Rodrigo, M. M. T. et al. (Eds.) (2021). Proceedings of the 29th International Conference on Computers in Education. Asia-Pacific Society for Computers in Education

Developing a Generic Skill Assessment System Using Rubric and Checklists

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Abstract: In higher education, the development and assessment of generic skills are important issues, in addition to learning specialized knowledge. This paper clarifies the characteristics of generic skill assessment activities, and then describes the necessity of an information system for generic skill assessment in relation to Learning Management Systems (LMS) and e-portfolio systems, and finally, the requirements of such a system are proposed. The basic functions of the system that meets the proposed requirements were developed in accordance with the technical standards. More specifically, to manage assessment indexes such as rubrics, the database schema was designed with reference to IMS CASE. In addition, IMS LTI (Learning Tools Interoperability) was adopted, and the system was implemented as an LTI tool in order to be interoperable with educational systems such as LMS. The developed system was used in generic skill assessment activities at the Department of Information and Electronic Engineering, Teikyo University. The result of the usage demonstrated that the system was well-received by students, indicating that it can be fully used as an assessment system. A future issue will be to verify its usefulness as an assessment system by using the system over the long term.

Keywords: Generic skills, rubric, self-assessment system, LIT, CASE

1. Introduction

In recent years, educational reforms such as the introduction of active learning have been promoted in higher education. One of the objectives is to shift from the conventional "education that emphasizes knowledge" approach to "education that emphasizes both knowledge and generic skills." Generic skills are abilities and skills that can be used universally in any specialized field. Examples include communication skills, problem-solving skills, and the ability to work in a team. In order to provide education for the development of generic skills, it is necessary to assess them.

There are several methods to assess generic skills or 21st century skills (Geisinger, 2016). In the Programme for International Student Assessment (PISA) 2012, complex problem-solving skills were assessed by computerized simulations based on the multiple complex systems (MCS) approach (Herde, Wüstenberg, & Greiff, 2016). The Assessment and Teaching of 21st Century Skills (ATC21S) project took approach to assess collaborative problem-solving skills using log data on the real time collaboration task via an online assessment system (Care, Scoular, & Griffin, 2016). Although these are effective assessment methods, these focus on problem solving skills and difficult to deal with all generic skills in a unified manner.

Kawasaki, Kubota and Yajima (2020) adopted an objective test for checking generic skills called PROG for the assessment of generic skills. The PROG test consists of two parts: literacy and competencies. Of these, competencies determine the level of a test subject based on the similarity with the response results of working adults, but there is no certainty that the level determined in this way accurately represents the competency of the test subject. In other words, although PROG is an objective index, it is not always accurate. Generally, universities set their own educational goals based on their own diploma policy. These goals do not always match the assessment items of PROG. Therefore, PROG can be used as a reference when assessing generic skills, but it is not appropriate to assess by PROG alone.

Another approach is an intersubjective assessment using rubrics. For example, the VALUE Rubric Development Project (https://www.aacu.org/value/rubrics) by AAC&U in the United States developed rubrics to assess learning in undergraduate level education and are used in higher education.

Kyndt et al. (2014) created a questionnaire consisting of 44 items as a self-assessment instrument for generic working life competencies in vocational education. Sumaryati et al. (2019) developed a generic skills assessment index for use in self-assessments and peer assessments in accounting education. Khlaisang and Koraneekij (2019). developed an assessment system after defining assessment indexes for improving information literacy, media literacy, and ICT literacy.

The Department of Information and Electronic Engineering at Teikyo University (our department) has adopted PROG, an objective index, and CASEC, a diagnostic test for English communication skills. Our department decided to conduct a self-assessment using our own rubrics and checklists after referring to the results of these objective tests. This paper focuses on systems to perform a self-assessment using assessment indexes such as rubrics and checklists.

As the development of generic skills is important in higher education such as universities, the following is deemed necessary:

- The system should be easy to use in the process of assessing and developing generic skills in the university education curriculum.
- The system should be properly positioned in relation to LMS and e-portfolio systems as the educational information infrastructure of the university and should be interoperable with those educational systems.

However, there have been no existing examples of developing a generic skills assessment system from these points of view. Therefore, the objectives of this study are as follows:
To clarify the requirements that the generic skill assessment system used at the university must meet.
To implement the basic functions of the system according to the requirements and clarify its effectiveness.

In the following, Section 2 examines the general requirements of generic skill assessment activities based on the efforts of development and assessment of generic skills in our department and describes the necessity of a generic skills assessment system. Section 3 proposes a generic skill assessment system, and Section 4 describes the implementation of basic functions of the system. Section 5 describes the results of using the system in the assessment activities at our department, followed by discussions and a short summary.

2. Assessment of Generic skills

2.1 Example at Department of Information and Electronic Engineering, Teikyo University

In order to clarify the requirements for generic skill assessment activities, this section describes case studies of specific assessment efforts. Our department defined target generic skills to be assessed as shown in Table 1. Then, a generic skill rubric was created from the viewpoint of each item of the generic skills shown in Table 1. In addition, as a specific assessment index for each item, a checklist was created per item.

Table 1. *Target Generic Skills*

1. Information Literacy
2. Thinking and Problem-solving
3. Communication
   - 3.1 Written Communication
   - 3.2 Oral Communication
   - 3.3 Quantitative Literacy
   - 3.4 English Communication
4. Action and Learning
   - 4.1 Self-directed Learning
   - 4.2 Action
5. Team Work

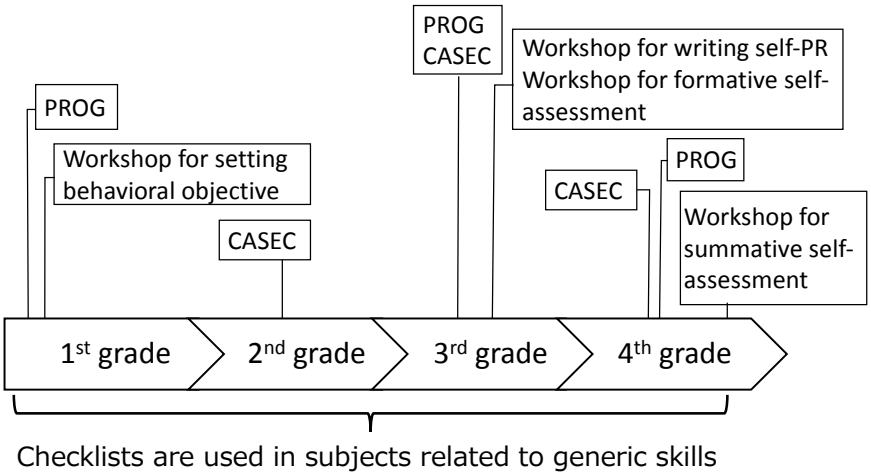


Figure 1. Assessment of Generic Skills in 4-Year-Educational Curriculum.

In many cases, specialized knowledge is taught in a specific subject, and it is thought to be appropriate to carry out an assessment in the subject. On the other hand, generic skills are not acquired in a specific subject alone, and so it is necessary to develop and assess them through the four-year educational curriculum at university. Thus, we decided to assess the generic skills as shown in Figure 1 during the four-year educational curriculum.

In Figure 1, the passage of time goes from left to right. The generic skill diagnostic test PROG and the English communication ability diagnostic test CASEC, which were adopted as objective indexes, were taken at the specified time. At the beginning of the second half of the third year and the end of the fourth year, an initiative called the "Achievement Confirmation Workshop" is conducted to self-assess generic skills overall. The final Achievement Confirmation Workshop for fourth-year students is somewhat of a summative assessment. Meanwhile, the self-assessment of each item is performed in the class related to each item of the generic skills. These assessments are a formative assessment, and also aim to make students aware of their generic skills.

2.2 Requirements for Generic skills Assessment Activities

From the efforts described in the previous section, it is considered that the generic skill assessment activities have the following characteristics:

(**Requirement 1**) It is necessary to carry out multiple assessment activities through the four-year educational curriculum at the university.

(**Requirement 2**) Basically, it is based on the student's self-assessment, but it should be assessed subjectively by using rubrics, etc., in addition to a subjective assessment.

Our department uses objective assessment indexes such as PROG together with the self-assessment, but in general, this is not an essential requirement.

(**Requirement 3)** In the assessment indexes such as rubrics and checklists, there are multiple assessment indexes that compose a parent-child relationship like overall generic skills (parent) and each item (child).

The generic skill rubrics we created and the checklists for each item of the rubrics have a parent-child relationship. In addition, Sumaryati et al. (2019) also developed a rubric made up of a parent-child relationship of (1) generic skills rubric and (2) measurement rubric of each attribute of generic skills, and it is considered to be a general requirement that the assessment index of generic skills has a hierarchy.

(**Requirement 4**) There are two types of assessment activities: one is to assess the generic skills of students as a whole, and the other is to assess specific items that make up the generic skills.

As generic skills are composed of various items, in subjects dealing with individual items, it is thought that there is a general need to assess only these items.

2.3 Necessity of Generic skills Assessment System

The utilization of an existing system is examined to carry out the assessment activities described in the previous section.

First, an LMS test function could be used for the self-assessment using rubrics and checklists. However, as the relevance of each test is not defined for LMS, it is not easy for faculty members and students to understand the assessment results by associating multiple items of generic skills or compare them with the past assessment results. Moreover, as LMS basically conducts management by subject (course), it is not suitable for operation beyond the scope of the subject. It is thought that the aforementioned Requirement 1 and Requirement 3 make it difficult to use LMS for the assessment of generic skills.

On the other hand, the use of an e-portfolio system is also conceivable. In the e-portfolio system, the main activity is to collect the output and compile it together as a portfolio, and then the portfolio is evaluated. Any e-portfolio system with rubric functions can be used to assess generic skills that meet the Requirements 1, 2, and 4 described above. However, we find no e-portfolio system that can manage an assessment index satisfying Requirement 3. Also, as generic skills consist of a relatively large number of assessment items, the burden on the students increases when trying to collect the output for all assessment items. In addition, the operation of assessment activities becomes complicated, and there is a greater burden on faculty members who run these assessment activities. Therefore, the following requirements are also important:

(**Requirement 5**) Assessment activities that do not require collecting output and evidence are needed.

Thus, as for showing evidence of assessment results and collecting related output, it is appropriate to selectively introduce them by considering trade-offs with operating costs.

Given the above, smooth operation will be difficult by utilizing the existing LMS and e-portfolio systems, so an information system specialized for the assessment of generic skills is required.

3. Proposal of Generic skill Assessment System

3.1 Functions of Generic skill Assessment System

Based on the requirements of the generic skill assessment activities described in the previous section, a system for the assessment of generic skills is proposed. It is desirable to limit the basic functions to those that are as simple as possible and yet are possible to perform assessment activities that meet the requirements, and extended functions for carrying out better assessment activities can be used selectively. The basic functions required for the assessment system are as follows:

- A function to manage assessment indexes such as rubrics and checklists. In management, the parent-child relationship of the assessment index can be handled like the overall generic skills versus each item.
- A function to manage the tasks of assessment activities according to the objectives, such as activities to assess the overall generic skills and activities to assess specific items.
- A function that allows students to make a self-assessment for a specified task and a function for students to visually browse their assessment results.
- A function that allows faculty members to visually browse the status of students' self-assessments. Also, a function to download the assessment results as a text file such as a csv file.
- A function that links with LMS and other educational information systems with regards to user ID and authentication.

The following functions can be considered as extensions to be used selectively:

- A function to manage and refer to the results of objective indexes such as PROG, which can be used as a reference in self-assessment.
- A function to present a portfolio that is the evidence of the assessment result linked thereto.
- A function to perform peer assessment and assessment by others such as teachers.
- A function to statistically analyze student assessment results.

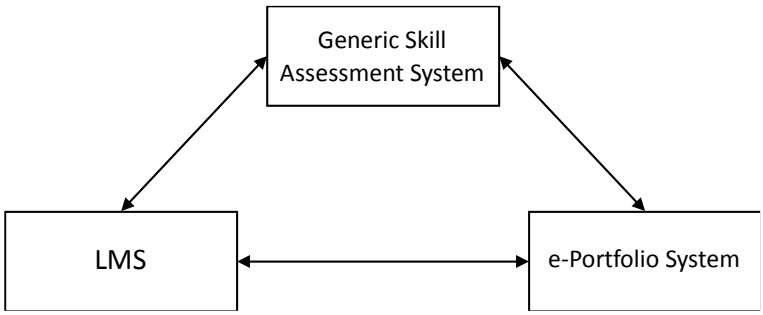


Figure 2. Relationship among LMS, e-Portfolio System and Generic Skill Assessment System.

3.2 Relevance to Existing Educational Systems

Figure 2 shows the relationship of the proposed generic skill assessment system to the LMS and e-portfolio system.

LMS is used on a day-to-day basis in class. As it is considered that assessment activities for specific items of generic skills are often carried out in class, it is desirable that the system has a linkage capability in which the assessment tasks of the generic skill assessment system can be seamlessly transferred from LMS. Given that LMS has been used in many universities in recent years, linkage between a generic skill assessment system and LMS should be implemented.

On the other hand, with the e-portfolio system, the aim is for students to develop by collecting and organizing the outputs for their learning goals and repeating activities to reflect on them, which leads to further learning. When collecting, organizing, and reflecting on output in association with class activities, it is desirable to be able to link with LMS. As it is conceivable to present a snapshot of the portfolio as evidence of the assessment results in the assessment of generic skills, the generic skill assessment system and the e-portfolio system should also be linked. However, compared to LMS, few universities use an e-portfolio system, so the generic skill assessment system and the e-portfolio system will be linked selectively.

Khlaisang and Koraneekij (2019) have made it possible to use an assessment system for improving information literacy, media literacy, and ICT literacy compatible with the Open edX platform or as a stand-alone system. Such linkage is important, and it is desirable to adopt a standardized method for linkage between systems. We, thus, decided to use IMS LTI (Learning Tools Interoperability, https://www.imsglobal.org/activity/learning- tools-interoperability).

4. Development of Basic System

4.1 Development Environment

In this paper, the basic functions of the proposed assessment system are implemented as an initial stage. The following was adopted as the development policy for the implementation:

- To actively comply with technical standards and standard specifications.
- To fully utilize open source software.

As the development framework, PHP's Laravel (https://laravel.com/) was employed. The system was an MVC model web application with a layered pattern of a presentation layer, business logic layer, and data access layer. Intuitive navigation was achieved by expressing information for operation and navigation with icons and pictograms. For this purpose, the front end of the view was designed using Bootstrap4 (https://getbootstrap.jp/), which is a web framework, and Font Awesome (https://fontawesome.com/), which is a web icon font.

4.2 Database Schema Design

For modeling of the rubric, the model and database schema were designed with reference to the rubric data model included in the standard specifications of IMS CASE (Competencies and Academic Standards Exchange, https://www.imsglobal.org/activity/case). The relationship among rubric data models in CASE is shown in Figure 3. It shows that the CFRubricCriterionLevel is a part of the CFRubricCriterion, and the CFRubricCriterion is a part of the CFRubric. Levels and points for each CFRubricCriterion were defined as follows: a rubric of academic standards and competencies is defined in CFRubric, rubric table rows in CFRubricCriterion, and rubric table columns in CFRubricCriterionLevel.

CASE data model names begin with the prefix CF. In consideration of readability in creating the model, different names were used for table names and column names as necessary like CFRubric being changed to Rubric.

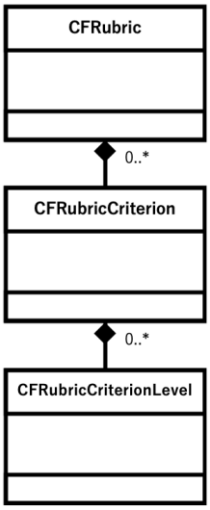


Figure 3. Relationship among Rubric Data Models in CASE.

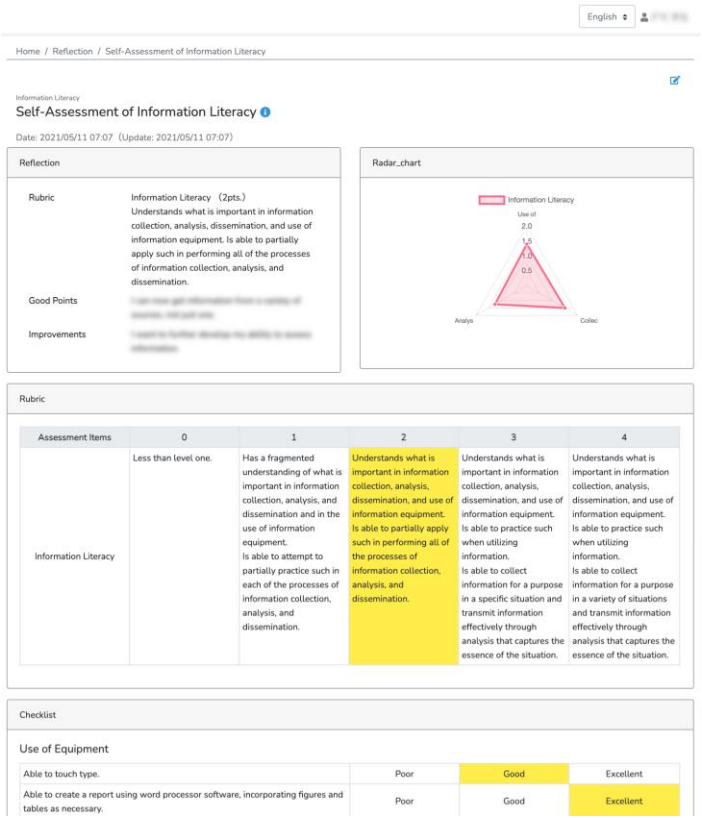


Figure 4. An Example of a Self-assessment Result Screen for Students.

4.3 Implemented Functions

As a basic system, the basic functions described in section 3.1 were implemented. However, with regards to the "function to manage assessment indexes such as rubrics and checklists," the management itself was performed outside the system and imported into the system, but the system can manage the versions of rubrics and checklists and it is possible to handle the parent-child relationship of the assessment index. In addition, given that "assessment activities for the overall generic skills" can be replaced by "assessment activities for specific items," it was not implemented in the 1st version of the system.

Examples of the self-assessment result screen and student self-assessment input screen are shown in Figure 4 and Figure 5, respectively. Also, an example of the faculty's assessment activity summary screen is shown in Figure 6.

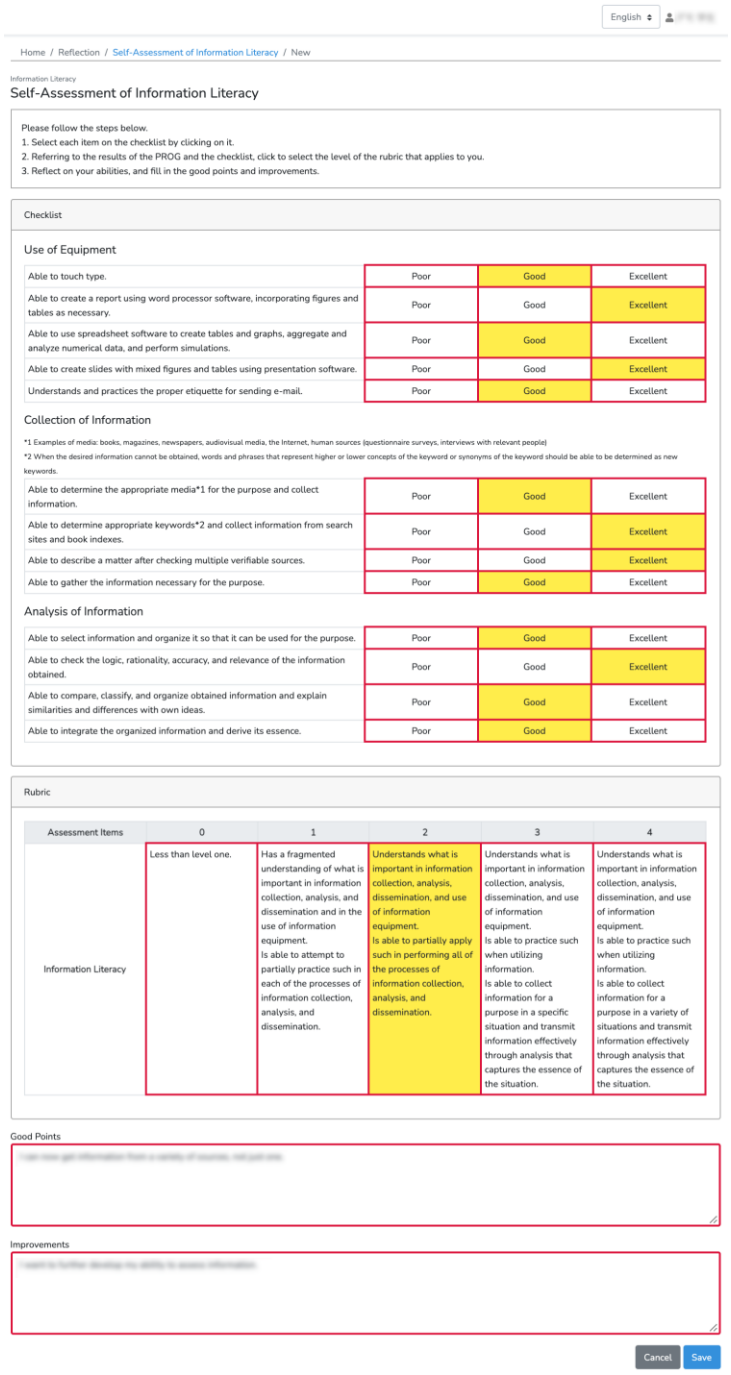


Figure 5. An Example of a Self-assessment Input Screen for Students.

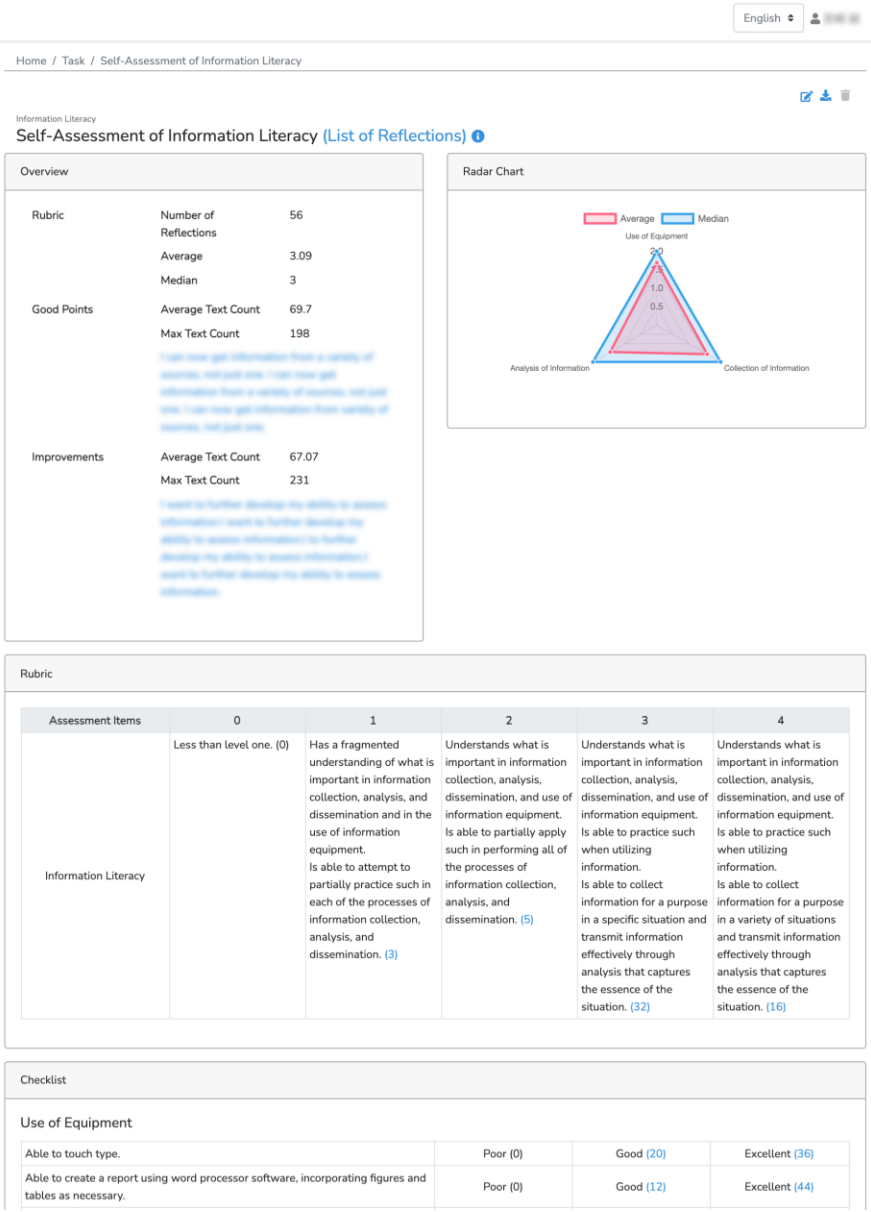


Figure 6. An Example of an Assessment Activity Summary Screen for Faculty.

5. Evaluation of Basic System and Discussions

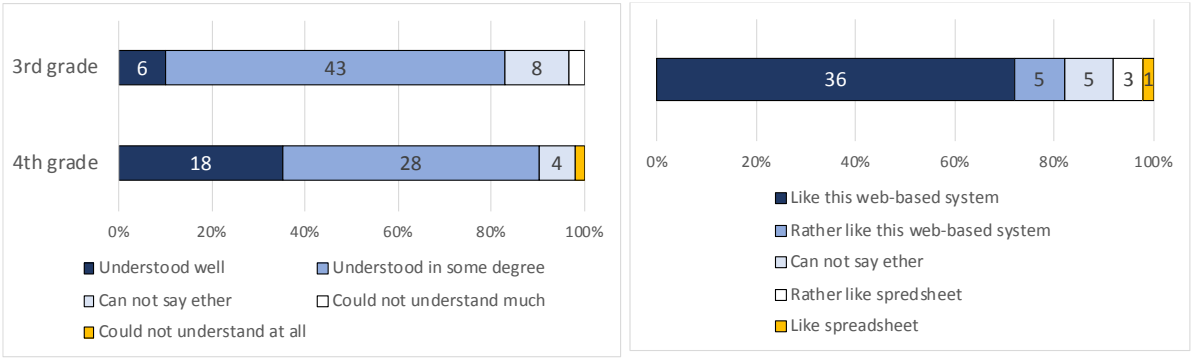
5.1 Overview of Basic System Trial

In order to verify the usefulness of the developed basic system, it was actually used on a trial basis at the Achievement Confirmation Workshop held by the fourth-year students in FY 2020 at the Department of Information and Electronic Engineering, Teikyo University.

At previous Achievement Confirmation Workshops, spreadsheet software was used for student self-assessment activities. More specifically, a worksheet for self-assessment was created as a spreadsheet, and the students downloaded the file, entered the self-assessment, and submitted it to the LMS. At the Achievement Confirmation Workshop for third-year students, the fourth-year students who experienced self-assessment using spreadsheets conducted a self-assessment using this system.

In the LMS Achievement Confirmation Workshop folder, a video explaining the significance and method of the self-assessment and a task of nine self-assessment items that make up the generic skills as an LTI link to this system were uploaded. The fourth-year students were notified that these activities be carried out from January 22 to February 5, 2021. After the completion of these activities,

the students were asked to answer a questionnaire. Of the 59 fourth-year students, 51 completed all self-assessment activities and answered the questionnaire.



(a) Could you understand your generic skills? (b) Which do you like this web-based system or spreadsheet?

Figure 7. Results of Questionnaire.

5.2 Questionnaire Results

Figure 7(a) shows the results of the questionnaire on the status of ascertaining the generic skills through assessment activities. Also shown are the results of a questionnaire similar to those conducted when they were third-year students (n = 59). The number of fourth-year students who answered "Understood well" increased compared to that when they were third-year students, and the total ratio of students who answered "Understood well" or "Understood in some degree" also increased. It is thought that the number of students who could understand well increased as the students matured year by year and deepened their understanding of generic skills. Although the use of this system cannot be said to be a factor in the increase, at the very least it demonstrates that the assessment activities using this system could be carried out without any problems.

Figure 7(b) shows the results of a questionnaire on the comparison between assessment activities using spreadsheets and those using this system. A total of 82% of students supported this system, with 72% of the students saying, "Like this web-based system" and a further 10% saying, "Rather like this web-based system." Many students also gave the following types of feedback supporting this system in the open comments field:

- The web-based system is easier to read and fill in.
- Except for the open comment part, answering was easy because I just had to click.
- I was able to input easily without feeling stress.
- The web-based system is much easier to use than the spreadsheets.
- I tried entering the information on an iPad and it was very easy to do.
- It was good that the information I entered could be confirmed as a diagram once I entered everything, and it was easy to understand my strong points and weak points.

On the other hand, the following comments were also found.

- It was easy to answer, but it was bothersome to have to return to the LMS each time I answered the checklist questions.
- It took extra effort because it was divided up for each item.

These are thought to indicate the need for a function that can handle the task of "assessment activities for the overall generic skills," which was not implemented in the 1st version of the system.

5.3 Discussions

Basic functions were implemented in the generic skill assessment system and the system was used by students in actual assessment activities. The results showed that it was able to be used without any problem for conducting assessment activities. From the results of the questionnaire, more than 80% of the students felt that it is better than the previous assessment activities using the conventional spreadsheet, and also from the open comments section, many students thought that this system is very convenient. On the other hand, one of the faculty members who is also one of the authors and was not

involved in the implementation of the system but set up the assessment task on the LMS and checked the students' response status, stated that the system was easy to use from a faculty member's point of view as well. From these facts, it was made clear that this system is highly useful for both students and faculty members and can be fully used in generic skill assessment activities.

As the questionnaire results indicated the need for a function that can handle the task of "assessment activities for the overall generic skills," the function was implemented after the assessment by way of the trial run of the 1st version of the system.

This system was interoperable with LMS by way of LTI. The LMS of our university is Blackboard Learn, but we confirmed that it works properly with Moodle. It is thought that the system can be linked to any LMS that supports LTI. In addition, if the rubric is written in a CASE-compliant format, it can be imported into this system, and so the system can be used for assessment activities based on other assessment indexes. For example, generic skills can be assessed using rubrics different from those of our department. In addition, assessments other than generic skills are possible as long as they are based on rubrics.

The high interoperability of this system by adopting LTI and CASE enables the system to be used utilized in other institutions or different educational contexts. The skill development of students can depend on the curriculum and the instructional methods used in the courses. Also, methods or indexes of the assessment vary depending on the curriculum. Nevertheless, the system should be used as long as self-assessment activities using rubrics are conducted in the curriculum. We would like to investigate the effectiveness of the system in different educational contexts.

6. Conclusion

In this paper, after clarifying the requirements of a generic skill assessment system, a basic system that meets the said requirements was implemented and was verified of its usefulness by way of a trial run in the field. As a result, it was demonstrated that the system would work effectively in the assessment activities of generic skills at universities.

In future, while adding the extensions that can be used selectively as described in this paper, we would like to use this system over the long term and verify its usefulness in greater detail.

Acknowledgements

This work was supported by KAKENHI 17K12805 & 20K03075.

References

Care, E., Scoular, C. & Griffin, P. (2016). Assessment of Collaborative Problem Solving in Education Environments. *Applied Measurement in Education*, 29(4), 250-264.

Geisinger, K. F. (2016). 21st Century Skills: What Are They and How Do We Assess Them?. *Applied Measurement in Education*, 29(4), 245-249.

Herde, C. H., Wüstenberg, S. & Greiff, S. (2016). Assessment of Complex Problem Solving: What We Know and What We Don't Know. *Applied Measurement in Education*, 29(4), 265-277.

Kawasaki, K., Kubota Y. & Yajima, K. (2020). Proposal of a Generic Skills Improvement System in Which Students, Parents and Teachers Cooperate. *Proceedings of 5th International Conference on Information Technology*, InCIT2020, 7-11.

Khlaisang, J. & Koraneekij, P. (2019). Open Online Assessment Management System Platform and Instrument to Enhance the Information, Media, and ICT Literacy Skills of 21st Century Learners. *International Journal of Emerging Technologies in Learning (iJET)*, 14(7), 111-127.

Kyndt, E., Janssens, I., Coertjens, L., Gijbels, D., Donche V. & Petegem, P. V. (2014). Vocational Education Students' Generic Working Life Competencies: Developing a Self-Assessment Instrument. *Vocations and Learning*, 7, 365-392.

Sumaryati, S., Joyoatmojo, S., Wiryawan S. A. & Suryani, N. (2019). Alternative Assessment Instrument for Measuring Generic Skills of Accounting Education Students. *Proceedings of the 2nd International Conference on Education*, ICE 2019, 27-28.