct patterns of using settings can be identified and (2) these patterns are not significantly correlated with research type (particular discipline) or particular research lab / students' room affiliation.

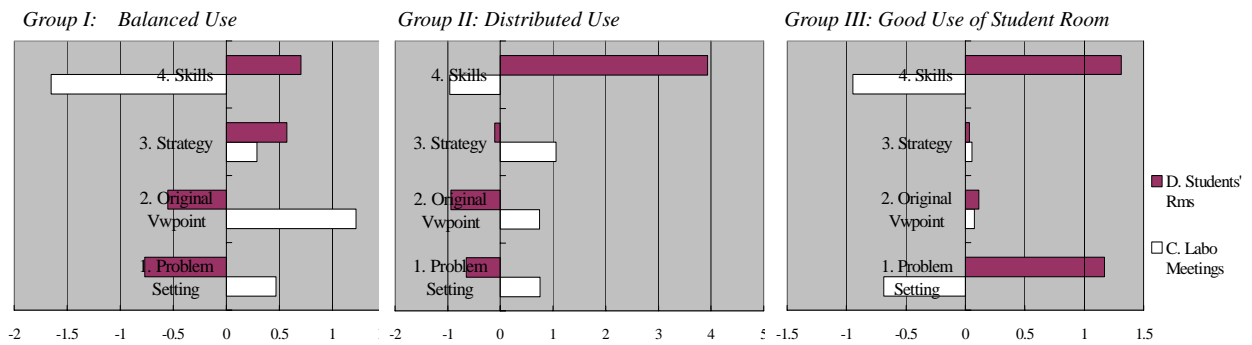
## 8. General Considerations:

Finally, based on the results obtained so far, we investigated to see if the way in which different "settings" are used by graduate students is correlated with different stages of research. Specifically, we applied residual analysis to the average degree of benefit of the different "settings" for each of the three groups. The results showing just the distinctive features are presented in **Fig.4** Distinctive features are most apparent in two types of "settings", "laboratory meetings / joint seminars" and "informal conversation in students' rooms," and in four types of research data: "problem setting", "defining original viewpoint," "determining strategy," and "skill improvement." The horizontal axis of the figures represents the adjusted residuals, and the more toward the plus signifies that the average degree of benefit for that "setting" is relatively high. The type of research data is represented on the vertical axis, though, as we noted earlier in Section 7.2, research data useful for "improving



**Fig. 3 Usage of Different Research Settings by the 3 Groups**





**Fig. 4 Stages of Research & Benefit of Research Settings – a Residual Analysis**

skills” was related to the "actual execution" phase, while others were assumed to be more strongly related to the "exploratory" phase.

With only 6 – 8 members in each group, the number of subjects is really too few to represent a trend, but **Fig.4** does reveal that the “research lab / joint seminars” was regarded as especially beneficial in the "exploratory" phase by different 2 groups, group I and group II, while the “ informal conversation in students’ rooms” was relatively useful for these groups in the "actual execution" phase. These results suggest that use of “settings” does indeed tend to differ depending on the stage of research. This tendency is not apparent in group III. However, this is because the “informal conversation in students’ rooms” was regarded by this group as beneficial throughout the entire research process.

### 9. Conclusions: whether the use of “settings” varies for different stages of research ?

Survey 1 investigated the research process of graduate students. We found that the research process of all our subjects could be divided into three distinct stages: "exploration," "actual execution," and "summation."

This was followed by Survey 2 focusing on the utilization of different kinds of research “settings”—specifically, which “settings” were most useful in obtaining the “research data” needed to further the students' research. This led us to classify the way research “settings” are utilized into three types: “balanced”, “distributed”, and “good use of students’ rooms”. It was found that these differences in the usage of “settings” did not show any significant correlation with particular disciplines or research lab affiliation. Rather, they seemed to be related to how the research itself was perceived and the attitude of the researcher as manifested in the point of the research considered most significant (research in which a novel solution to an existing problem is most significant, research in which the discovery of a new issue is most significant, etc.), how the theme was determined, and the student's consciousness and attitude.

Finally, based on the results of both Surveys 1 and 2, we examined whether different kinds of “settings” were used in different ways during different stages of research. It was observed that at least two of the different usage groups (the “balanced” and the “distributed”) exhibited a shared tendency to regard the “lab meetings / joint seminars” as most beneficial than the “informal conversation in the students’ room” during the "exploratory" phase, and just the reverse, the informal conversation in students’ rooms as the more useful setting during the "actual execution" phase. These results suggest that graduate students do indeed pursue research by utilizing different kinds of “settings” at different stages of their research.

These findings suggest that, when discussing the environmental planning for facilitating graduate level research, there should be assumed at least two major stages involved in the graduate level research process—the "exploratory" phase and the "actual execute" phase—and it is necessary to clearly acknowledge how these environments are used in the different stages of research. We also found that the different usage of "settings" identified in this paper are not determined by the research type (particular discipline) nor by the research labs or students' rooms with which the students were affiliated. Although today we usually classify researchers according to their discipline or area of expertise, this study suggests that another valid approach when considering research environments could be defined in terms of how different kinds of research "settings" are used to further creative research. At the graduate school, for example, it is not enough to just consider what monolithic research environment is best for a particular discipline. On the contrary, this research suggests that a more fruitful environment would be one made up of multiple research "settings" that researchers of varying styles could mutually access without any sense of restraint or inhibition.

### NOTES

- 1) Garvey et al. (1979) surveyed the informational activities of several thousand scientists from an organizational standpoint, and found that the sources of information used tended to differ for different disciplines and fields. Specifically, they found that presentations at academic meetings and technical reports were more useful to those in the natural sciences, while interaction with colleagues in the workplace and libraries were more useful to those in the social sciences. As the main motivation behind this study was to prepare various sources of information for use by researchers, and the objectives of this study are different from ours, we take slightly different categories of information.
- 2) We opted for retrospective interviews with the subjects because (1) it was virtually for some of the subjects to arrange time to be interviewed when they were so intensively involved in preparing their theses, and (2) we wanted to assess the significance of the whole process of preparing a thesis from beginning to end.
- 3) The Department of General Systems Studies is made up of four main programs—Basic Systems, Information Systems, Natural Systems, and Complex System Planning—which encompass a broad range of research areas including information science, space and terrestrial sciences, ecology and biology, cognitive science, science and technology policy, graphic sciences, spatial planning, and human geography.
- 4) The master's theses dealt with in this study covered a broad range of knowledge from natural science and engineering to some aspects of the humanities, but they had little in common with such humanities disciplines as history or literature.
- 5) We should also note that, in many cases, the "summation" and the "actual execution" phases tended to overlap, and some of the subjects continued to work on their theses right up until submitted.

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