

*Towards Efficient and Effective Doctoral Education in Biomedical Sciences:  
Nurturing Transferable Skills*

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**Abstract**

Graduate education funding organisations in Japan focus on nurturing transferable skills in doctoral students to help them broaden their minds and see beyond academia. Biomedical doctoral students prioritise practical research, dedicating themselves to basic research and devoting their time to a research-centred daily life; their specialty is narrowed down to its deepest level. Moreover, most of the students have a part-time job outside the research activities. In this context, this study seeks to investigate what would be an effective and efficient approach for training students so as to cover a range of transferable skills, considering that students come from diverse backgrounds and have different lifestyles. This study introduces a holistic approach used in a credit module conducted in English at an interdepartmental doctoral training programme within biomedical sciences at a traditional national university in Japan. The module aims to improve students' transferable skills as a scientist. Each session includes a series of research communications where students introduce and exchange research concepts and approaches, followed by discussions in a student-led symposium format. The findings of a questionnaire survey reveal students' reflections and evaluations of the module as well as their perceptions of whether the module was efficient and effective. The module also contributed to increasing participants' interest in interdisciplinary learning overall.

Keywords: Doctoral Education, Transferable Skills, Interdisciplinarity

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## **Introduction**

Graduate education funding organisations in Japan focus on nurturing doctoral students with transferable skills to broaden their minds and see beyond academia, instead of only research experiences, and they stipulate such education upon receiving the education funding.

The following question arises: What would be an efficient and effective approach for training doctoral students such that a range of transferable skills would be covered, given that students come from diverse backgrounds and have different lifestyles? This study aims to show student responses to an activity module that seeks to nurture transferable skills among doctoral students in biomedical sciences in an interdisciplinary setting.

Biomedical doctoral students prioritise practical research, dedicating themselves to basic research and devoting their time to a research-centred daily life; their specialty is narrowed down to its deepest level. As a Ph.D. professional, their priority is to acquire superior research skills and produce cutting-edge research results for a doctoral degree. Moreover, most doctoral students have a part-time job outside their research activities.

Efficiency can be part of effectiveness, and education should be concerned with not being a burden on their research activities. It is desirable to provide doctoral education by considering the connection between education and research as well as research-integrated education by ensuring that education contributes constructively to their research.

This study introduces an approach involving a student-led symposium to acquire transferable skills with an aim to achieve efficiency and effectiveness at module level. This approach was evaluated based on student responses to a questionnaire survey.

### ***Integrative and interdisciplinary training***

Universities have adopted diverse ways for implementing interdisciplinary education. Leišytė et al. (2022) suggest that more study should look at the reasons behind the adoption of regulations and policies that make interdisciplinarity successful for various “types” of universities. Integrative interdisciplinary projects have become an increasingly common approach to manage the balance of technical professional competence and transferable skills; however, the desirable approaches differ for the following groups: graduates, undergraduates, or even students of younger ages. According to Lowe and Goldfinch (2021), there has been minimal research on ‘the level’ of integrative skills that might be considered as appropriate at different stages of degree programmes and whether the learning outcomes of integrative projects vary with their stage in degree programmes. In the study by Li (2020), about half of the students did not view the value of interdisciplinary education for academic research; nevertheless, students were generally in favour of such education and agreed that it was necessary and beneficial.

### ***Transferable skills and integrated holistic approach***

Theoretical models and approaches for developing transferable skills are available in the literature. Transferable skills must be gained through repeated experiences over a long-term period. Porter and Phelps (2014) state that it is necessary to become deeply integrated within a holistic doctoral education experience for Ph.D. studies and for professional development;

such a broader integration requires substantial reform in universities in terms of defining the impact of research and flexibility in doctoral degree requirements.

The mainstream attempts in enhancing transferrable skills involved problem-based learning activities. Vidic (2008) introduced and encouraged the development of transferable skills using problem-based learning. Students learn through experiences and from each other's behaviour, which is an important factor in such cooperative learning. Enhancement of transferable skills via student-led formats have also been reported. Chadha (2006) mentioned that a student-led workshop in which students are assessed on both their professional knowledge and transferable skills by applying approaches for a 'holistic view' was successful in a curriculum model. Camarinha-Matos et al. (2020) demonstrated student-led conference based on a holistic approach, along with evidence based on student feedback that confirmed the validity and effectiveness of the proposed approach.

Journal clubs constitute a popular approach at the graduate level and are more pertinent to one's research field; these usually involve meetings with people in similar fields. Kaur et al. (2020) indicated that providing repeated and blended sessions in a journal club is effective in developing critical appraisal skills of postgraduate students, and a multisession format may be beneficial to develop critical-thinking skills. In contrast, people from outside the close fields also participate in an interdisciplinary setting; consequently, they may need explanations in the form of a research presentation that communicates the wider context, as in the case of the Three Minute Thesis. According to Hyland and Zou (2022), the Three Minute Thesis competition cultivates students' academic, presentation, and research communication skills.

### ***Efficiency and effectiveness***

Doctoral students in biomedical sciences are busy just as many professional researchers. In addition to regular graduate school activities, research for doctoral thesis, and miscellaneous duties at the laboratory of their affiliation, these students are required to publish as a candidature, work as a teaching or research assistant or as medical practitioners in the case of some students. Students are required to take several educational modules in addition to their research. The study by Jordan and Howe (2018) showed that the principal problem with the graduate teaching assistants emerged as time pressures. Lei (2019) revealed that doctoral students are under increasing time pressures to publish in order to meet institutional publication requirements.

The 'effectiveness' of a teaching programme or module is typically evaluated through a questionnaire survey; however, fewer studies are concerned with 'efficiency' compared to 'effectiveness'. Previous studies have given scant attention to the lifestyle of doctoral students and the busyness and time burden they experience. This study aims to contribute to this 'efficiency' aspect based on the students' responses.

Efficiency and effectiveness are sometimes interpreted similarly and differently. In the statistical procedures, efficiency is a measure of the quality of an experimental design or test hypothesis, calculated based on test scores. For example, the efficiency and effectiveness of a learning module can be analysed using mean values and percentages based on the test scores. Meanwhile, with regard to 'satisfaction' measurement, Waaijer et al. (2017) measured job satisfaction regarding job content, terms of employment, and work-life balance by asking the respondents to rate the variables on a five-point Likert scale. Likewise, the term 'efficiency'

does not imply a statistical analysis of variance in this study, but instead is based on student feedback using a Likert scale on how efficient the module approach was when concerned with their outside activities.

Time efficiency is a strength brought by the online learning style. The online environment will continue to change and evolve with time. Two major alternative teaching styles have emerged in the new-normal era after COVID-19: hybrid, a mix of online and onsite, and hybrid-flexible (HyFlex), where students choose their modality within the same course (James et al., 2022). In case of the latter, students may end up choosing the online modality throughout, which could lead to a risk of not being able to enhance in-person skills.

## Methods

### *Participants*

Of the 41 graduate students who participated in the proposed module, 40 participants completed the survey. Based on the Japanese graduate educational system, 12 participants were first-year student in a doctoral course and 28 participants were second-year students in a master's course. Participants belonged to graduate schools in fields related to biomedical science: medicine, health science, dentistry, pharmaceutical sciences, and biosciences.

### *Design*

This credit module was held in the afternoon period throughout the academic year at a traditional national university in Japan; it was conducted in English to set an international tone.

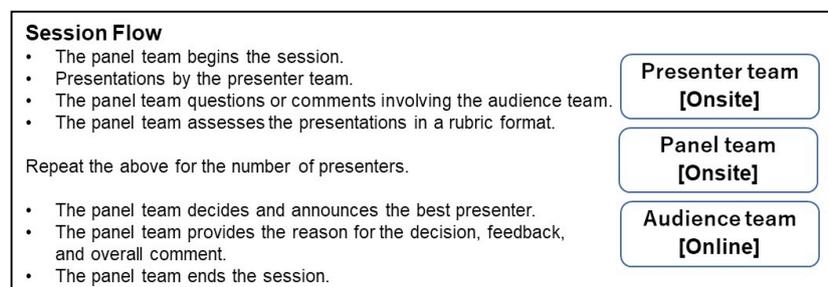


Figure 1. Session flow

As Figure 1 shows, each session includes a series of international symposia. Students introduce and exchange their research concept and approach, followed by discussions. The rationale for this module is to make one's research presentation to an audience comprising the researchers from different backgrounds – biomedicine, public health, statistics, epidemiological studies, medicine, health studies, imaging, deep learning and so on – ranging from dry to wet research, leading to a multidisciplinary group. As a rule, students were not to use presentation tools; they were required to stand right in the centre, in front of the screen, talking to the listeners.

In the introduction session of the module, the instructor explained the purpose and flow of each session. The presenter team began with providing the big picture in real life, instead of starting with definitions as done in scientific presentations at academic conferences; the presenters then got progressively more specific, linking back to the bigger picture at the end. The panel team chair facilitated the session as well as peer review using a rubric-based

assessment of the presenters similar to a real conference. Participants were grouped into the presentation, panel, and audience teams in turns.

### ***Skills expected to be covered***

The module employs role play to enhance transferable skills. Students are expected to develop an awareness of the various fields in biomedical sciences through outputting own research and inputting others' research and actively participating in discussions, chairing, and facilitating the session. Regardless of the roles taken – presenter, panel, and audience – each of the following skills will be put into practice.

As English was the medium of instruction, the module provided an international setting, thereby enhancing global skills. The interactions in an interdepartmental environment inevitably provide interdisciplinarity skills that are enhanced by knowing other research groups' activities, exploring links with others' research activities and methods, and obtaining feedback from an interdisciplinary audience. Communication skills were enhanced by presenting to non-technical audience and discussions. Facilitation and leadership skills were promoted by acting as panel, chairing, leading and facilitating the session, giving constructive feedback and comments, dealing with difficulties, and time management. The audience can also exhibit leadership by, for example, asking questions.

### ***Data collection***

A questionnaire survey in the form of self-reflection and module evaluation was administered at the end of the module. The survey consisted of eighteen items, with six being assessed on a Likert scale.

### **Results**

For the statistical analysis, R and RStudio were used. The unit in all the tables is the number of participants or responses. Where applicable, students' feedback and comments were obtained using open-ended questions on how the students would improve the module or what the students would do differently.

To the question, 'Did the module activity provide you with more experiences than other similar modules you have taken? If you have not taken any other similar modules, leave this question blank', 19 students responded 'yes', 5 responded 'no', and 16 left the question blank, which could imply that they have not taken other similar modules before.

### ***Skills***

By comparing the pre- and post-module levels, students evaluated the improvement in each of the skills in Table 1.

|                      | Very much | Somewhat | Neutral | A little | Not at all |
|----------------------|-----------|----------|---------|----------|------------|
| Leadership Skills    | 5         | 16       | 17      | 1        | 1          |
| Facilitation Skills  | 4         | 20       | 13      | 2        | 1          |
| Communication Skills | 13        | 23       | 4       | 0        | 0          |

Table 1. Number of responses to how the skills improved (n=40)

In all the three skills, the median was in the ‘somewhat’ category.

### *Efficiency and effectiveness*

Tables 2 and 3 show the comparison between doctoral students and master’s students in relation to efficiency and effectiveness of the module, respectively.

|          | Efficiency |       |         |        |            |
|----------|------------|-------|---------|--------|------------|
|          | Very much  | Maybe | Neutral | Hardly | Not at all |
| Doctoral | 4          | 6     | 2       | 0      | 0          |
| Master’s | 10         | 12    | 3       | 2      | 1          |

Table 2. Efficiency by doctoral and master’s students (n=40)

|          | Effectiveness |       |         |        |            |
|----------|---------------|-------|---------|--------|------------|
|          | Very much     | Maybe | Neutral | Hardly | Not at all |
| Doctoral | 4             | 6     | 2       | 0      | 0          |
| Master’s | 11            | 10    | 3       | 2      | 1          |

Table 3. Effectiveness by doctoral and master’s students (n=39)

More dispersion was found in master’s students’ responses (n=28 vs. n=12 for doctoral students). Overall, Table 4 shows the cross tabulation of efficiency and effectiveness.

|            |            | Effectiveness |       |         |        |            |       |
|------------|------------|---------------|-------|---------|--------|------------|-------|
|            |            | Very much     | Maybe | Neutral | Hardly | Not at all | (n/a) |
| Efficiency | Very much  | 11            | 2     | 0       | 0      | 0          | 1     |
|            | Maybe      | 3             | 14    | 1       | 0      | 0          | 0     |
|            | Neutral    | 1             | 0     | 4       | 0      | 0          | 0     |
|            | Hardly     | 0             | 0     | 0       | 2      | 0          | 0     |
|            | Not at all | 0             | 0     | 0       | 0      | 1          | 0     |

Table 4. Efficiency and effectiveness of the module (n=40)

Approximately 80 percent answered ‘very much’ or ‘maybe’ for efficiency, and approximately 79 percent answered ‘very much’ or ‘maybe’ for effectiveness. Both in efficiency and effectiveness, the median is in ‘Maybe’ category respectively. A correlation between efficiency and effectiveness was found, with a Spearman’s  $\rho$ -value of 0.766. As for correlation between preparation time for presentation and efficiency (effectiveness), a Spearman’s  $\rho$ -value of 0.032 (0.132) was calculated.

Tables 5 and 6 show the cross tabulation of employment status and efficiency and effectiveness, respectively.

|                       | Efficiency |       |         |        |            |
|-----------------------|------------|-------|---------|--------|------------|
|                       | Very much  | Maybe | Neutral | Hardly | Not at all |
| Full-time work        | 2          | 0     | 1       | 0      | 0          |
| Part-time work        | 6          | 9     | 3       | 1      | 1          |
| Not working           | 5          | 8     | 1       | 1      | 0          |
| Do not wish to answer | 1          | 0     | 0       | 0      | 0          |

Table 5. Employment status and efficiency (n=40)

|                       | Effectiveness |       |         |        |            |
|-----------------------|---------------|-------|---------|--------|------------|
|                       | Very much     | Maybe | Neutral | Hardly | Not at all |
| Full-time work        | 2             | 0     | 1       | 0      | 0          |
| Part-time work        | 9             | 5     | 3       | 1      | 1          |
| Not working           | 3             | 10    | 1       | 1      | 0          |
| Do not wish to answer | 1             | 0     | 0       | 0      | 0          |

Table 6. Employment status and effectiveness (n=39)

A couple of comments were seen regarding class time table, with students requesting to avoid afternoon period and hold the module in the morning or evening instead, so that it will not interrupt their daily experiments.

Table 7 shows the preferred venue for each role activity.

|        | Presenter | Panel | Audience |
|--------|-----------|-------|----------|
| Onsite | 32        | 33    | 12       |
| Online | 8         | 6     | 27       |

Table 7. Preferred venue (n=40)

Although the majority preferred the audience to be online, some comments pointed out that the audience involvement was not enough. The panel invited questions from the audience, but the questions from the audience remained low in all sessions. Related comments in the student feedback are as follows: ‘No online. All students should attend at the classroom’; ‘We want to get more questions or comments from an online audience.’

### ***Interdisciplinarity***

Table 8 shows the responses related to interdisciplinarity.

|  | Yes | To some extent | No |
|--|-----|----------------|----|
| Were there any similarities between your research concept/approach and others’ presentation talks? | 6   | 23             | 11 |
| Did the module benefit you in increasing your interest in interdisciplinary learning?              | 30  | 10             | 0  |
| Do you wish to interact in the same way in any field other than the biomedical science field?      | 30  | n/a            | 10 |

Table 8. Interdisciplinarity (n=40)

No negative responses were received for the question on the module’s benefits in terms of increasing an interest in interdisciplinary learning. Not all wished to interact with fields other than the biomedical science field. Those who responded yes to ‘Do you wish to interact in the same way in any field other than the biomedical science field?’ were asked a follow-up

question to determine to what extent they wish to interact beyond biomedical sciences; the responses are shown in Table 9.

|                        | Yes |
|------------------------|-----|
| Natural science        | 20  |
| Engineering            | 15  |
| Information            | 15  |
| Social science         | 6   |
| Economics/law          | 5   |
| Linguistics/literature | 1   |

Table 9. Interests in other fields beyond biomedical sciences (Multiple answers)

The supporting comment for ‘linguistics/literature’ answer was ‘I will invite the members from “completely different fields” outside biomedical sciences, to be fairer, let them choose the best presentation.’

## **Conclusion**

The purpose of this study was to seek an efficient and effective training approach that covers transferable skills for doctoral students. The study adopted a holistic approach to providing doctoral education by connecting education with research and ensuring that the learning contributes constructively to students’ own research. According to the survey results, approximately 75 percent of the students responded positively that the module approach was both efficient and effective. The module also contributed to increasing participants’ interest in interdisciplinary learning and leadership, facilitation, and communication skills.

### ***Limitations and prospects for improvement***

Reflecting on the student feedback, a blended approach is proposed. This would involve not just a symposium format but a pre-conference event in the form of groupwork under a certain topic, which enables students to get to know the other members prior to a symposium, could increase student satisfaction. In the responses, some students suggested using presentation topics outside one’s research: ‘set a big theme and students discuss to come up with good answers or ideas’; ‘add a session, in which doctoral students talk about their lives, values, and future plans’; ‘not only research presentation but also life-presentation may improve communications’. If the module focuses on enhancing communication skills, such topics might be suitable.

Although communication skills in English was one of the transferable skills to be enhanced, the language barrier might have been a challenging factor. Some still had conversation in groupwork in Japanese. One student stated, ‘I will make everyone use English strictly in all classes.’

Many people spoke about their research in depth, while others did not. Although it is necessary to talk about one’s research in depth and with clarity, students from completely different fields may find it difficult to understand; however, those close to the field may find similarities and consequently, discussion is enhanced. To encourage joint research or to get feedback on the presentation, the presentation content must be in depth to a certain extent. On the other hand, to understand what other people are doing and to acquire general knowledge,

a non-technical presentation as in the case of Three Minute Thesis is desirable; however, it is often too shallow and the students find it difficult to decide what to discuss. In future, a presentation template could be provided to support the presentation attempted in this module; students could pitch their research content to be more interesting so that others feel like listening further.

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