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# Multidimensional Analysis of University Students' Subject Perceptions: Insights from Principal Components

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## ABSTRACT

*In this study, principal component analysis (PCA) was applied to survey data to examine the conscious and unconscious attributes university students associate with various academic subjects. The analysis produced 20 principal components, with five showing eigenvalues above 0.1 and the cumulative explained variance reaching 80% by the tenth component. The first component revealed a contrast between memorization-oriented and rule-based subjects, while the second distinguished humanities from sciences. Higher-order components reflected evaluative dimensions of academic engagement, mid-level components represented broader epistemological orientations, and lower-order components captured relational and interpersonal perceptions of subjects. Overall, the findings highlight the value of adopting holistic and interdisciplinary perspectives to improve educational guidance and practices across diverse academic fields.*

**Keywords:** Subject Perception, Holistic Learning, Interdisciplinary Education, Educational Frameworks, Principal Component Analysis (PCA)

# INTRODUCTION

Understanding learners' perceptions of academic subjects has long been a central concern in educational research, as such perceptions are closely linked to motivation, engagement, and academic achievement. Students do not simply learn isolated subjects; rather, they form implicit evaluations of each subject's difficulty, usefulness, and relevance within the broader curriculum. These evaluations shape how students engage with learning and how they position subjects in relation to one another.

In recent years, educational discourse has increasingly emphasized interdisciplinary learning frameworks, reflecting the growing complexity of knowledge required in contemporary society. Scholars argue that interdisciplinary expertise is essential for addressing real-world problems that transcend traditional disciplinary boundaries (Markauskaite et al., 2023). Within this context, frameworks such as STEM and STREAM have been promoted as effective approaches to fostering integrated learning across subject domains.

At the same time, advances in educational technology—particularly the emergence of generative AI tools such as ChatGPT—have accelerated the move toward more personalized and adaptive forms of learning (Naznin et al., 2025) [1]. These developments further highlight the need to reconsider how subjects are conceptualized and connected within educational systems. However, despite growing attention to interdisciplinary education and personalization, existing research has largely focused on institutional or pedagogical frameworks rather than on how students themselves perceive relationships among subjects.

Previous studies suggest that students' perceptions of subject matter expertise also play a crucial role in learning outcomes. When students perceive instructors as having strong subject-matter knowledge, their academic performance tends to improve (Adediwura & Tayo, 2018). This finding underscores the importance of understanding how students conceptualize individual subjects within a broader academic structure, as such perceptions may influence both instructional effectiveness and learner motivation.

Nevertheless, empirical research has rarely examined students' perceptions of multiple subjects simultaneously from a holistic perspective. As a result, there is limited understanding of how students implicitly organize academic subjects in relation to one another. To address this gap, the present study employs principal component analysis (PCA) to explore students' perceptions across a range of school subjects. By identifying latent structures underlying these perceptions, this

[1] Beyond its application in self-directed learning, emerging research has explored ChatGPT's potential not only as a tool for academically oriented interactive learning but also as a source of mentor-like psychological support for learners (e.g., Sakai, 2025b). Accordingly, a holistic perspective on learning is likely to expand and evolve as it incorporates an increasingly diverse set of factors.

study aims to clarify how students conceptualize the relationships among disciplines within an integrated educational framework.

## LITERATURE REVIEW

Understanding students' perceptions of their educational experiences is fundamental to developing effective teaching methodologies and promoting academic achievement. A growing body of research explores these perceptions across various educational contexts, revealing the intricate relationships between curricular design, pedagogical approaches, and individual subject preferences. This section synthesizes findings from studies on several subjects, emphasizing their interconnected influence on motivation, learning outcomes, and career aspirations.

Beginning with humanities and social science courses, English, as a global lingua franca, holds a central role in contemporary education systems. Japanese high school students often struggle with low self-assessment of their speaking abilities, attributing their challenges to insufficient practice and a cultural emphasis on perfectionism (Wilkins & Peet, 2024). Similarly, while learning in one's native language is often assumed to enhance confidence, this relationship does not always hold in practice (Sakai, 2025a). In contrast, students in contexts such as Pakistan view English as a critical tool for global competitiveness and access to scientific knowledge (Ali et al., 2014). Research on English literature education in Malaysia further indicates that while students may be intrinsically and instrumentally motivated, cultural and linguistic barriers can hinder comprehension and participation (Awang & Kasuma, 2010).

Studies in social studies and science education similarly emphasize perception-related challenges. In Western Australia, students recognize the value of social studies for understanding global issues, though its relevance to future careers is often unclear (Darby, 1991). In physics education, students who enroll in the subject tend to perceive it as less difficult and more engaging than expected, whereas non-enrolled students often view physics as excessively challenging and irrelevant (Checkley, 2010). Biology education research from Nigeria identifies teacher-centered instruction and limited resources as key factors contributing to students' learning difficulties and reduced engagement (Etobro & Fabinu, 2017).

Mathematics education research further underscores the influence of student perceptions. Mutodi and Ngirande (2014) report that while language background alone does not strongly predict mathematics performance, proficiency in English plays an important role in conceptual understanding. They also highlight the negative impact of widespread beliefs that mathematical ability is innate, emphasizing the importance of fostering positive attitudes and effort-oriented mindsets.

Regarding practical subjects, physical education (PE) remains central to fostering lifelong health and wellness. A comparative analysis of traditional and online PE courses reveals that while students value the flexibility of online platforms, traditional settings provide unparalleled opportunities for direct interaction and engagement (Williams et al., 2020).

Beyond individual subjects, research within STEM frameworks has examined students' attitudes toward grouped disciplines. Studies in Malaysia indicate generally positive perceptions of STEM assessments, while also revealing disparities related to school type and resource availability (Chew et al., 2014). Australian research documents gender differences in science subject choices, often rooted in self-perception rather than actual differences in enjoyment or ability (Quinn & Lyons, 2011). Longitudinal studies in England further show that students' subject preferences reflect a balance between perceived utility and enjoyment, with increasing emphasis on career-oriented subjects and declining valuation of arts and humanities (Stables & Wikeley, 1997). Furthermore, informal STEM learning experiences have a positive effect on students' interest in and attitudes toward STEM (Xia et al., 2025).

Additional research highlights the importance of perceived competence across domains. Zghidi and Loumi (2016) demonstrate that higher perceived competence is positively associated with motivation, goal orientation, and academic performance, whereas low perceived competence increases the risk of disengagement. Similarly, Tsai, Ting, and Chu (2025) identify multiple attitudinal dimensions underlying students' orientations toward STEM learning and report moderate associations between positive STEM attitudes and motivation for STEM-related careers.

While these studies offer valuable insights into subject-specific perceptions, they share a common limitation: most examine academic subjects independently or within predefined disciplinary groupings. Consequently, they provide limited insight into how students perceive the relationships among multiple subjects simultaneously.

One exception is Sakai (2025c), who investigated Japanese university students' retrospective preferences for high school subjects using a multivariate approach. The findings revealed that English as a Second Language was not perceived as belonging to the humanities, contrary to common assumptions in Japan, but instead emerged as an independent domain, occasionally grouped with physical education. This result demonstrates how holistic analyses can challenge entrenched curricular classifications and reveal students' implicit conceptual structures.

Taken together, previous research underscores the importance of students' perceptions in shaping learning outcomes while also revealing a critical gap in understanding cross-subject relationships. To address this limitation, the present study applies principal component analysis to examine students' perceptions of multiple academic subjects concurrently. By identifying latent dimensions that transcend individual disciplines, this research seeks to contribute to a more nuanced understanding of how students conceptualize the academic curriculum as an integrated whole.

## RESEARCH METHOD

In this study, an analysis was conducted based on survey data collected from 793 university students in Japan regarding their preferences for various academic subjects. As for data collection, between 2021 and 2024, the researcher conducted informal surveys during the initial English classes at five private universities in Japan, whose academic levels are average to slightly above average based on standard score metrics. These surveys aimed to assess students' abilities and backgrounds as well as to familiarize them with Google Forms. In addition, the survey aimed to alleviate students' anxiety about university-level English education by addressing their preconceptions and demonstrating the researcher's willingness to understand their opinions, as well as to identify their strengths and areas for improvement.

The collected data were immediately and fully anonymized, then securely stored for purposes of educational self-development. The survey solicited students' preferences regarding 20 major subjects from elementary through high school, excluding certain subjects less frequently featured in written entrance examinations: Japanese language (as a national and native language), Japanese-classics, Chinese classics, Arithmetic, Mathematics, Social-studies, Geography, Japanese history, World history, Contemporary society, Science, Physics, Chemistry, Biology, Earth science, English (as ESL), P.E. Art, Home economics, and Technical arts. [2] This survey also inquired about their English-related qualifications. However, as this falls outside the scope of the present study, no further discussion will be provided on this matter.

The responses were primarily obtained by asking participants to select and click on the option that best represented their preference for each subject (e.g., "I like it"). Due to the simplicity of this format, it is assumed that the responses reflect participants' natural preferences. The survey responses, measured on a 5-point Likert scale ranging from "strongly like" to "strongly dislike," were analyzed through principal component analysis (PCA).

To assess the suitability of the data for the analysis, the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity were conducted. The KMO measure of

[2] Regarding music, its dual nature as both an academic subject and a general interest—encompassing personal preferences and varying levels of proficiency—creates a complex interplay that could lead to uncertainty among respondents. For this reason, music was not included in this study.

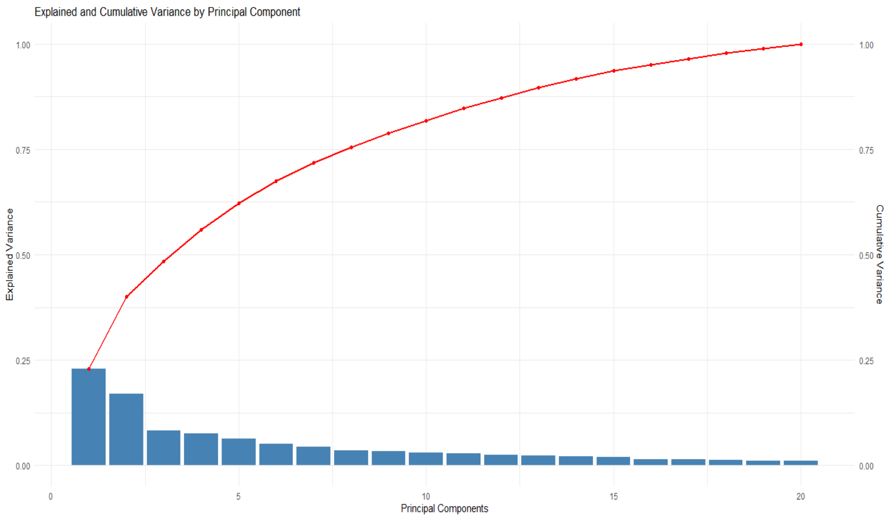
sampling adequacy was 0.79. Bartlett's test of sphericity yielded $\chi^2(19) = 125.51$, $p < 2.2\times10^{-16}$, suggesting that the correlation matrix was not an identity matrix. These results confirmed that PCA was appropriate for this dataset.

As illustrated below, the explained variance of each principal component were calculated to elucidate the structure of students' preferences. To provide a more holistic understanding of the findings, an interpretive analysis was undertaken for all principal components, with the aim of uncovering latent dimensions and the broader implications of students' subject preferences.

## RESULTS

PCA identified a total of 20 principal components. Figure 1 presents a plot of the explained variance and cumulative explained variance for these components.

**Figure 1.**
*Explained and cumulative explained variance (right axis)*



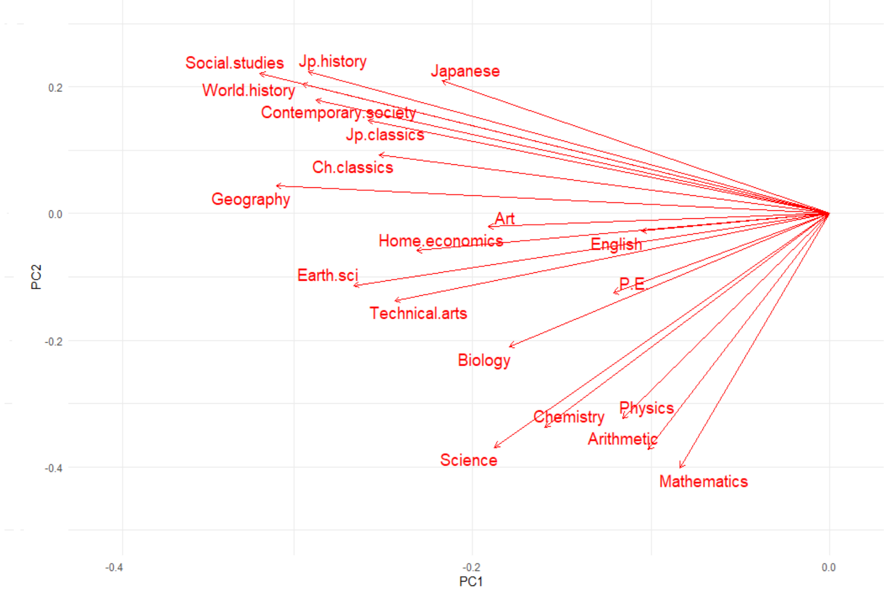

Notably, the first two components exhibit an explained variance greater than 0.10, indicating their status as primary components. Furthermore, the cumulative explained variance exceeds 80% by the tenth component, which, under conventional criteria, would suggest that the first ten components represent the most significant contributions. However, to ensure a more comprehensive analysis, this study extends its interpretation to all 20 principal components.

The interpretation of each principal component (PC) is derived based on the output of their respective PC vectors. By analyzing the loadings and contributions of individual variables to each PC, insights into the unique characteristics and underlying patterns captured by each component are provided.

Figure 2 presents the output related to PC1 and PC2. Examining PC1, we observe that subjects such as mathematics, physics, and arithmetic align with the positive direction of the x-axis, whereas subjects like geography and history align with the negative direction.

**Figure 2**

*Loadings Plot of Principal Components 1 and 2 for Subject Preferences*



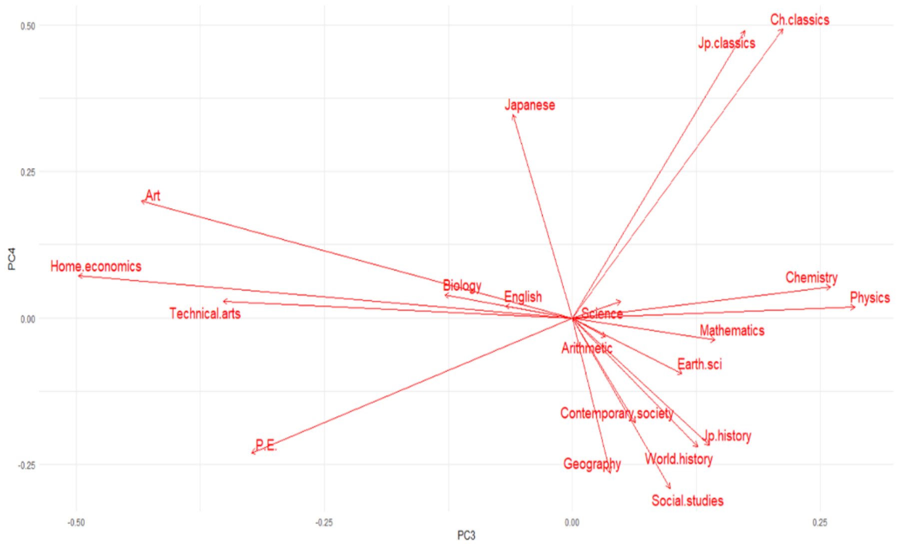

This distribution suggests that PC1's positive axis encapsulates disciplines centered on the acquisition and application of structured rules, while its negative axis represents subjects rooted in memorization.

Turning to PC2, the grouping is more straightforward: humanities subjects are situated at the upper end, science subjects at the lower end, and practical disciplines occupy an intermediate position. This arrangement underscores a logical and coherent interpretation of PC2.

Figure 3 presents the output for PC3 and PC4, revealing distinct patterns in the distribution of subjects. In the case of PC3, the negative axis is characterized by subjects such as home economics, technology, and art, while the positive axis features physics, chemistry, and classical literature. This arrangement suggests that PC3 represents a progression from subjects rooted in practical, everyday skills to those embodying more academically oriented and theoretical disciplines.

**Figure 3**

*Loadings Plot of Principal Components 3 and 4 for Subject Preferences*




For PC4, the positive axis is dominated by subjects like Japanese language, classical literature, and Chinese classics, whereas the negative axis includes social studies and physical education. This distribution implies that the positive axis is associated with subjects emphasizing creative and imaginative pursuits, such as storytelling, while the negative axis corresponds to disciplines focused on the description and analysis of real-world phenomena and tangible experiences.

The remaining plots involve similar lines of analysis. Owing to space constraints, they are provided in the Appendix, and readers may consult them as necessary.

PC5 and PC6 elucidates distinct patterns in subject alignment. For PC5, a dichotomy emerges between mathematics and arithmetic on one hand, and English, biology, and earth science on the other. Mathematics and arithmetic are inherently introspective, relying on abstract reasoning, whereas English and the natural sciences are outwardly oriented, engaging with the external world. The central positioning of Japanese language suggests a mediating role, balancing the continuum of linguistic focus. The marked alignment of English on the negative axis, particularly as a foreign language, reinforces the logical coherence of this interpretation.

In the case of PC6, the negative axis is dominated by subjects such as biology, earth science, art, and history—fields that frequently utilize visual materials as foundational tools for learning. In contrast, the positive axis highlights disciplines like English and physical education, which emphasize active, experiential engagement. This distribution suggests that PC6 represents a spectrum ranging from visual comprehension and representation to hands-on, practical activity, encapsulating a duality between visual understanding and action-oriented learning.

For PC7, the negative axis includes subjects such as biology, arithmetic, and Japanese language, whereas the positive axis features physics, English, art, and technology. Although the interpretation requires careful consideration, a comparative analysis of the pedagogical demands of these subjects reveals a significant distinction: biology and arithmetic prioritize iterative "operations" and "procedures" governed by established rules, while physics, art, and technology emphasize "design," characterized by the integration of abstract concepts and creative frameworks. English, in this context, aligns with art and technology, as it involves the intentional crafting and "designing" of output, grounded in foundational principles such as grammar, thus justifying its position on the positive axis.

For PC8, the spectrum appears to represent a progression from foundational knowledge to its application. Subjects on the positive axis, including language studies, arithmetic, and mathematics, are primarily foundational, focusing on the acquisition of core skills and principles. By contrast, subjects such as history, chemistry, and Chinese classics (classical Chinese literature) on the negative axis reflect the application of foundational knowledge to interpret and understand broader contexts and complexities of the world. Physical education, through its emphasis on purposeful and dynamic physical activity, serves as a practical and embodied application of fundamental motor skills, further exemplifying the axis's distinction between foundational learning and applied practice.

For PC9, the negative axis is dominated by subjects such as history, while the positive axis includes geography and earth science. This alignment suggests that PC9 reflects a spectrum leaning toward the humanities, differentiating disciplines rooted in historical and cultural analysis from those that focus on understanding the physical and natural world.

In other words, PC9 appears to emphasize a broader orientation toward societal and global engagement. For example, technology is situated within the realm of societal advancement, while art is emblematic of cultural expression and creativity. The natural sciences occupy an intermediary position, reflecting their dual applicability: they contribute to both individual understanding and collective societal development. Their central placement within PC9 supports a balanced interpretation, illustrating their relevance to both humanistic and societal domains. This positioning highlights the fluid continuum between the humanities and social sciences, eschewing a rigid dichotomy in favor of a more integrated perspective.

In the context of PC10, subjects such as chemistry, technology, and contemporary society align with the positive axis, while earth science, art, physical education, and world history are positioned on the negative axis. This pattern can be interpreted as reflecting a dichotomy between disciplines that engage with human-constructed, artificial phenomena and those that focus on natural or non-artificial elements.

The positive axis encompasses fields like chemistry and technology, which involve the study and manipulation of artificial or engineered systems, as well as contemporary society, which addresses human-made systems and rules. Conversely, the negative axis is defined by disciplines such as earth science and history, which emphasize the observation and understanding of phenomena as they exist independently of human alteration. Similarly, art and physical education, while inherently human activities, emphasize unbounded creativity and embodied expression, resonating with the idea of freedom from external constraints.

The placement of earth science on the negative axis might also reflect an implicit acknowledgment of the natural world's overwhelming presence as the ultimate non-artificial entity. This distinction between the artificial and the natural provides a coherent and intellectually compelling framework for interpreting PC10's underlying structure.

PC11 and the subsequent components represent increasingly subtle dimensions. Although the cumulative Explained variance exceeds 80% by PC10, implying a diminishing impact of subsequent components, examining PC11 and the subsequent components would provide valuable depth for comprehensive analysis.

For PC11, the negative axis features subjects such as contemporary society and Japanese language, while the positive axis includes geography, art, and English. This axis may be interpreted as a continuum from a localized, introspective focus on one's immediate environment to a more expansive, outward-looking and global orientation. Art, for instance, often embodies high culture and externalized creativity, aligning with the notion of an outward-facing discipline. Similarly, while physics explores vast and abstract phenomena such as the universe or subatomic particles, it is often perceived, particularly by non-specialists, as engaging with familiar, everyday experiences—such as the mechanics of a thrown ball or a falling object—anchoring it closer to one's immediate surroundings.

PC12 offers an axis that may reflect the breadth of subject matter within each discipline. The positive axis includes Japanese language, alongside disciplines such as chemistry and social sciences, while the negative axis features contemporary society, classical literature, Chinese classics, and mathematics. Japanese language, encompassing all aspects of native language use, represents a broad and inclusive field of study. In contrast, contemporary society, as its name suggests, is temporally and geographically constrained, often focusing on specific societal systems within modern Japan, and thus may be perceived as narrower in scope.

Similarly, Japanese classical literature and Chinese classics, while rooted in historical languages, may appear limited in breadth due to their focus on specific temporal contexts. However, their linguistic nature allows for interpretive originality, offering a degree of conceptual expansiveness. Art, despite being intrinsically expansive as a medium of creative expression, may be viewed more narrowly in an academic sense, where it is often reduced to the study of famous works and techniques by those outside the field. This interplay between perceived and academic breadth highlights the complex and subjective nature of how disciplines are categorized and understood within this framework.

For PC13, the negative axis includes subjects such as art, geography, physical education, and Japanese language, while the positive axis features home economics, technology, history, and English. This axis appears to reflect the ease or difficulty students encounter in conceptualizing effective study methods. Subjects on the positive axis, such as home economics and technology, are closely tied to practical, everyday activities, making their study methods relatively straightforward. Similarly, history and English offer a clear path to improvement through memorization and practice.

Conversely, art is often perceived as a field where innate talent plays a dominant role, making structured study less apparent. Geography can seem diffuse and lacking focus, while physical education and modern Japanese may evoke challenges rooted in physical limitations or the familiarity of one's native language, which complicates its formal study.

For PC14, technology is prominent on the positive axis, while home economics is positioned negatively. This axis likely reflects the degree to which subjects are perceived as intellectually prestigious or socially advantageous. Mastery of technology, such as advanced computing skills, is often regarded as a valuable asset in professional and social settings, conferring tangible benefits. Similarly, knowledge of biology, particularly regarding flora and fauna, may be viewed as indicative of intellectual breadth and cultural sophistication. In contrast, disciplines like home economics or highly specialized scientific fields might be perceived as overly niche or esoteric. For instance, a deep dive into nutritional science, while intellectually rigorous, might be seen as excessively specific or meticulous in broader social contexts. While expertise in these fields is undoubtedly commendable, they may not align with conventional notions of general intellectual prestige or societal literacy.

PC15 and PC16, offers insights into the curricular distinctions and classification of subjects within the context of Japanese high school education.[3] In PC15, subjects such as physics, biology, geography, world history, and home economics align with the positive axis, while chemistry, earth science,

[3] With regard to this issue, no publicly available official data exist; therefore, information provided by cram schools and preparatory institutions serves as the primary source. However, since subject selection is largely determined by university entrance examination requirements, a sociolinguistic examination of discussions on social media platforms such as X—where users reflect on their entrance examination experiences and high school studies—suggests that these accounts do not deviate substantially from the general pattern.

contemporary society, Japanese history, and art occupy the negative axis. This axis appears to reflect the specificity of subjects typically chosen after students have selected their academic track—science, humanities, or practical studies (e.g., home economics). Physics, for instance, is predominantly chosen by students in the science track, while world history is often selected as the social studies subject by science-oriented students. Biology, similarly, is commonly pursued by humanities students requiring a science credit, in addition to science-track students. In contrast, subjects like chemistry, earth science, Japanese history, and contemporary society are core subjects studied by students in both tracks, making them less distinctive as indicators of academic specialization.

PC16, by contrast, reflects the degree to which a subject serves as an indicator of whether a student belongs to the humanities or science track. Subjects such as physics, broader science disciplines, and contemporary society are strongly associated with science-track students, making them reliable markers of a science orientation. Conversely, their absence in a student's curriculum is often indicative of a humanities focus. Subjects such as chemistry and world history, however, are less definitive, as they are widely studied across both academic streams and do not distinctly signal a student's orientation.

The distinction between PC15 and PC16 lies in their conceptual focus: PC15 identifies subjects characteristic of a particular academic track once a selection has been made, whereas PC16 measures how strongly a subject reflects a student's academic affiliation from an external perspective. For example, while world history is frequently chosen by science-track students as a social studies subject, the mere presence of world history in a student's curriculum does not unequivocally indicate their academic stream. By contrast, Japanese history, which is more commonly selected by humanities students, serves as a stronger indicator of a humanities orientation.

For PC17, the distinction between subjects such as Japanese history and biology versus natural sciences and world history suggests an axis that categorizes subjects based on the extent to which they are rooted in formal education versus informal or general knowledge sources. Japanese history and biology, for example, are disciplines where knowledge can often be acquired outside the classroom through popular media, such as television programs or independent exploration.

By contrast, natural sciences and world history are more closely tied to formal instruction. While the natural sciences, when fragmented into specific topics, may relate to everyday experiences, their broader theoretical frameworks remain firmly within the realm of formal education. Similarly, world history typically requires deliberate academic engagement, as it is not commonly encountered in daily life without intent. Subjects closer to the center, such as those balancing general knowledge with formal instruction, likely reflect a hybrid nature.

PC18 appears to capture the extent to which subjects are chosen as elective "examination subjects" within the humanities or sciences tracks. The positive axis includes subjects such as classical literature, Japanese history, geography, and a broad category of science, which are frequently selected by humanities-track students for university entrance exams. On the negative axis, subjects like classical Chinese and contemporary society often serve as humanities-oriented electives recommended to science-track students.[4] Subjects positioned near the center, typically compulsory rather than elective, exhibit a lower degree of selectivity, reflecting their universal inclusion in the curriculum and limited role in differentiating academic tracks.

This analysis underscores the dual dimensions of knowledge acquisition—formal versus informal—and the degree of academic selectivity, providing a nuanced understanding of the perceptions and roles of various disciplines within the broader educational landscape.

PC19 and PC20 provides nuanced insights into the perceived characteristics of academic subjects in terms of student performance and the challenges of mastery. In PC19, subjects such as mathematics, classical literature, and social studies align with the negative axis, while the positive axis includes Japanese classical literature, arithmetic, and Japanese history. This axis can be interpreted as reflecting the extent to which excelling in a subject creates differentiation among students, particularly in the context of test preparation. Subjects on the negative axis are likely perceived as areas where strong performance establishes a clear advantage over peers, marking a significant divide between those who master the material and those who do not. Conversely, subjects on the positive axis may be regarded as more universally accessible, where achieving proficiency is less likely to result in pronounced differentiation among students.

PC20, by contrast, reflects the perceived difficulty of overcoming challenges in specific subjects. Progressing from the positive to the negative axis, subjects are increasingly associated with the impression that difficulties in understanding or mastering them are particularly intractable. Mathematics, for instance, is frequently cited as a subject that humanities-oriented students find nearly insurmountable despite concerted effort.[5] This axis underscores the psychological and practical barriers inherent in certain disciplines, illustrating how students' perceptions of accessibility and achievability vary across academic subjects.

The following Table 1 summarizes the discussions above, presenting the explained variance, cumulative explained variance, and their interpretations.h.

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[4] Because this issue relates to strategies for Japanese university entrance examinations, similar to the above discussions on PCs 15 and 16, it has been discussed more often in reports and publications issued by preparatory schools than in peer-reviewed academic research. This point likewise informs the interpretation of PC19 presented in the following section. Nevertheless, a small number of scholarly studies have addressed this topic. For instance, Aoki et al. (2010) analyzed applicants to medical and law faculties and obtained findings consistent with the tendencies described here.

[5] Beyond the scope of this study, but Dieter and Törner (2012, as cited in Geisler, et al., 2023) reports that in Germany approximately 80% of mathematics majors drop out or switch their major, with the majority of cases occurring in the first year. The study highlights low mathematical self-concept as a significant factor associated with early dropout, which aligns with the implications of the present research.

**Table 1**
*Summary of principal component analysis results*

| N | Explained variance | Cumulative Explained variance | Interpretation |
|---|---|---|---|
| 1 | 0.2294 | 0.2294 | Memorization-focused vs. Theory-oriented |
| 2 | 0.1708 | 0.4002 | Social Sciences and Humanities-focused courses vs. Natural Science-focused courses |
| 3 | 0.0835 | 0.4837 | Everyday contexts vs. Academic settings |
| 4 | 0.0757 | 0.5594 | Creative expression vs. Realistic depiction |
| 5 | 0.0634 | 0.6227 | Internal worldview vs. External worldview |
| 6 | 0.0518 | 0.6745 | Practical application vs. Visual understanding |
| 7 | 0.0438 | 0.7183 | Operational tasks vs. Conceptual design |
| 8 | 0.0361 | 0.7543 | Emphasis on fundamentals vs. Applied knowledge |
| 9 | 0.0337 | 0.7881 | Humanities-based vs. Social sciences-based |
| 10 | 0.0306 | 0.8187 | Artificial constructs vs. Non-artificial topics |
| 11 | 0.0281 | 0.8468 | Immediate surroundings vs. Global perspectives |
| 12 | 0.0258 | 0.8726 | Broad academic scope vs. Narrow specialization |
| 13 | 0.0235 | 0.8960 | Challenging to conceptualize vs. Easy to grasp |
| 14 | 0.0213 | 0.9174 | High value as general education vs. Low value |
| 15 | 0.0189 | 0.9363 | Low career orientation vs. High career relevance |
| 16 | 0.0145 | 0.9508 | Strength as an indicator to distinguish between humanities and sciences tracks |
| 17 | 0.0141 | 0.9649 | Knowledge acquired from non-academic settings vs. knowledge rooted in academic contexts |
| 18 | 0.0132 | 0.9781 | Subjects considered by science-track and humanities-track students as examination subjects |
| 19 | 0.0113 | 0.9894 | High potential for score variation vs. Low potential |
| 20 | 0.0106 | 1.0000 | Achievable through effort vs. Difficult to overcome |

## DISCUSSION & REMARKS

In Section 4, we provided interpretations of the PCs derived from the PCA analysis. Building upon the summary presented in Table 1, we now engage in a deeper discussion. First, the top two PCs, each with an explained variance exceeding 10%, represent broad frameworks: whether a subject is memory-based or understanding-based, and whether it aligns with the humanities or sciences. These distinctions point to fundamental categorizations. Interestingly, while subjects in Japan are often discussed in terms of humanities or sciences—largely determined by academic tracks—this analysis reveals that learning methods play a more substantial role in shaping perceptions, suggesting that learners themselves place greater emphasis on approaches to study rather than traditional categorizations.

The PCs accounting for up to 80% cumulative explained variance predominantly relate to the inherent properties of academic disciplines, such as their practical relevance to daily life and their internal versus external orientation. This indicates a progression in students' perspectives from concrete to abstract dimensions when considering the relationship between the self and the external world. These findings imply that students' perceptions of academic subjects transcend simplistic external labels like "humanities" and "sciences," evolving into more nuanced, self-referential frameworks, often operating unconsciously.

Beyond this point, the PCs shift focus to the broader academic system, reflecting dimensions such as the degree of artificiality of a subject, its breadth, and its perceived value in general education. However, it is essential to note that these perceptions are influenced by learners' existing knowledge and may not directly correspond to the actual scope or depth of the subjects themselves.

In the latter PCs, themes emerge related to the inferred characteristics of students who excel in particular subjects and the perceived advantages of mastering them. These components reflect an awareness of the relationship between the self and others within the context of academic subjects. Anecdotally, in Japan, competitive exams are a major focus, and discussions often center on which subjects confer strategic advantages. However, in this analysis, such concerns appear to play a minor role, perhaps due to their indirect relevance within the broader context of this study.

Finally, the smallest PCs pertain to perceptions of whether a subject is easy or difficult to master. These components, derived largely from individual experiences, carry relatively little weight in the analysis. It is also plausible that students avoid consciously reflecting on subjects they find particularly challenging, contributing to the low prominence of these PCs.

Reflecting on the findings, the PCs—from general beliefs to aspects more closely related to the self, and subsequently to less personally relevant factors—appears intuitively reasonable and supports a sound interpretation of the data. These results suggest that the elements often emphasized by educators, such as the perceived difficulty of subjects or strategies for exam preparation, are relatively secondary in importance. Instead, placing greater emphasis on concrete study methods and comparisons with everyday life may better align with the information learners seek. Nevertheless, while lower-ranked PCs may be less consciously recognized, they are by no means insignificant. Strategically providing such information at key moments could, conversely, play a critical role in fostering broader societal success. These insights also underscore the potential for more effective instructional strategies by analyzing the relative positioning of each subject within this framework.

A limitation of this study is that it focuses on Japanese university students who, by the time of the survey, had typically completed their entrance exams and determined their academic tracks. It is plausible that surveys targeting students actively preparing for major exams or those still deciding between humanities and sciences could yield differing results, with some shifts in emphasis. Addressing this limitation presents an important avenue for future research.

Moreover, the dataset lacks information on individual characteristics such as gender and age, which suggests that the inclusion of such variables in future analyses could enable more refined and precise interpretations. It should also be acknowledged that the participants of this study are exclusively Japanese students, and as such, the findings are inevitably shaped by the unique curricular structures and educational frameworks specific to Japan.

That said, the study's strength lies in its engagement with students who have already acquired some level of academic experience. As such, their perceptions of the characteristics of various subjects and their relative significance are likely to be both insightful and well-founded. In the context of the increasing prominence of interdisciplinary education, the ability to examine perceptions of individual subjects through a multi-disciplinary lens is especially valuable. This approach not only aligns with contemporary educational trends but also provides meaningful guidance for integrating subject-specific perspectives into broader educational paradigms.

Note: The author utilized generative AI solely for the purpose of identifying minor grammatical errors and typographical mistakes.

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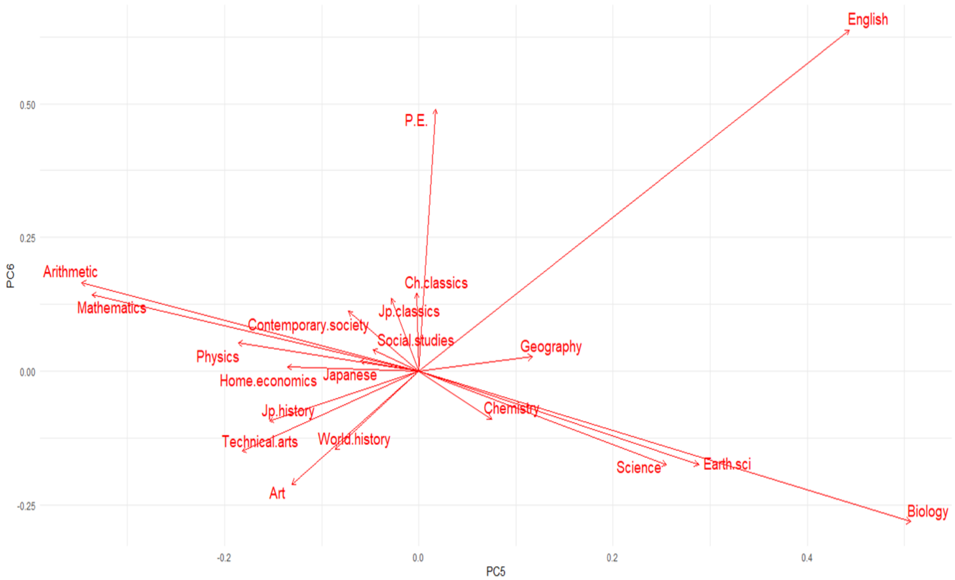
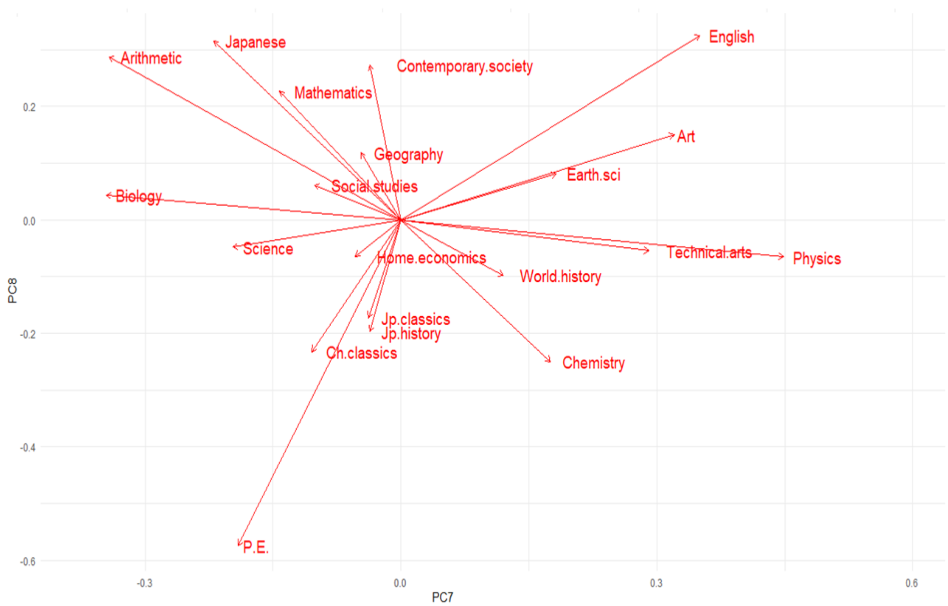
**APPENDIX A. Loading Plots of Principal Components 5 to 20**

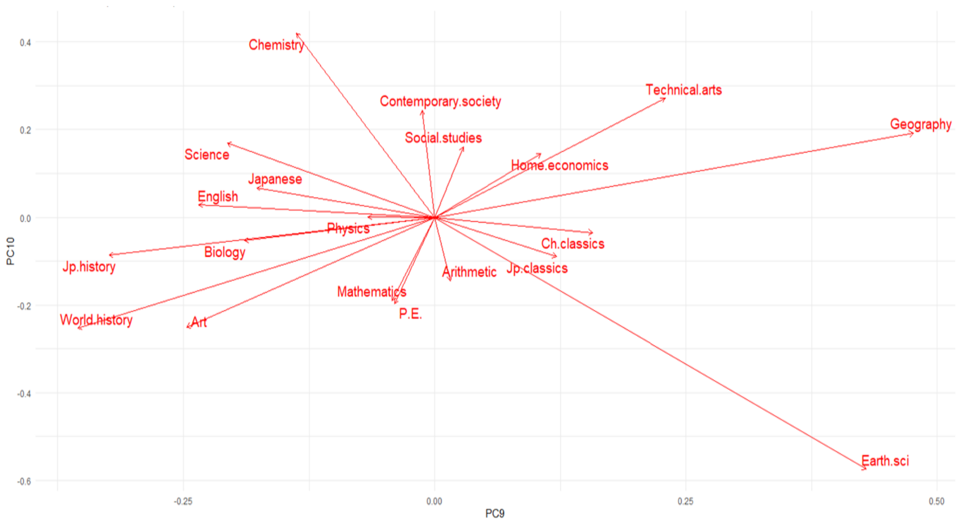
*Loadings Plot of Principal Components 5 and 6 for Subject Preferences*



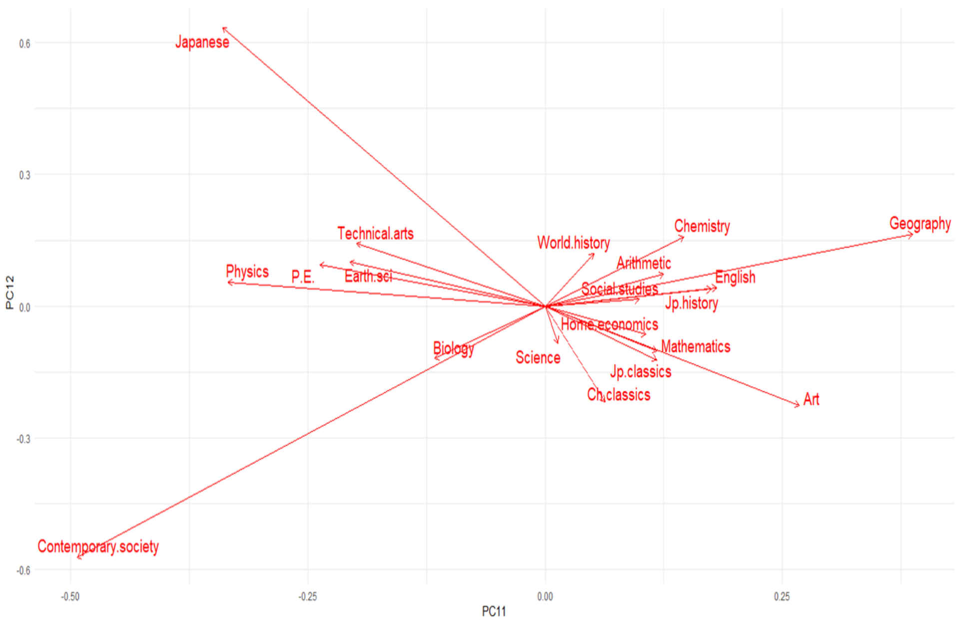

*Loadings Plot of Principal Components 7 and 8 for Subject Preferences*



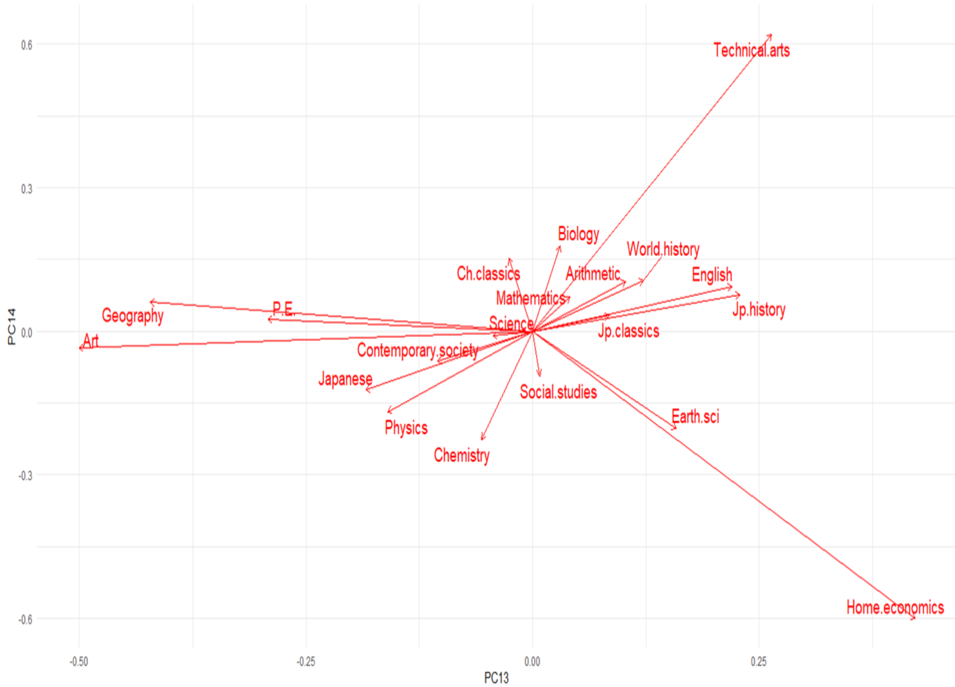

*Loadings Plot of Principal Components 9 and 10 for Subject Preferences*



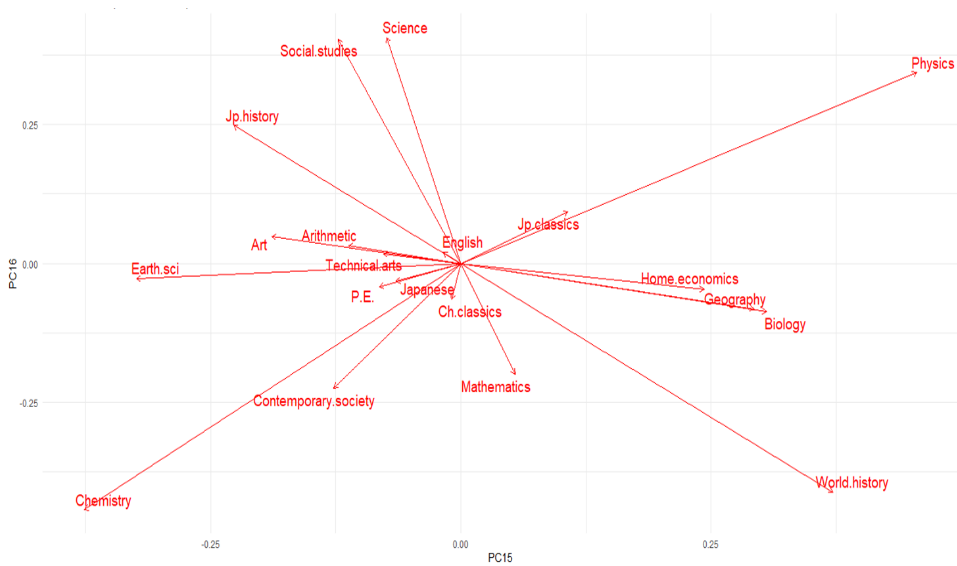

*Loadings Plot of Principal Components 11 and 12 for Subject Preferences*



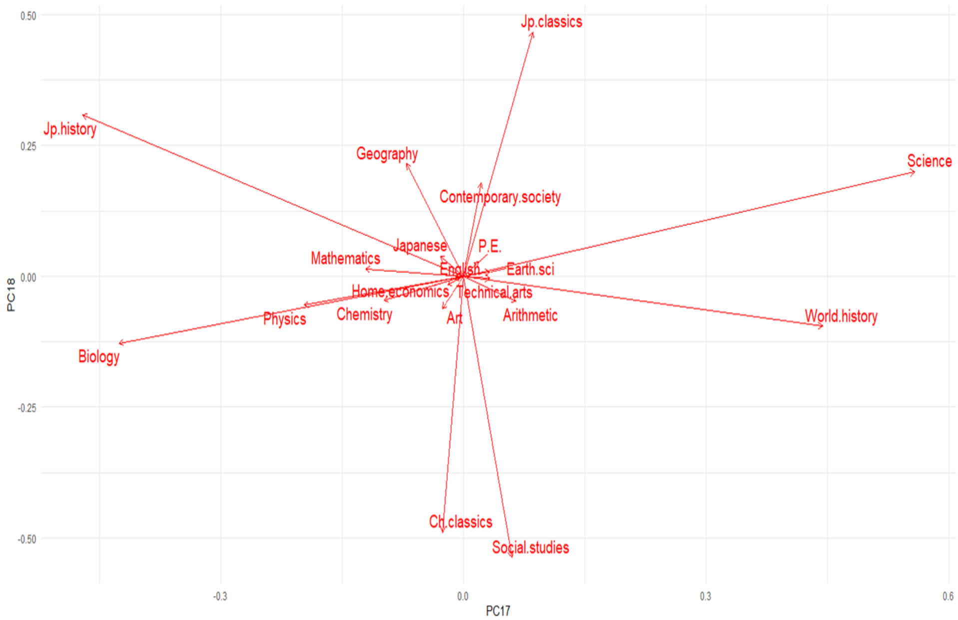

*Loadings Plot of Principal Components 13 and 14 for Subject Preferences*




*Loadings Plot of Principal Components 15 and 16 for Subject Preferences*




*Loadings Plot of Principal Components 17 and 18 for Subject Preferences*




*Loadings Plot of Principal Components 19 and 20 for Subject Preferences*