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Assessment of Students' Information Literacy and Information Fluency Competency: A Case Study in Japan

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I. Introduction

"Digital natives", who are the generation of young people born in the digital age, are assumed to be inherently savvy in technology [1]. Students often use "cloud" applications such as Facebook, Twitter, and GoogleDocs as their learning environments. Taking pictures with a smartphone of the projection screen happens far too frequently in the classroom. "Information literacy" and "information fluency" are the two main terms that consider the skills needed to use computers and access information. However, the definitions of these terms vary.

Many countries have judged that it is essential to offer educational programs in information fluency for students to prepare for life and work in today's world, in which our information society continues to expand. However, differences regarding educational style exist between Western countries and non-Western countries. Education in Western countries tends toward a student-centered style, but the education in non-Western countries tends toward a teacher-centered style.

Given such a background, this paper describes the assessment of students' information literacy and information fluency competency in order to assess the levels of university student competency in Japan. In addition, the results of investigation of the students' performances are also described.

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II. Related Work

a) Information Literacy and Information Fluency

Three terms regarding the skills needed to use computers and to access information are "information literacy", "IT fluency", and "information fluency".

The term "information literacy" is relatively new. It was first employed in a report by the 1974 National Commission on Libraries and Information Science [2]. The report describes the skills needed to use a variety of information tools to access and synthesize information from primary and other sources. However, as digital technologies have grown in importance, definitions of information literacy have expanded to include their specific uses [3].

In 1999, the National Research Council Committee on Information Technology Literacy proposed the new term "IT fluency", which is the requisite knowledge and skills of IT-fluent students promulgated by a group of experts from research and academic computing communities [4,5]. In addition, Ref. [5] explored three diverging concepts and terms—information literacy, IT fluency, and information fluency—and described the emerging connections and discussions concerning information literacy and IT fluency between and among various levels of education in the United States. The author also stated the following regarding "information fluency":

> *Due to all of the discussion concerning the development of these terms that describe accessing, evaluating, and using information, a new concept has emerged in recent years called information fluency. This concept blends many of the characteristics of traditional information literacy and IT fluency and similar concept such as digital literacy, or e-learning.*

Since then, the term "information fluency" has proliferated: in Ref. [6], a search engine generated approximately 2,267,400 results in 2.54 seconds on 4 March 2011 for the number of information fluency-related terms and an additional 14,139,700 results a month later. This study focuses on the two terms "information literacy" and "information fluency", which includes information literacy, IT fluency, and similar concepts.

Ref. [7] proposed that the modern or contemporary classroom should enhance the learning experience and promote twenty-first century competencies and concluded that having a successful hybrid learning (use of face-to-face instructional methods and various learning technologies) environment is important.

Our university has required programs in information literacy since 2001. The students obtain the ability to use computer applications and the Internet in the following ways: to write, search, and evaluate programs; to use and manage information; and to create web pages and gain knowledge of the social and legal implications. In 2008, we conducted 34 information literacy classes (50–80 students per class). In 2003, information study became a required course in most high schools in Japan. Because students had learned the rudimentary knowledge in high school, the university curriculum was reorganized on the basis of the results of a questionnaire survey of the knowledge level of freshmen, and an introductory class was added as a traditional course.

Since then, the curriculum was reorganized again with the development of information technology, and the courses regarding information literacy as required courses were abolished and a wide range of courses on information fluency were provided as electives [8,9]. Table 1 shows the course catalog for the categories "Information Literacy" and "Information Fluency".

Table 1 : Course catalog for "Information Literacy" and "Information Fluency"

Category	Course Title	Number of classes	Number of students
Information Literacy	Introduction To Information Literacy	1	around 80
	General	14	around 40 - 80
	Information Retrieval and Searching	2	90
	Statistics	2	around 30
	Data Transactions	2	90
	English Version	2	44
	Information Science	2	80
Information Fluency	Systematic Information Processing	1	44
	Programming Method	2	80
	Systems Consulting	1	80
	OOP & JAVA	1	19
	Informatics and Human Interaction	1	90
	Multimedia Communication	1	44
	Media and Networking Technology	1	20
	Informatics and Digital Network Interactions	1	36
	IT Passport Exam I *	1	36
	IT Passport Exam II	1	40
	Fundamental Course Excel Transactions	1	66
	Advanced Course in Excel Transactions	1	80
	Web Pages in HTML and CSS	1	44
	C Programming	1	36
	Excel Transaction by VBA	1	80
	Game Programming	1	44

*IT passport is a Japanese national examination regarding fundamental knowledge of IT.

The goal of this discipline is that students obtain the knowledge and skill for living in a world in which our information society continues to expand.

All of the courses are basically conducted as hands-on exercise lessons in the computer room. That is, students are required to create something by using a computer application or students in a course must configure their computer to communicate on the Internet. Most courses are teacher-centered lectures, although some courses adopt the student-centered approach.

The author taught the Information Literacy course from 2008 to 2010, and has continued to teach the information fluency course, Informatics and Human Interaction (see shaded area in Table 1), since 2011. In addition, the author has taught Computers and Human Interaction, which is similar to Informatics and Human Interaction, at another university since 2010. The details are described later in the Methods section. In Informatics and Human Interaction as well as Computers and Human Interaction, the author adopted blended style lectures, that is, the first half of a lesson follows a teacher-centered style and the last half follows a student-centered style that includes discussion, peer-review, and so on. It is known that it is difficult for some Japanese students to join in the discussions. However, the author did not force such students to join and a brief period of discussion seems to be acceptable for most students.

In the course, the author carried out student assessments of contemporary skills. The assessment was the same during 2008–2011 and in 2014.

This article reports the results of the questionnaire survey for suggesting the direction for future research regarding what students are not able to understand and how lecturers should compose our course curriculum.

b) Information and Communication Technology (ICT) competence

Various reports have investigated the measurement of information literacy and information fluency competence [10-14]. In Ref. [10], Aesaert et al. state that most of the measures that have been developed are directed toward students' ICT self-efficacy, which is mostly measured by using a Likert scale. A big disadvantage of a Likert scale is that we cannot exactly assess how competent a pupil is, because the different positions on the scale are not assumed to be equally spaced.

c) Teaching Style

In Ref. [6], the author suggests the following.

> *amongst the estimated two billion Internet users worldwide in 2010, approximately 61% are from countries in Asia, the Middle East, the Caribbean and South America.(p.15)*

In addition, the author added a variety of discussions that focused on whether the Western educational approach of information fluency could be applied to non-Western country students because the culture and the education system are different between Western countries and non-Western countries, as follows.

> *Education systems in countries like China, Taiwan, and Japan are interpreted as conservative and teacher-centered.(p.15)*
>
> *The expectation might be that education in these countries is not really geared to embrace IF and would resist it as a foreign way of thinking brought on by globalization. (p16)*

However, the author described the following.

> *Watkins (1998) and Biggs (2003) noted that research has established that, in practice, much of the university teaching in countries such as Australia and the United States is more about lecturers being knowledgeable about their subject and imparting this knowledge to their students in a teacher-directed fashion. (p.17)*
>
> *Watkins, D. (1998). A cross-cultural look at perceptions of good teaching: Asia and the West. In J. Forest (Ed.), University teaching: International perspectives (pp. 19-34). New York: Garland Publishing, Inc.*
>
> *Biggs, J. (2003). Teaching for quality learning at university (2nd ed.). Maidenhead: Open University Press.*

Another article [15] stated the following.

> *The Academic Achievement Challenge: What Really Works-in the Classroom by the late Jeanne S. Chall makes the assertion, sure to be controversial, that a traditional, teacher-centered approach generally results in higher academic achievement.*

On the other hand, Ref. [16] evaluated web searching competency based on students' searching performance. The participants included 141 undergraduate and graduate students from Wuhan University, China. The results are described as follows.

> *Competency levels for searching academic tasks were higher than those of daily-life tasks, especially when the degree of difficulty increased. In information literacy education it is therefore vital to teach students comprehensive web searching competency that includes knowledge and techniques for both academic and daily-life search tasks.*

Therefore, in this study, we evaluated competency levels for information literacy and information fluency of students who took a course in

information literacy or information fluency during 2009–2011 and in 2014.

Moreover, this study used performance-based tasks to develop a direct measure of ICT competence.

III. Method

Three courses are described in this paper: Information Literacy, and Information and Human Interaction at our university ("S" university in Tables 2, 3, and 5), and Computers and Human Interaction at "I" University. The Information Literacy course was a required subject for freshmen (2009–2010). The author has been teaching the new course Information and Human Interaction, which is an elective subject for all years of students (after 2011). Both this course and Information Literacy consist of one 90-minute period per week for 14 weeks. Our university is on the semester system, but "I" University is not (three terms per year). "Computers and Human Interaction" at "I" University is an elective subject for all years of students and consists of three 70-minute periods per week for 10 weeks. Course schedules are shown in Table 2. Although a few minor changes are made every year for each subject, the contents of the courses remain about the same.

For all of the courses, students typically submit their assignments to the Moodle (Modular Object-Oriented Dynamic Learning Environment), an open-source course management system, for each class, watch short video clips regarding information ethics (computer viruses, intellectual property rights, net manners, and so on) and they hand in a term paper at the end of the semester.

Table 2 : Course schedules

Information Literacy ("S" university)
Orientation
Touch Typing
How to Use the Informational Service of the Library
Touch Typing
Writing
Writing (advanced)
Spreadsheet (simple calculations)
Spreadsheet (using functions)
Spreadsheet (macros)
Making a Presentation
Programming Language (HTML)
Net Manners
Information Ethics
General Overview
"Information and Human Interaction" ("S" university)
Orientation
Internet Mechanism
How Email Works, How Web Communication Works
Media Literacy
Information Ethics
Intellectual Property Rights
Privacy and Security
How Information Is Represented in the Computer
What Computation Is

Hardware Configuration
Overview of Information Systems
Programming Language (Dolittle)
Programming Language (Scratch)
The Role of Humans in this Information Society
Computer and Human Interaction ("I" university)
Orientation, Programming Language (Dolittle)
Internet Mechanism
How Email Works, How Web Communication Works
Media Literacy
Information Ethics
Intellectual Property Rights
Privacy and Security
How Information Is Represented in the Computer
Fundamental Information - Communication What Computation Is
The Role of Humans in this Information Society

Table 3 shows an overview of the courses and the students' performance in the pre- and post- tests. In this table, "M" is the mean, "SD" is the standard deviation. The "Number" column indicates the number of valid responses of an assessment, that is, the number of students who took both the pre- and post-tests.

Table 3 : Overview of the courses and the students' performance

Year	Course	Faculty	School Year	Pre-test M (SD)	Post-test M (SD)	Number	Type	Univ.
2009	Information Literacy	Foreign Studies	Freshman	20.8 (2.6)	22.5 (2.0)	55	required	S
2010	Information Literacy	Foreign Studies	Freshman	19.0 (2.9)	20.9 (3.8)	45	required	S
2010	Computers and Human Interaction	mix	mix	22.4 (1.9)	23.4 (1.8)	52	elective	I
2011	Informatics and Human Interaction	mix	mix	21.5 (2.5)	23.6 (2.3)	30	elective	S
2011	Computers and Human Interaction	mix	mix	21.3 (3.2)	22.6 (3.1)	60	elective	I
2014	Informatics and Human Interaction	mix	mix	N/A	22.0 (2.7)	65	elective	S

As stated above, the student assessment has two major components: a pre-test and a post-test (through 2011). In the pre- and post-tests, students were asked to answer 25 questions (1 point for each question except Question 1) in 7 parts to assess their skills. Table 4 shows the details of the questions.

Table 4 : Details of the pre- and post-tests

Total points: 26	Description	Question/Detail
Part 1 (2 points)	Identifying accurate/inaccurate statements about extension of file	1 / regarding the file whose extension is .exe
Part 2		2 / .txt
		3 / .ppt
		4 / .doc
		5 / .docx

Part 3	Understanding the meaning of BCC and CC	6 /
Part 4	Identifying the case of violation of law or infringement of rights	7 / uploading something to the Internet
		8 / private use
		9 / private use
		10 / uploading something to the Internet
		11 / uploading something to the Internet
		12 / uploading something to the Internet
Part 5		13 / copyright-protected period in Japan
Part 6	Identifying accurate/inaccurate statements about information ethics	14 / evaluating the appropriateness for forwarding messages (e.g., chain e-mail)
		15 / keeping personal information
		16 / gaining a correct understanding of the hazards of chatting with strangers
		17 / net manner (no-subject e-mail)
		18 / net manner (being polite)
		19 / forwarding a message without acquiring permission from the sender
		20 / sending message without writing your identities
Part 7	Identifying accurate/inaccurate statements about computer virus	21 / definition of computer virus
		22 / dealing with computer virus infection
		23 / How a computer gets infected with a virus or spyware?
		24 / necessity of seeing what it is when getting email from strangers
		25 / necessity of keeping one's antivirus software's virus definition files updated

IV. Analysis

a) Students' performance (Course evaluation)

The results of a paired samples two-sided t-test between the pre- and post-tests for each course showed a significant difference between the two tests for all courses. A P value less than 0.01 was considered statistically significant. The results indicate that the students' skill improved through these courses.

b) Year-to-year difference

Is there any difference between years? The results of an independent samples t-test assuming unequal variances (P value less than 0.01 was considered statistically significant) are shown in Table 5 for "S" university. For both the pre- and the post-tests, the performance in 2011 is higher than that in 2010. The 2011 performance of the post-test is the highest of all four years.

The new course started in 2011 and the number of students who took the course was less than that in other years; therefore, the number of students is considered to be the reason for the highest score. The importance of small-group teaching to foster engagement with educationally effective practices was shown [17,18]. In addition, we offered a face-to-face class with small-group instruction for the weaker students, while we provided the fully online course for the regular students. We succeeded in helping the weaker students to overcome their programming phobia and to develop the ability to create basic programs [19]. The importance of small-group teaching was thus reaffirmed.

In contrast, the results comparing 2010 and 2011 of "I" university by using an independent samples t-test assuming unequal variances (P value less than 0.05 was considered statistically significant) indicates that a significant difference occurred (2010 results were higher than those in 2011).

Table 5 : Year-to-year difference of "S" university

Pre-test (S)	2009	2010	2011	
Average score	20.8	19.0	21.5	
2009	-			
2010	**	-	**	
2011			-	
Post-test (S)	**2009**	**2010**	**2011**	**2014**
Average score	22.5	20.9	23.6	22.0
2009	-		*	
2010	+	-	**	
2011			-	
2014			**	-

***: significant difference in the two-sided t-test; *: significant difference in the one-sided test; +: two-sided test with a P value between 0.01 and 0.05.*

Consequently, although year-to-year differences occurred, no overall trend was seen.

c) Difference between types of school year

Regarding the mixed-year courses, is there any difference between the types of school year? The result of a two-sided t-test for independent samples assuming unequal variances (P value less than 0.01 was considered statistically significant) indicates that no significant difference occurred between the types of school year.

d) Difficult fields for students to understand

We analyzed what questions resulted in a lower student performance. Figure 1 shows the percentage of questions answered correctly for both pre- and post-tests without "S" university in 2014 only.

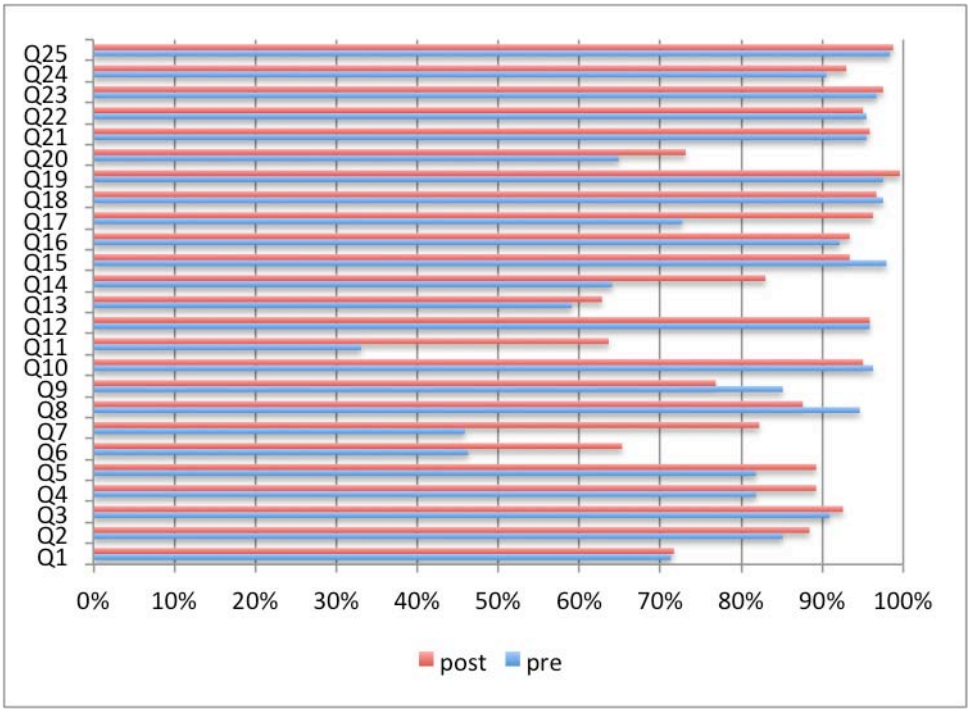

Figure 1 : Students' performance for post- and pre-tests: The percentage of questions answered correctly (without "S" university in 2014 only)

Lower rates are shown for questions 11, 7, 6, 13, 14, 20, 1 for the pre-test and questions 13, 11, 6, 1, 20, 9, 7, 14 for the post-test, in order of increasing number of students answering correctly. Question 11 and Question 7 are both about uploading something to the Internet. Question 11 is "You uploaded a music video where you played a very common song on the piano to your website" and Question 7 is "You uploaded the picture of a famous character you drew to your website". As shown in Figure 2, Question 6 is about understanding the meaning of BCC and CC.

BCC and CC are expected to be well known now as compared with a decade ago. The reason why the accuracy rate was low could be that this question was worded as "Select WRONG statement" instead of "Select RIGHT statement". However, if students did not correctly select "wrong statement", does this result indicate that the students did not fully understand the question? Question 13 is about the copyright-protected period in Japan: "How long do the author's rights continue?" The answer is "In principle, 50 years after the author's death". As shown in Figure 3, Question 1 is about the file whose extension is .exe.

Question 13 and Question 1 did not show a significant difference between the pre- and post-tests. Consequently, we have to improve the quality of teaching the information regarding these questions.

Question 6: Assuming sending email to the following address.

To: Bob

CC: Carol, Dyane, Emma

BCC: Frank, Gabriel

Select the wrong statement.

Options:

Ans1: The address of Bob is disclosed to Carol.

Ans2: The address of Carol is disclosed to Dyane.

Ans3: The address of Dyane is disclosed to Emma.

Ans4: The address of Emma is disclosed to Frank.

Ans5: The address of Frank is disclosed to Gabriel.

Figure 2 : Question 6 (Part 3): Understanding the meaning of BCC and CC

Question 1: Select the incorrect statement regarding the file whose extension is .exe.

Options:

Ans1: The program for installing software on the computer.

Ans2: If you double-click the file, the program is executed.

Ans3: The virus-infected program.

Ans4: You should not execute the file whose extension is .exe.

Ans5: If you download the file whose extension is .exe, you should confirm where it came from.

Figure 3 : Question 1 (Part 1): The file whose extension is .exe

Question 20 is relevant to sending a message without including the senders' identities. This result affected the performance of "S" in both 2009 and 2010. The correct answer rates of the pre- and post-tests of "S" in 2009 were 45% and 62%, respectively, and 38% and 49% in 2010. Smartphones were starting to come out at this time, and when people sent an email using a smartphone or a mobile phone, they did not write their identities (name, affiliation, etc.) because it was easy to identify who the email was from if the address of the sender was registered. Therefore, it was no longer necessary for senders to write their identities explicitly. However, identities are necessary when using traditional email.

The overall results also show that students tend not to understand the accurate definitions of some technical terms and lack net manners for sending email.

V. Conclusion

In this paper, we evaluated the competency levels for information literacy and information fluency of students who took a course in information literacy or information fluency during 2009–2011 and in 2014.

Moreover, this study used performance-based tasks to develop a direct measure of ICT competence.

Significant differences occurred between pre- and post-tests for all of the courses. These differences indicate that the students' skill improved through the courses.

In addition, although year-to-year differences occurred, no overall trend was seen.

For the mixed-year courses, no difference occurred between school years.

The result of the investigation about fields difficult for students to understand revealed that students tend not to understand the accurate definitions of some technical terms and lack the net manners for sending email.

This research did not clarify whether a student-centered style or a teacher-centered style is better. However, a blended style is efficient when considering the outcome of this research.

Beginning in 2013, taking a course on information studies became a requirement for all newly admitted high school students in Japan. Therefore, it will be necessary to investigate whether the performance of these students improves after several years. In addition, because the pre- and post-tests used in this research might not cover all aspects of the essential knowledge about information literacy and information fluency, they should be refined in the future.

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