Fostering Global Engineers through the Study of the Humanities: Assessment of the Course "Science and Religion in Japan" from a Racial Equity Perspective

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Hiroyuki Ishizaki is a Visiting Professor at Shibaura Institute of Technology (SIT), a leading Japanese engineering school. His research interests include multidisciplinary teaching and learning, cross-cultural competence, collaborative online international (COIL), technopreneurship, and project/problem-based learning methods. As a Director of the Malaysia Office, he has been expatriated in Malaysia since 2014 and leading the internationalization of SIT and its partner universities throughout the Southeast Asian region. Under his initiatives, various short-term mobility programs and student exchanges have been started. He is also Chair of the Mobility Special Interest Group of Asia Technological University Network (ATU-Net) and initiated a COIL program called Virtual Asia Exploration (VAx) by orchestrating the collaboration of six Asian universities. He is also an entrepreneur through his consulting company established in 2004, and has been rendering management consultation services to both small-medium size companies and multi-national enterprises such as global strategy planning, cross-border business entry, middle manager training, and partner development. These business achievements are reflected in his academic activities through the designing of lectures and mobility programs with practical implementation perspectives. Ishizaki has been actively presenting and publishing his academic achievements at international conferences in the Asia Pacific region and North America such as APAIE, WERA, and NAFSA.

He earned a Master of Business Administration majoring in international business at the University of Southern California in the United States of America, and a Bachelor in Law at Hitotsubashi University in Japan.

Fostering Global Engineers through the Study of the Humanities: Assessment of 'Science and Religion in Japan' from a Racial Equity Perspective

Abstract

This was an exploratory study to examine the effectiveness of the Spring and Fall courses in the Academic Year (AY) 2022 of 'Science and Religion in Japan' from an engineering education perspective. Technological innovations are occurring through the fusion of science and engineering fields into new cutting-edge disciplines. Such a world requires engineers with broad knowledge, a global perspective, an appreciation of racial equity, and the capability of working in interdisciplinary teams. Therefore, it is worth discussing the effectiveness of including humanities components in engineering courses.

'Science and Religion in Japan' comprises students mainly from Europe, Asia, and South America. Thus, class discussion is conducted through a racial equity lens, as students participate in the conversation from diverse standpoints. This paper demonstrates insights about 1) how this 'Science and Religion in Japan' course promotes global competence and cross-cultural understanding, 2) the effectiveness of interdisciplinary approaches in higher education, as exemplified by the inclusion of humanities components in engineering courses, 3) the value of diverse perspectives in the study of history, and 4) the methodology used to assess this humanities course and the program evaluation results.

Keywords: Effectiveness of Interdisciplinary Approaches in Higher Education, Humanities in Engineering Education, Value of Diverse Perspectives in the Study of History, Assessing Humanities Courses in the Research-Based Learning Program, MGUDS-S

Introduction: Liberal Arts in the curriculum of the research-based program

Many researchers have been trying to bridge the gap between the engineering field and the humanities [1], [2], [3], [4]. The course 'Science and Religion in Japan' is included as one of the humanities topics in the Innovative Global Program, a newly launched research-based English degree program for the College of Engineering at Shibaura Institute of Technology (SIT) [5]. With a maximum of nine students per year, this undergraduate global program incorporates "Research-Based Learning (RBL)" throughout the entirety of a four-year course. This is in contrast to the conventional model, which is well known for including RBL solely in the final year of the graduation thesis project (see figure 1 below). The program begins to introduce students to laboratory research from their first year, while providing an

environment that enables them to pursue cutting-edge research, doing so directly under the guidance of a supervisor, advisers, and graduate students.

To ensure students gain the deep understanding needed for advanced research while engaged in RBL, they will also study foundational natural science courses, required specialized subjects, and other disciplines. We also encourage students to take Liberal Arts courses in which they learn to communicate professionally, confirm the wider social significance of their own research, and gain motivation to tackle various societal problems. 'Science and Religion in Japan' introduces some lesser-known aspects of Japanese history. The quest for natural science to understand the design and principles of the universe was a major reason behind the advance of science in the West. However, Japan had a different story. Science was brought over to the country by European Christians. In the class, the participants' challenge is not to discuss religion vs science but historical facts. In Japanese history, western religion and western science arrived at the same time. This course is designed to help students understand the impact of this arrival on Japanese concepts of religion and science and its lasting influence on modern Japanese society.

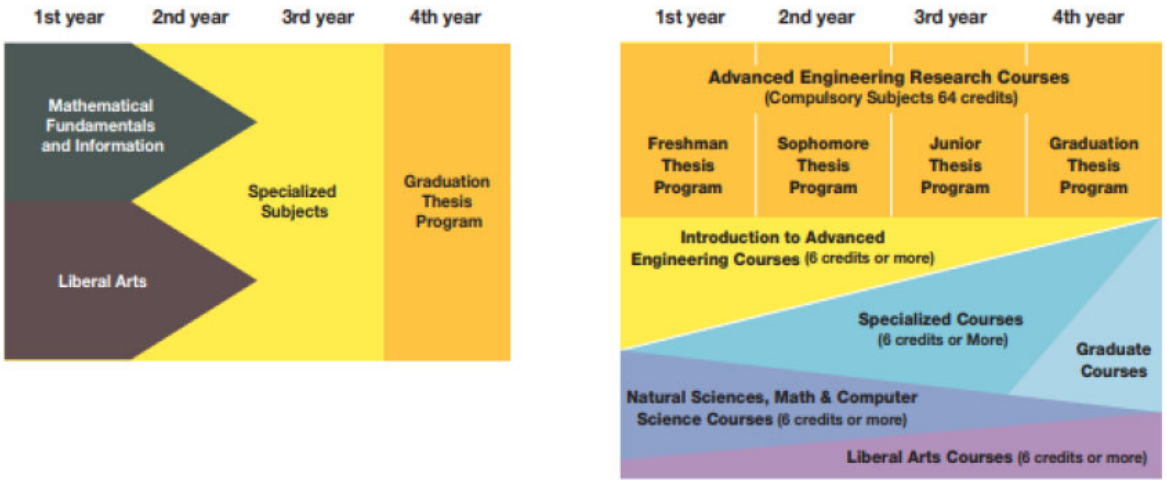

Figure 1: Comparing Conventional Curriculum and Research-based Curriculum [6]

Research objectives

The course 'Science and Religion in Japan' has been well received by both the research-based program students and engineer-majored international students. The class size is more than 20 every semester, consisting of students mainly from Europe, Asia, and South America. Therefore, class discussion is always conducted from diverse standpoints borne from their

different cultures, religions and personal backgrounds. Our research questions (RQ) in this paper are:

1. Can the students' global competency be increased more after the Fall 2022 semester? - Which can be examined by comparing pre and post program global competence scores of students taking the Spring and Fall AY2022 courses.
2. Does including 'Science and Religion in Japan' in an engineering education curriculum help students gain flexibility, an appreciation of equity, and a greater richness of ideas? - These aspects are required if students are to become 'global engineers'.
3. Are their expected learning outcomes being achieved, or are there any unexpected by-products gained from this course?

Achieving expected learning outcomes

1. The class contents

Table 1 shows the course syllabus for the AY2022 'Science and Religion in Japan'. Students will explore the process of transformation that religious traditions including Shintoism, Buddhism, and Christianity went through in Japanese society, education, and science.

Table 1: AY2022 Course Syllabus

	Science and Religion inn Japan: Course Syllabus
1	An Overview of Shintoism and Buddhism/ Japan's Encounter with Foreign Cultures 1: China
2	Special Lecture 1: Importance of Having Philosophical Thoughts and Religion in the Field of Engineering
3	Japan's Encounter with Foreign Cultures 2: Portugal
4	Japan's Encounter with Christianity during the Warring State of Period: The Three Great Unifiers of Japan
5	Japan's Encounter with Foreign Cultures 3: Netherland
6	The Tensho Embassy and the Martyrs of Japan
7	Mid-term Review: presentations and discussion
8	Special Lecture 2: The History of the Shinkansen and the Importance of Engineers Having the Peaceful Mindset
9	Hidden Christians in Japan
10	The Evolution of Castles in Japan
11	Japanese Printing Technology 1: Kawaraban as Tabloid Newspaper of the Edo Period
12	Japanese Printing Technology 2: Edo Culture and Infrastructure in Ukiyoe
13	Meiji Restoration and Bunmei-kaika
14	Final review: Presentation and discussions

Below are the expected learning outcomes of this course:

1) To familiarize themselves with the knowledge of the characteristics of some religious traditions in Japan, and how they were transformed in the modern period in the context of their encounter with the West.
2) To study the different cultures, religions, and races that played important roles in Japanese history.
3) To learn about the value of equity in the field of history.
4) To understand the importance of interdisciplinary approaches through the humanities course.

2. Evaluation criteria and writing summary and response papers for weekly assignments

In order to pass this course, students need to earn at least 60% of the total score. Grades are given based on:

- Assignments (20%)
- Mid-term review (30%)
- Final review (50%)

Figure 2 Student's Presentation Poster

For both the mid-term and the final review, students are required to choose one or two topics they have learned from the course, then elaborate it more as a poster presentation (Figure 2). The content should be academically argumentative, and complete with references. To prepare for their mid-term and final review, students work in groups reviewing, analyzing and discussing the topics they encounter in the class. They are also asked to summarize and respond to two topics from what they have learned. Each topic should be no more than 300 words and be submitted as weekly assignments. Writing summary and response papers are the best ways to demonstrate their understanding of the contents and their creativity – which

are required if they are to gain flexibility, an appreciation of equity, and a greater richness of ideas and adaptability. Furthermore, in our research-based program, defined and structured training in how to write clearly and convincingly is needed for their publication which are required for their third- and fourth-year curriculum.

What has been observed while teaching international students in the 'Science and Religion in Japan' course is that, in general, both our research-based program students and international exchange students can express their thoughts logically while speaking, however, in writing, they cannot express their opinions clearly. Below are instructions to complete their summary and response paper:

- Step 1: Choosing two topics from the lecture.
- Step 2: Deciding the thesis statement for each topic.
- Step 3: Identifying their opinions and thoughts.
- Step 4: Write logically to support their ideas.

3. Inviting guest speakers

To enhance students' understanding of the class concepts more, every semester two guest speakers are invited to give special lectures on their topics of their expertise: One demonstrates the importance of having philosophical thoughts and religion, and how these worldviews have influenced the concept of 'humanoid robots' in present-day Japanese society. The other addresses the importance of engineers having the mindset that they should apply technical expertise solely for peaceful purposes.

1) Lectures on Robotics: Humanoids, Androids, Culture and More

Two lectures were conducted on Robotics in 2022, which is a discipline that can be considered at the intersection among Computer Science, Mechanics and Electronics. Not only these three disciplines define Robotics: a number of additional ones (to name a few, Materials Science, Anatomy, Psychology, Medicine, Linguistics) can be extremely relevant, and make research in Robotics an extremely interdisciplinary affair.

Japan has one of the world's longest traditions in the design and production of robots, which traces back Karakuri puppets used in Shinto festivals and in tea ceremonies since the 14th century. A review paper by Trovato et al. [7] covers many of these developments, in different fields of application (humanoids, robots for rescue, ethical aspects, arts, and more). Humanoids nowadays constitutes one of the biggest branches of Robotics, and it originated in

Japan, since Prof. Ichiro Kato started developing the first modern humanoid (called WABOT) in 1970.

Hardware limitations affected the dream of making an “artificial human”, however, through the years, research on robots for social uses gained more presence compared to industrial purposes. The need of being in close contact with humans brought even more need to blend humanity studies with the technical side of Robotics. This is the reason why these two lectures covered mainly topics that are in between the two sides:

- A historical overview of the idea of humanoids since earliest automata;
- The impact of androids and their possible unsettling effects;
- The importance of culture and philosophy on what users think of machines;
- the newest developments of the crossover between Robotics and religion.

Religion in Robotics was the theme of a recent special issue of the International Journal of Social Robotics [8], and it is gaining relevance while still being considered a niche. A lecture in a class can broaden the mind of the students through the creation of bridges between disciplines that are far apart. In addition, it may also serve to the researcher as a tool for collecting fresh ideas. At the end of the lectures, in fact, the students had to submit their essays, and it was definitely possible to find fresh ideas at least in three or four out of the total number of students (Figure 3).

Figure 3: Lecture on Robotics

2) Lectures on ‘History of the Shinkansen and the Importance of Engineers Having a Peaceful Mindset’

This is a special lecture whose purpose is to reveal the story behind the development of the Shinkansen. The Shinkansen, also known as the ‘Bullet Train’, is a vehicle that is a symbol of Japan’s cutting-edge technology and economic development, and is loved by many Japanese people.

Participating engineering students will learn about the relationship between technology and various social sciences. The aim of this lecture is to make students aware of the social factors surrounding the development of the Shinkansen, and to embed these in their own perspectives on the field of engineering. At the beginning of the lecture, the following three learning objectives are clarified:

- Students should gain a detailed knowledge of the history of Japan’s defeat in World War II; international students do not necessarily start the course with a significant amount of knowledge on this topic.
- Students should recognise the relationship between Japan’s past history and the social and developmental path that modern Japan has taken since the end of the war, exemplified by the emphasis Japanese society and politics places on peace.
- Students should develop an awareness of what technology and engineers have done and are doing to contribute to creating a better world, and an ability to ponder further on what they could do in the future.

Less than 80 years ago, Japan as a nation was utterly destroyed by its devastating defeat in World War II. After the war, it was the effective and peaceful application of science, technology, and engineering expertise that enabled Japan to recover and return to the international stage as an economically developed nation.

One of the best-known examples of Japan’s rapid post-war technological advancement is the Shinkansen or ‘bullet train’, which is still one of the world’s fastest trains nearly sixty years on from its introduction. The achievement of ‘zero fatalities’ in that time must be at least partly attributed to its designers’ and operators’ research and development (‘R&D’) philosophy, which sets the protection of human lives as its highest priority.

As part of the introduction to this course, students learn the meaning of the Kanji 和 (pronounced roughly as ‘WA’). As well as representing Japan itself, this Kanji also relates to ideas and concepts such as ‘harmony’, ‘mixture’, ‘sum’, ‘peacefulness’, and ‘collaboration’.

The articles of the Japanese Constitution are also explained, with discussion of how these stipulate the desire for peace and the desire to contribute to global stability. After learning the history of the Shinkansen's development and the stories of three of the engineers who contributed to it, participating students will discuss what lessons they learned and how they will themselves be able to contribute to society as future engineers (Figure 4).

It is worth noting that the original intention for much of the technology used for the Shinkansen was developed during the war for non-peaceful purposes. However, post-war Japanese engineers felt the need to expunge their guilt at having developed such technology and instead utilised it for more peaceful purposes.

The learning outcomes from this lecture were measured by filling out a questionnaire. Most of them mentioned their redemption by developing technology used for the war, importance of having a peaceful mindset, safety, and/or the contribution of the three engineers as the most impressive lessons learned (see their feedback in 'Program evaluation' below).

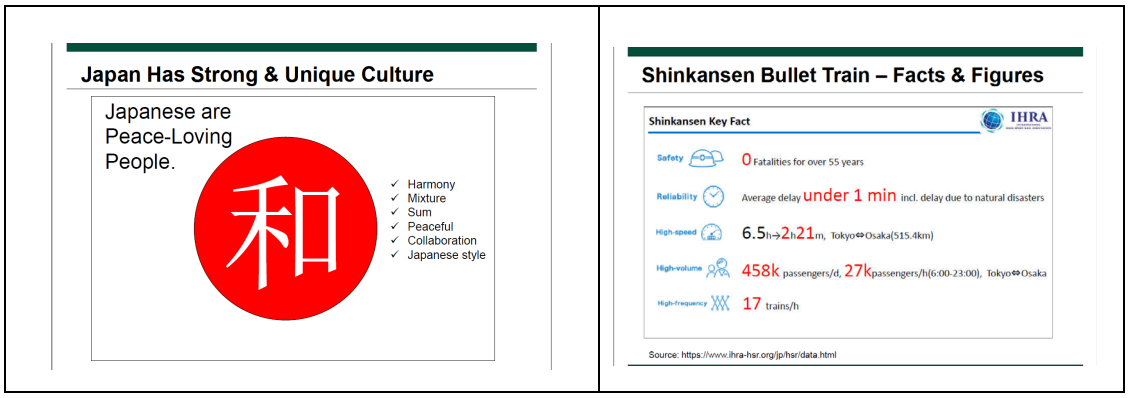

Figure 4: Some slides from Lectures on Shinkansen

Program evaluation

1. Quantitative analysis: MGUDS-S

SIT values the set of attributes defined by The Organisation for Economic Co-operation and Development (OECD) as 'global competence', as this trait in turn influences the acquisition of knowledge, awareness, and intercultural skills which are required for students majoring in science and engineering, in order for them to succeed in their careers in a globalised society [9]. Global competence is the ability to demonstrate recognition, respect, openness, and readiness to participate in activities with people from diverse cultural backgrounds. In this paper, the Miville-Guzman Universality-Diversity Scale - Short Form

(MGUDS-S) was used to examine how participants' global competence levels differed before and after completing a humanities module on 'Science and Religion in Japan' as part of an undergraduate study program.

MGUDS-S was originally created by Prof. Marie Miville at Columbia University in the United States. It has proven itself to be an effective assessment system, both in American higher education and in universities worldwide [10], [11]. The MGUDS-S tool has been the standard method for evaluating all study abroad programs, including international collaborative workshops, conducted by our institution at SIT since AY2019. Previous studies have demonstrated the effectiveness of the MGUDS-S tool in evaluating students' competency levels before and after their participation in international programs [12], [13] [14], [15], [16]. It consists of a 15-question written survey, with responses scored on a 6-point Likert scale. It outputs an 'overall score' and three sub-scores, which are as follows:

1) 'Diversity of Contact (DC)' - the behavioral aspect of global competence, measuring a subject's interest and willingness to participate in activities with people from diverse backgrounds.
2) 'Relativistic Appreciation (RA)' - the cognitive aspect, indicating recognition of the value diversity adds to one's life and respect for cultural differences.
3) 'Comfort with Difference (CD)' - the affective aspect, indicating the level of comfort subjects feel when interacting with people from diverse backgrounds.

When analysing the survey data, the analysis of responses to research question 1 ('RQ1') focuses on the pre- and post-program global competence scores for 'all students' taking the 'Science and Religion in Japan' course in AY2022, including one group who took the course in the spring semester and the other in the fall semester. In both cases there were 23 students taking the course, and the number of those who responded to the survey was 19 and 22 for the spring and fall semesters respectively.

The fall semester participants' overall global competence scores display a larger increase than those of the spring semester participants (Table 2 below). This may be due to the fact that for the fall semester students, the participants' total competence scores at pre-survey time were lower than those of the spring semester students, making the latter increase more pronounced. The data also suggests that average overall competence scores for groups of students will be around 70 points, and that it is unusual for individual students to achieve an overall competence score higher than 75 points. In addition, 'CD' scores were always the lowest among the three subscales; no student in either study showed a higher score for CD

than for either of the other two measures. Therefore, increasing 'CD' scores and total competency scores will be the challenge for the upcoming Spring 2023 semester.

Table 2

Pre- and post-program global competence scores: Spring and Fall 2022 semesters

Result: AY2022 Spring			
All (n=19)	Pre-survey	Post survey	
MGUDS-S Three Subscales	Mean	Mean	Change
Diversity of Contact (DC)	26.42	26.74	0.32
Relativistic Appreciation (RA)	26.42	27.05	0.63
Comfort with Difference (CWD)	18.05	19.11	1.05
Total score	70.89	72.89	2.00
Post Asian Students (n=5)	Pre-survey	Post survey	
MGUDS-S Three Subscales	Mean	Mean	Change
Diversity of Contact (DC)	24.40	24.67	0.27
Relativistic Appreciation (RA)	25.60	26.83	1.23
Comfort with Difference (CD)	16.25	16.33	0.08
Total score	66.25	67.83	1.58
European&south american students (n=	Pre-survey	Post survey	
MGUDS-S Three Subscales	Mean	Mean	Change
Diversity of Contact (DC)	27.14	27.69	0.55
Relativistic Appreciation (RA)	26.71	27.29	0.57
Comfort with Difference (CD)	19.29	20.38	1.10
Total score	73.14	75.36	2.22
Result: AY2023 Fall			
All (n=22)	Pre-survey	Post-survey	
MGUDS-S Three Subscales	Mean	Mean	Change
Diversity of Contact (DC)	24.64	26.23	1.59
Relativistic Appreciation (RA)	23.73	25.32	1.59
Confront with Difference (CD)	17.82	18.82	1.00
Total score	66.18	70.36	4.18
Asian students (n=4)	Pre-survey	Post-survey	
MGUDS-S Three Subscales	Mean	Mean	Change
Diversity of Contact (DC)	25.25	27.75	2.5
Relativistic Appreciation (RA)	24.75	26.75	2
Confront with Difference (CD)	10.75	12.25	1.5
Total score	60.75	66.75	6
European&south american students (n=	Pre-survey	Post-survey	
MGUDS-S Three Subscales	Mean	Mean	Change
Diversity of Contact (DC)	24.50	27.75	3.25
Relativistic Appreciation (RA)	23.50	24.82	1.32
Confront with Difference (CD)	19.39	20.53	1.14
Total score	67.39	73.10	5.71

To ensure a significant increase in scores, statistical tests were performed on the data. Shapiro-Wilk test for Normal distribution was first applied to each of the three subscales, by grouping the Pre and Post-surveys of Spring and Fall into one. The resulting sample size was 82, and in all three cases normality was rejected (DC: $W=.9369$, $p=.0006$; RA: $W=.9555$, $p=.0063$; CD: $W=.9145$, $p<.0001$).

Given the existing skewness of the data, rank sum tests were performed in place of t-tests. For paired samples (Pre v Post), Wilcoxon test was used. Sample size was 41 (Spring and Fall grouped into one). Data from all three subscales showed significant differences: for DC, $p=.0156$; for RA, $p=.0031$; for CD, $p<.0001$.

Significance of further breakdown is limited by the sample size of different nationalities. The group of European and Americans still demonstrated a significant result ($p=.0170$, $p=.0179$, and $p=.0001$ respectively), while the Asian group demonstrated a significant result only within the subscale RA ($p=.0391$). We expect that aggregating further data in the next years will confirm the tendencies also for the Asian group.

2. Qualitative analysis: Students feedback

Student feedback was the focus of research questions 2 and 3, which formed part of the student satisfaction survey conducted on students after they completed the course. The results of the student feedback analysis are shown below. The faculty running the course should strive to improve the course content for future years, to generate greater student satisfaction and greater measurable improvements in students' global competence. Figures 5-1 and 5-2 down below show the most popular topics that were chosen by Spring and Fall program participants; the number in the bracket to the left of each topic shows its position in the teaching order of class content. Multiple answers were allowed for each question.

Analysing the survey results, we can see that the content of the module 'History of the Shinkansen and the Importance of Engineers Having a Peaceful Mindset' was well received by both the Spring and Fall AY2022 students. Down below, Table 3 displays some excerpts of student feedback regarding this course module.

It should be noted that 'History of the Shinkansen and the Importance of Engineers Having a Peaceful Mindset' was one of the later modules taught in the course (see Table 1 above). So it is possible that its popularity was due to the 'Recency Effect', a cognitive tendency in which ideas or arguments that were heard most recently are remembered more clearly and vividly by people than those they were exposed to at an earlier time [17].

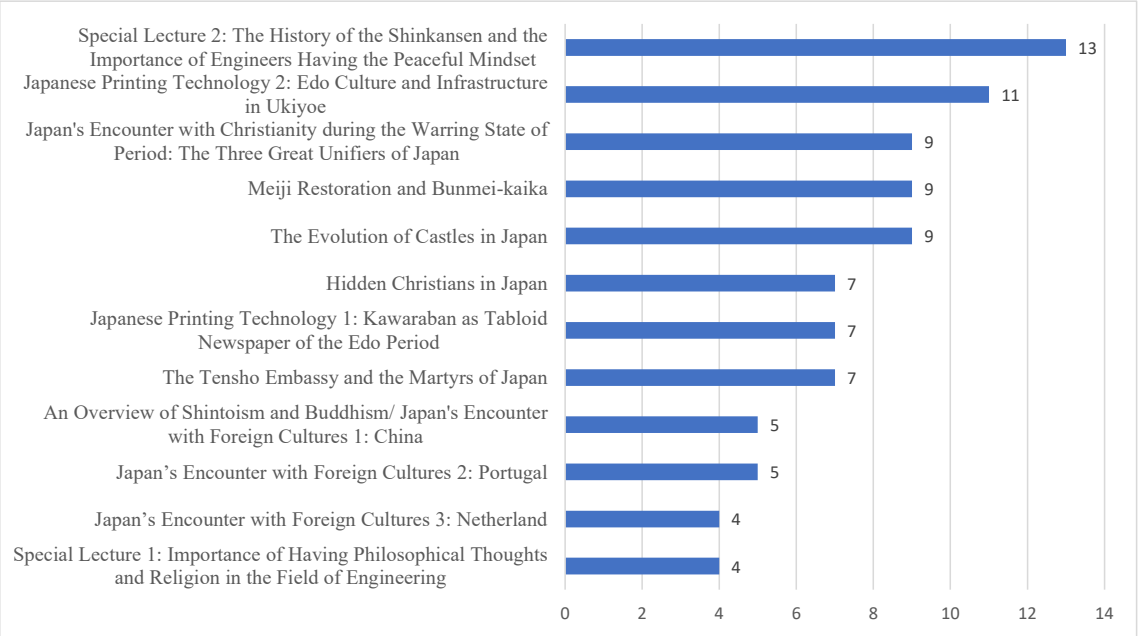

Figure 5-1: Popular Topics in the AY2022 Spring Semester (n=19)

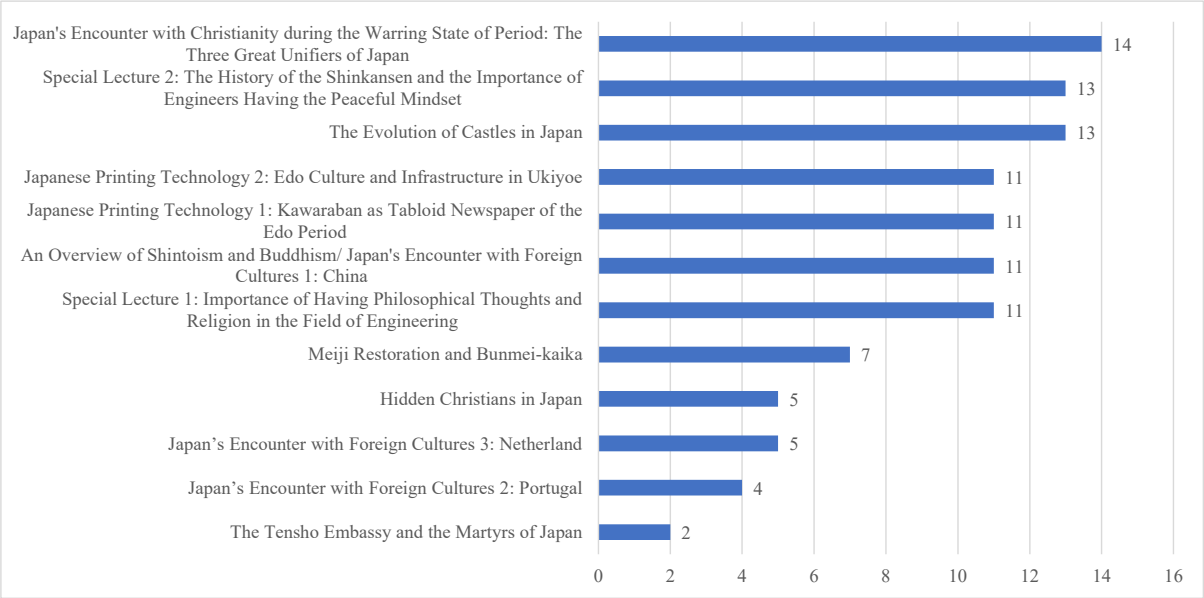

Figure 5-2: Popular Topics in the AY2022 Fall Semester (n=22)

This theory was proposed and verified in 1976 by Norman H. Anderson, an American psychologist. In addition, according to research conducted by British psychologist Donald Broadbent, the ‘Recency Effect’ is enhanced when important pieces of information are presented in series within a short period rather than ‘separately’ with a longer interval

between them [18]. Therefore, one of our next challenges will be to examine the possible greater effectiveness of teaching both special lectures at the very end of the course.

Table 3: Some Excerpts of Student Feedback on ‘Shinkansen’ Story

- 'I love to hear the stories of how from the war, an invention was able to come out to help the world once the war was over. Almost every conflict has one [invention like this] and I find it reassuring that despite the horror of war, some minds manage to improve the world (GPS, penicillin, Shinkansen)'.
- 'I think that one of the general messages of this lesson is that despite the horror of the war, this conflict allowed a great technological progress because the engineers knew how to take advantage of their research and their knowledge. They were then able to combine their work to create an amazing and peaceful invention. Indeed, the technology that was created to stop the oscillations of fighter planes was used to stop the derailment of the high-speed train. And because of this, the Japanese economy was reinforced'.
- 'Among the subject and fact talked about the story of the Shinkansen, I was surprised that so many engineers and scientists gathered their knowledge from the horrific past they have been through with the World War II. Indeed, it is quite disturbing to know that for instance the three main creator and engineer of the Shinkansen did a so powerful and fast engine while years before they were serving for the army and created destructive weapons in order to kill. But still, I admire their redemption by creating something useful and convenient for many and do not using anymore their knowledge to create weapons'.
- 'What impressed me the most is that the engineers who worked and design the Shinkansen were military engineers. I mean that it is the perfect proof of two things. Firstly, if we put all the effort not in weapon research but in technologies that can simplify our lives here, we can reach some incredible contribution. Secondly, that redemption is possible and people can have a second chance'.

The student satisfaction survey discussed above was similarly used to collect students’ answers to Research Question 2: ‘Does including ‘Science and Religion in Japan’ in an engineering education curriculum help students gain flexibility, an appreciation of equity, and

a greater richness of ideas? Regarding expected learning outcomes, all students answered that they felt these had been achieved. Below are some excerpts on RQ2 (Table 4).

Table 4: Excerpt from the Students Feedback Survey on RQ2

- 'I think that this class can be useful in the sense that people always use the past to take decision for the future. When studying the history of religion and science, it gives a better understanding to the decision taken in the modern world. Knowing that for example the Shinkansen was built by people who participated in Operation Cherry Blossom shows the train in a different light.'
- 'Knowledge helps to take more things in concern so it can never be a break to technology, but you often have to make choices when you create something. The more you know the easier it is to take everyone point of view. It's easier to understand a country state with knowing its history and past.'
- 'It can help engineering on many points: First of all, it helps to open your mind and to understand more deeply cultures. It permits to understand the way of thinking when people initiate projects. I think that engineering is also apart from culture because it is a way to represent technical ideas. It is a way to express yourself as it can be in art. So it is normal to pick up inspiration in every subject you can, to reach a wider "audience" by mixing those understandings.'
- 'As a student, taking a course on "Science and Religion in Japan" in an engineering education curriculum can provide me with a broader perspective on how different cultures approach science and technology. This can help me to become more flexible in my thinking and better equipped to work with people from different backgrounds. The course can also help me to develop an appreciation of equity and diversity by understanding the historical and cultural contexts that shape the development of technology. This can help me to be more aware of potential biases and to be more sensitive to the needs and perspectives of others. Additionally, it can provide me with a greater richness of ideas by learning about how technology has been developed in Japan and how it has influenced the culture. This can help me to think outside the box and come up with new and innovative solutions to engineering problems'.

The following table shows some student excerpts on RQ3 'Are their expected learning outcomes being achieved, or are there any unexpected by-products gained from this course?'

It indicates what they felt they had learned from the course, including both expected outcomes and also 'unexpected' knowledge that they felt they had gained as a result of completing this part of the program (Table 5):

Table 5: Excerpts from the student feedback on RQ3

- 'I didn't expect to learn about modern things like Shinkansen or robots in Japan and that made me even more impressed by them.'
- 'Some unexpected by-products are new knowledge and some information from the guest speakers.'
- 'I was pleasantly surprised by the diversity of content. For example, I didn't think that we would treat the subject of Christians so much. The two guest speakers were very appreciated on my part. I also enjoyed the robots and the videos of the shinkansen. I also liked the last lesson on westernization and the passage on the printing press and the impact it had on the country after it was banned. I can also say that at first, I was not very inclined to achieve 600 words of writing every week. But with hindsight, after the work provided, it allowed me to synthesize, to better understand and above all to retain the lessons taught.'

Discussion and conclusions

This preliminary study aimed to demonstrate how humanities components could provide substantial educational benefits to students currently majoring in engineering. Throughout the course being observed, participants joined together in groups to study and discuss the simultaneous arrival in Japan of Western religion and science, the impact that the appearance of these had on Japan's own culture and conception of science, and the lasting impact on Japanese society. Students then prepared for the course's mid-term and final poster presentations while building their logical thinking skills by completing a weekly assignment to write a 600 word summary-and-response paper based on that week's covered topics.

Regarding the overall effect of the course on students' global competence, the results of the course evaluation suggested the following conclusions which can also serve as answers to the research questions posed by this paper:

1. The average 'overall global competence' scores of students taking the course in the Fall semester showed a more significant increase than those of the Spring participants (see Table 3 above). This could be caused by the fact that the Fall semester students' overall global competence scores at pre-survey were lower than those of the Spring semester

students, making the increase in skills they experienced due to the course more noticeable (RQ1).

2. The data also suggest that the average global competence score for a group with an approximate size of 20 students will typically be around 70 points and that it is unusual for individual students to achieve a score higher than 75. Moving forward, our target is to achieve a situation where our students group average scores for 'overall global competence' reach 75 points or higher.

3. Regarding these recent Spring and Fall semester courses, we have seen that - according to student feedback - providing weekly writing assignments allows students to synthesise better the knowledge they gain from the system, to understand it more deeply, and to retain it better. How to move from this kind of 'qualitative' feedback to a 'quantitative' analysis of the effectiveness of these sorts of writing activities will be one of our main topics for further research (RQ2).

4. Having two special lectures by guest speakers produced some welcome by-products. Once again, considering student feedback, we find that students found these lectures thought-provoking and believed them to positively affect their ability to think critically and creatively and to engage more deeply with the subject matter of the course as a whole (RQ3).

5. The survey of which topics were most popular with students has provided some pointers for improving the effectiveness of the 'Science and Religion in Japan' course. Clearly, the modules taught later in the course received more positive feedback from students than those which came at the start (see Table 1, Figures 5-1 and 5-2). Therefore, as our pedagogical studies in this area progress, we intend to make use of the 'Recency Effect' to further improve students' recall of the essential parts of the program, including these two special guest lectures.

6. As well as referring simply to the fact that 'more recently received knowledge' tends to be remembered more clearly, the 'Recency Effect' also describes the tendency for the impartation of knowledge to be stronger when the information is presented coherently within a short space of time rather than sporadically over a more extended period. We believe that amending the schedule so that the guest lectures on humanities topics are taught in the last two weeks of the course could be the best approach to ensuring that the impact of these lectures on students is maximised, which may, in turn, lead to an

improvement in students' global competence scores. The results of this format change will be examined and explored further in the following semesters.

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