Relationship between Subject-specific and Generic Competencies: Evidence from a Survey on Japanese Universities

Maki Kato* and Daiju Aiba**
** Mori Arinori Center for Higher Education and Global Mobility, Hitotsubashi University, Japan*
***Graduate School of Economics, Hitotsubashi University, Japan*

Abstract

This paper aims to clarify the relationship between subject-specific competencies (SSC) and generic competencies (GRC) using the results of a questionnaire survey conducted in 2015, which asked students, academic staff, and graduates of Japanese universities about graduates' SSC in six university subjects and GRC. The empirical results show that recognition of SSC and GRC has a positive relationship with different levels of correlation among stakeholders and subjects; the relationship in students shows relatively weak ties compared with that of other stakeholders, as well as that of both Chemistry and Mechanical Engineering subjects. Factor analysis indicates the existence of factors that impact both SSC and GRC in all subjects with heterogeneous structures by subjects; five fields excluding Business have fewer relationships based on commonalities between SSC and GRC such as information and communication technology skills and internationalization, but Business has a closely intertwined relationship between SSC and GRC.

1. Introduction

Competency is becoming a key concept in transferring higher education achievement from academic studies to workplaces and across career sequences. In this paper, competencies are defined as the capability to link individual attributes, including knowledge and skills, to the demands of tasks and activities as defined precisely by Gonczi [1]. Recently in Japan, accompanying this educational trend and changing in-house company education under the stagnation of the Japanese economy, significant attention has been given to the competencies acquired by university graduates, especially generic competencies (GRC) such as problem solving and critical thinking [2–4].

Following the increasing attention on GRC, Japanese universities have begun to teach them by setting up new classes separately from subject-specific education, which is the method to achieve the aims of universities to educate students in subject-specific knowledge and skills, i.e., subject-specific competencies (SSC). However, the best way to introduce GRC instruction is currently debated.

The authors question the current educational argument for GRC because we consider that teaching GRC should come after the clarification of the basic mechanism and characteristics of competencies. Based on this problem, the current paper aims to clarify the relationship between SSC and GRC as a very basic mechanism by using the results of a questionnaire survey conducted in 2015, which asked students, academic staff, and graduates of Japanese universities about graduates' SSC in six university subjects and GRC.

The empirical results show that recognition of SSC and GRC has a positive relationship with different levels among stakeholders and subjects; the relationship between SSC and GRC in students show relatively weak ties compared with that of teachers and graduates, as well as that of both Chemistry and Mechanical Engineering subjects compared with those of other subjects.

The remainder of this paper is organized as follows. Section 2 describes the results of the literature review and introduces the research questions. Section 3 explains the method, and section 4 summarizes the results. Section 5 concludes.

2. Literature review

Japanese universities have attempted to cultivate GRC in students by setting up new classes separately from subject-specific education. For instance, recent survey results show that the number of universities that provide GRC classes have increased steadily (442 universities [61% in total] in 2009 and 566 [76% in total] in 2015); however, these classes are categorized under the subject of career education [5]. The ease of introduction could be the reason for new classes, according to Kawaijuku [6].

However, researchers in the field of education have disagreed on the appropriate method of introducing GRC. Ogata [7] insists that teaching GRC alone deprives students of the opportunity to cognize the relevance of subject-specific learning for their future working career and the students acquire weak skills in thinking and learning attitudes because of GRC instruction's weak base in academic learning. Sugihara [8] was concerned with the current GRC education, which was described as losing its real-world context and was simply packaging methods without "realization" because acquiring GRC became the aim instead of a method for learning academic knowledge and skills. However, the criticism against the introduction of new classes does not appear to be successful enough to be supported by academic staff in charge of subject-specific education. One of the reasons for this lack of support could be based on the unclarified mechanism of competencies.

Previous studies have partially shown the relationship between SSC and GRC. For instance, in a comprehensive literature review, Camara et al. [9] concluded that there was a close relationship between study achievement and transferable abilities. González and Wagenaar [10] also described qualitatively that GRC are interpreted differently by researchers in different academic fields and are distinguished from SSC unclearly. This is consistent with Jones [11], who concluded that researchers in different disciplines understand GRC differently. These results suggest that two types of competencies have positive relationships with a variety of subjects.

Previous studies targeting Japanese students have analyzed GRC based on their respondents' academic fields [12–15]. For instance, Yamada and Mori [12] and the Prog Hakusho Project [13] found that students studying either education or health possessed more GRC, such as higher ability for socialization and self-expression, than did colleagues from other majors. The GLU12 Universities Tuning Working Group [14] concluded that students' recognition of the importance of competencies were relatively close to that of teachers, but far from that of business personnel. These results indicate the possibility of heterogeneous recognition of GRC depending on academic fields and higher education stakeholders. In Japan, however, former studies have not investigated SSC in depth, other than the participation in the OECD's Assessment of Higher Education Learning Outcomes [16]. To the best of our knowledge, no studies have explored the relationship between SSC and GRC in Japan. Therefore, the current study set up the following research questions to clarify it empirically in the various perspectives of Japanese university stakeholders:

Research question 1: Is the relationship between the recognitions of SSC and GRC positive?

Research question 2: Is the relationship between the recognitions of SSC and GRC heterogeneous by university subjects or stakeholders?

3. Method

3.1. Sample

A questionnaire survey was conducted from January to March 2015. Data were collected from 2,553 stakeholders of seven universities in Japan (1,850 students, 351 academic staff, and 352 graduates within 5 years after graduation). The students' academic achievement levels may be relatively higher than the standard achievement of university students in general and homogeneous among the sample because these selective universities were chosen based on the type of research performed. The survey targeted six subjects: Physics, Chemistry, Mechanical Engineering, Civil Engineering, History, and Business. Table 1 shows the number of participants by subjects and stakeholders.

Table 1 Number of participants

	SSC						GRC
	Physics	Chemistry	Mechanical Engineering	Civil Engineering	History	Business	
Students	501	349	602	192	152	78	1,850
Teachers	89	91	99	39	19	12	351
Graduates	52	40	146	65	23	10	352
Total	642	480	847	296	194	100	2,553

3.2. Questionnaire

The questionnaire was based on the one used by the Tuning Academy in Europe [10], which was translated into Japanese and changed slightly to follow the Japanese context. [1] Each questionnaire included SSC and GRC sections. The number of competencies was 31 in GRC and varied in SSC among the six subjects: Physics, 23; Chemistry, 24; Mechanical Engineering, 24; Civil Engineering, 24; History, 33; and Business, 24. For each competence, the respondents were asked to indicate the strength of their opinion about the importance of acquiring it before graduating from university on a Likert scale from 1 (weak) to 4 (strong).

4. Results

4.1. Relationship between competencies

This section shows the result of the analysis on the relationship between SSC and GRC. Although the SSC lists are completely different among the subjects, the authors consider the lists as being comparable regarding them as expectations of

[1] The questionnaire is available in English at http://www.arinori.hitu.ac.jp/pdf/CompetenceSurvey2014Report_Eng.pdf.

experts in the field to be achieved during university education.

Table 2 shows the recognition of the importance of both SSC and GRC by stakeholders. The respondents evaluated SSC slightly higher than GRC at 0.03. Graduates evaluated both competencies lower than did students and teachers. Students evaluated SSC higher than GRC at 0.05, teachers evaluated them almost equally, and graduates evaluated GRC higher than SSC at 0.05. On average, the difference between stakeholders is quite small.

Table 2 Importance of competencies

Stakeholders	Numbers	SSC		GRC	
		Mean	SD	Mean	SD
Students	1,826	3.20	0.46	3.15	0.42
Teachers	342	3.14	0.43	3.15	0.41
Graduates	336	3.05	0.51	3.10	0.38
Total	2,504	3.17	0.47	3.14	0.41

A scatterplot of means for SSC and GRC is shown by the stakeholders in Figure 1 and by the subjects in Figure 2. Their correlations are shown in Table 3. Figure 1 indicates the positive relationships between SSC and GRC for all types of stakeholders. Table 3 also shows the different levels of correlations among stakeholders. For instance, the correlation of students is around 0.3, which is almost half of both teachers and graduates at around 0.6. The scatterplot of means for the field also shows the same tendency. The relationships between SSC and GRC for all subjects are positive, but with different levels. The amount of correlation is smaller in Chemistry and Mechanical Engineering at around 0.3 than others showing at 0.6 in Business, at more than 0.5 in Civil Engineering and History, and at around 0.4 in Physics. Therefore, the results conclude that there is a positive relationship between SSC and GRC at different levels in stakeholders and subjects.

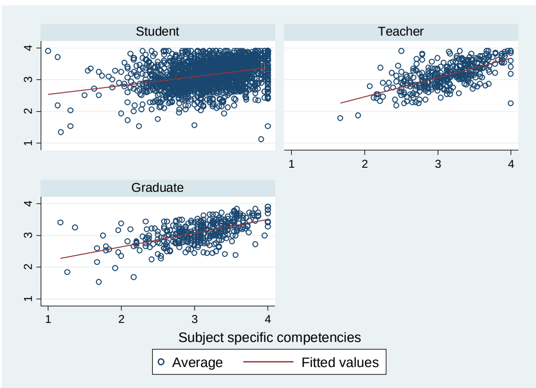

Figure 1 SSC vs GRC by stakeholders

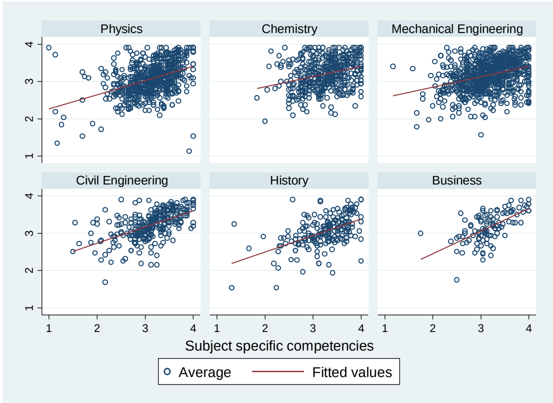

Figure 2 SSC vs GRC by subjects

Table 3 Correlation between SSC and GRC

Stakeholders	Correlation	Academic Subjects	Correlation	Academic Subjects	Correlation
Students	0.31***	Physics	0.41***	Civil Engineering	0.56***
Teachers	0.65***	Chemistry	0.29***	History	0.51***
Graduates	0.58***	Mechanical Engineering	0.33***	Business	0.61***

Note: *** 1%, **5%, *10% significance levels

4.2. Relationship between the pair of competencies

The different levels of relationships among subjects could be grounded on the relationships between pairs of competencies. We analyzed the relationships between pairs of competencies by subjects, targeting students who were the majority of respondents (72.9% of total), considering the different levels of relationships among stakeholders. Figure 3 shows the correlation and significance of each pair of competencies in GRC and SSC, where each matrix includes 1,458 correlations at least, i.e., the number in Physics is 1,458 based on the formula $(31\ \text{GRC} + 23\ \text{SSC})^2/2$. The color cell means that the *P*-value is under 0.05 where the null hypothesis that the correlation is zero is rejected.

As shown in Figure 3, two types of relationships are identified: First, a strong relationship within either SSC or GRC (triangles on the upper left side and on the lower right side), but a weak relationship between SSC and GRC (square shape on lower left side). In Figure 3, Chemistry and Mechanical Engineering subjects are categorized into this type with a clear shape of green triangles and white squares. Physics is also categorized into this category with relatively weak characteristics. Second, a relationship without clear differences as opposed to the first type. Business is categorized clearly into this type, but Civil Engineering and History are not categorized into these two types. The results indicate a heterogeneous structure among subjects. Although the relationships between each pair of competencies are interesting, they are not easily understood from the correlations of pairs. The structure of competencies will be discussed in the following section using the results of factor analysis.

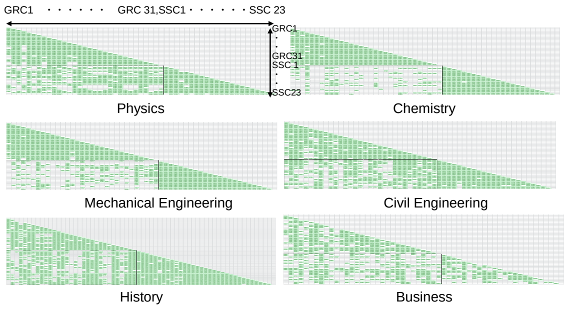

Figure 3 Correlation between competencies

4.3. Structure of competencies

This section shows the results of factor analysis to clarify the structure between SSC and GRC. We focus on the factors that impact on both SSC and GRC (FBTH). The factor analysis used the maximum-likelihood method and promax rotation to target all three types of stakeholders. Kaiser's criterion sets up the number of factors as one or more eigenvalues in a normalized correlation matrix.

Table 4 shows the number, ratio, and the factor order of FBTH based on the degree of contribution. Business shows a different tendency to other subjects. For example, the number of FBTH is 6 in Business, which is around 40% of the total; however, it is 3 in Civil Engineering and History, and 1 or 2 in the remainder, which is at most 23.1% of the total. The highest order of FBTH in Business is the second order, whereas other subjects do not have that kind of higher order of factors.

Table 4 Factor analysis results

Fields	Number of factors	Number of FBTH (ratio)	Number of FSSC (ratio)	Number of FGRC (ratio)	Factor order of FBTH
Physics	10	2 (20.0%)	4 (40.0%)	4 (40.0%)	4^{th}, 8^{th}
Chemistry	12	2 (16.7%)	4 (33.3%)	6 (50.0%)	10^{th},12^{th}
Mechanical Engineering	10	1 (10.0%)	3 (30.0%)	6 (60.0%)	5^{th}
Civil Engineering	13	3 (23.1%)	5 (38.5%)	5 (38.5%)	7^{th},8^{th},13^{th}
History	15	3 (20.0%)	7 (46.7%)	5 (33.3%)	7^{th},9^{th},12^{th}
Business	15	6 (40.0%)	2 (13.3%)	7 (46.7%)	2^{nd},6^{th},10^{th},13^{th}, 14^{th},15^{th}

To clarify the FBTH relationships, our analysis identified two types of factors: FBTH and factors impacting only SSC (FSSC) or only GRC (FGRC). The combination of correlations includes six types: pairs of the same types, such as FBTH and FBTH, FSSC and FSSC, and FGRC and FGRC, and pairs of different types, such as FBTH and FSSC, FBTH and FGRC, and FSSC and FGRC. In Table 5, the results show a relatively lower level of correlation from −0.22 to 0.50 regardless of the combination of factors. This result is lower compared with Yamada and Mori's [12] result; the middle to lower level of correlation (from 0.26 to 0.68) was obtained from eight factors based on 35 GRC.

In Table 5, the results show the consistency with these in the previous section. For instance, Chemistry shows a relatively higher correlation at around 0.40 within either FSSC or FGRC and relatively lower correlations in combinations between FSSC and FGRC at 0.16. Mechanical Engineering also shows the similar tendency. The other four subjects including Business do not show a clear difference between pairs of the same types or that of different types besides FBTH. The result implies the heterogeneous structure of competencies among subjects.

Table 5 Correlation of different types of factors

Field / Correlation based on	Physics	Chemistry	Mechanical Engineering	Civil Engineering	History	Business
FBTH and FBTH	0.22	-0.22		0.06	0.10	0.12
FSSC and FSSC	0.24	0.41	0.41	0.12	0.25	0.29
FGRC and FGRC	0.29	0.39	0.33	0.29	0.22	0.22
FBTH and FSSC	0.23	0.07	0.50	0.06	0.18	0.20
FBTH and FGRC	0.27	0.04	0.29	0.18	0.19	0.14
FSSC and FGRC	0.18	0.16	0.22	0.15	0.23	0.20

Note: The figure shows the mean of correlations

We analyzed the contents of FBTH by subjects. Regarding the natural science fields, in Physics, two factors were categorized into FBTH among 10 factors: the fourth factor is named as social responsibility and the eighth is experimental skills with safety consciousness. In Chemistry, two factors were categorized into FBTH among 12 factors: the tenth factor relates to internationalization both in FSSC and FGRC, and the twelfth relates to the development of the latest research technology in SSC with a negative sign and international work in GRC with a positive sign, which means that these competencies were regarded as being contradictory attributes. The fifth factor in Mechanical Engineering was categorized into FBTH among 10 factors, which include usage of information and communication technology (ICT). Mechanical Engineering has high factor loading in both ICT usage and spatial presentation in SSC as well as ICT usage in GRC. Three factors in Civil Engineering were categorized into FBTH: seventh, applying knowledge; eighth, internationalization; and thirteenth, interpersonal skills.

Regarding the humanities, arts, and social science fields, three factors in History were categorized into FBTH: seventh, internationalization; ninth, ICT usage; and twelfth, social relationship, which relates to social responsibility in SSC and 10 GRC that are relatively related to interpersonal and collaborative work. Business has six FBTH among 15 factors. The second factor is named as business leadership, which relates to 10 SSC and two GRC with communication and self-criticalness. The sixth factor is the improvement and innovation of business, the tenth is the understanding of business background, the thirteenth is organizational understanding, the fourteenth is the understanding of baseline systems in business, and the fifteenth is collaborative work.

In summary, all six subjects have at least one FBTH, but the number and order of correlations based on the degree of contribution are varied. For instance, there are two FBTH ranked tenth and twelfth among 12 factors in Chemistry and only one ranked fifth among 10 factors in Mechanical Engineering. However, there are six FBTH ranked starting at second among 15 factors in Business. The competencies of FBTH are also varied by subjects. There are commonalities in FBTH: internationalization, interpersonal/collaborative skills, ICT usage, and social responsibility. When these competencies are included in the lists of both SSC and GRC, they tend to be identified as FBTH. However, FBTH in Business indicates different characteristics, which show the more complicated and intertwined relationship between SSC and GRC.

5. Conclusion and discussion

The paper aimed to clarify the relationships between SSC and GRC using the results of a questionnaire survey conducted in Japanese universities in 2015, which asked students, academic staff, and graduates about graduates' SSC in six university subjects and GRC. The empirical results show that recognition of the importance of SSC and GRC has positive relationships at different levels among stakeholders and subjects. The relationship between SSC and GRC in students shows relatively weak ties compared with that of the other stakeholders, as well as both Chemistry and Mechanical Engineering subjects.

Factor analysis indicates the existence of FBTH in all subjects with heterogeneous structures by subjects, and differences in the number, order, and contents of FBTH. FBTH in the five subjects, excluding Business, are at most three, lower order, and with common contents such as internationalization, ICT usage, and interpersonal/collaborative skills. There are different characteristics shown by FBTH in Business: up to six, higher order as the second, and more complicated and intertwined relationship between SSC and GRC. These results could explain the various recognition of the importance of SSC and GRC by subjects.

The finding showing the positive relationship between SSC and GRC indicates that GRC could be acquired with SSC using subject-specific education in the universities. However, with the heterogeneity of relationships by the subject, the level and contents of GRC in graduates varied by subject. If the whole university attempts to educate students in GRC, the university stakeholders need to pay attention to the varied outputs by discipline and address these outputs appropriately.

The limitation of the generalization of the result is because of a limited sample. The data targeted only selective universities so that a wider targeted sample is necessary to describe the situation in Japan. There are two future research themes: an investigation using participant attributes, such as age, sex, or career plan; and further understanding the background of the results that the current paper shows. For instance, the current paper visualizes the differences in students' recognition from that of teachers and graduates, but the reason for this difference is not clear. One interpretation for this difference is the more impact of longer years belonging to the higher education and assimilation, but it is necessary to analyze this interpretation using evidence.

10. References

[1] A. Gonczi, "Teaching and Learning of the Key Competencies", *Contributions to the Second DeSeCo Symposium*, 2003, pp. 119-131.

[2] M. Kaneko, "Alternative Models for Relating Evaluation and Improvement: Standardized Outcome Assessment vs. Process Monitoring", *University Evaluation Review*, 8, 2009, pp. 17-29.

[3] N. Ogata, "The Impact of the Competency on Higher Education", *Japanese Journal of Higher Education Research*, 4, 2001, pp. 71-91.

[4] K. Matsushita, "The Impact of the Concept of Competence on University Curricula and its Problems: A Study of the Tuning Project", *Kyoto University Researches in Higher Education*, 13, 2007, pp. 101-120.

[5] Ministry of Education, Culture, Sports, Science and Technology, Japan, "Daigaku ni okeru Kyoiku Naiyo no Kaikaku Jyokyo ni Tsuite (Changing of Education in Japanese University)", 2015, Retrieved from http://www.mext.go.jp/a_menu/koutou/daigaku/04052801/__icsFiles/afieldfile/2016/01/27/1353488_01.pdf.

[6] Kawaijuku, "Ima, Daigaku Kyoiku ni Motomerareru Generic Sukiru: Shakai ni Tsuyo suru Chikara wo Ikani Hyoka/Ikusei Suruka (Generic Skill Expected to be Acquired through the University; How We Evaluate/Cultivate Skill Required in the Society)", 2011, Retrieved from http://www.keinet.ne.jp/gl/11/11/report_1111.pdf.

[7] N. Ogata, "*Daigaku kara Shakai he: Jinzai Ikusei to Chi no Kangen (From University to Society: Education*

and Return Knowledge to the Society)", Tamagawa University Press, Tokyo, 2011.

[8] M. Sugihara, "Atarashii Noryoku to Kyoyo ('New ability' and Refinement)", In K. Matsushita (Ed.) *Atarashii Noryoku wa Kyoiku o Kaeru ka ("New Ability" Change the Education)*, Minerva Publishing, Kyoto, 2010, pp. 108-138.

[9] W. Camara, R. O'Connor, K. Mattern, and M.A. Hanson, "Beyond Academics: A Holistic Framework for Enhancing Education and Workplace Success", 2015. Retrieved from: http://www.act.org/content/dam/act/unsecured/documents/RR2015-4-beyond-academics-a-holistic-framework-for-enhancing-education-and-workplace-success.pdf.

[10] J. González and R Wagenaar, *Tuning Educational Structures in Europe: Universities' Contribution to the Bologna Process, An Introduction*, 2nd Edition, Publicaciones de la Universidad de Deusto, 2008. Retrieved from http://tuningacademy.org/wp-content/uploads/2014/02/TuningEUII_Final-Report_EN.pdf

[11] A. Jones, "Redisciplining Generic Attributes: The Disciplinary Context in Focus", *Studies in Higher Education*, 34(1), 2009, pp. 85-100.

[12] T. Yamada and T. Mori, "Role of Regular- and Extra-Curricular on Generic Skills of University Students from the Students' Viewpoints", *Japan Society for Educational Technology*, 34(1), 2010, pp. 13-21.

[13] Prog Hakusho Project, "Prog Hakusho *2015; Daigakusei 10 man nin no Generic Skiru wo Hatsu Koukai (*Prog White Paper 2015*; The First Release of Generic Skills of Hundred Thousand Students)*", Gakuji Shuppan, Tokyo, 2015.

[14] GLU12 Universities Tuning Working Group, *Globally-required Abilities; The results of 2014 Competence Survey*, 2015. Retrieved from: http://www.arinori.hit-u.ac.jp/pdf/CompetenceSurvey2014Report_Eng.pdf.

[15] M. Kaneko, "Daigaku Kyoiku to Shokugyo no Chishiki Kozo (Higher Education and Knowledge Structure in Career)", in N. Ogata, (Ed.). *Daigaku kara Shakai he: Jinzai Ikusei to Chi no Kangen (From University to Society: Education and Return knowledge to the Society*, Tamagawa University Press, Tokyo, 2011, pp. 242-263.

[16] K. Tremblay, "OECD Assessment of Higher Education Learning Outcomes (AHELO)". In S. Blömeke, O. Zlatkin-Troitschanskaia, C. Kuhn, & J. Fege (Eds.), *Modeling and Measuring Competencies in Higher Education: Tasks and Challenges*, Sense Publishers, Rotterdam, 2013, pp. 113-126.