Open Online Assessment Management System Platform and Instrument to Enhance the Information, Media, and ICT Literacy Skills of 21st Century Learners

https://doi.org/10.3991/ijet.v14i07.9953

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Abstract—Information literacy (IL), media literacy (ML), and information communication and technology literacy (ICT Literacy: ICTL) are some of the most important skills for 21st century learning and which help promote other skills, including life and career skills and learning and innovation skills. This kind of learning allows students to connect as a learning network without barriers or borders. It fully supports the use of equipment and technology to develop the skills necessary for life. The purpose of this research study is two-fold: first, to develop a research-based Open Online Assessment Management System (OOAMS), and second to develop the standardized measurement for an assessment of IL, ML, and ICTL for higher education learners. The sample group consists of 2,300 higher education learners and the methodology was divided into 3 phases: (1) developing the conceptual framework, definition, and features of IL, ML, and ICTL for higher education learners; (2) examining requirements, designing wireframes, and developing an OOAMS for higher education students; and (3) testing the quality of OOAMS for IL, ML, and ICTL using exploratory factor analysis (EFA) and confirmation factor analysis (CFA) statistical methods. The research result found that, first, the specific features of the system included development using PHP and MySQL database and the design to interact with users with a responsive UI framework. The system is compatible with MOOCs and the Open edX platform, or can be used as a stand-alone application. It can create, share, copy, and extend both Likert scales and rubrics evaluation forms. It can also generate reports in both CSV and PDF formats. Secondly, the results of this research provided a standardized measurement for assessing IL (49 items), ML (63 items), and ICTL (69 items). Also, it can be improved or enhanced for online learning in a ubiquitous learning context such as e-learning, blended learning, virtual learning and MOOCs effectively.

Keywords—Assessment Management System, information literacy, media literacy, information communication and technology literacy

1 Introduction

Higher education institutions around the world have set the guidelines for e-learning and MOOCs. Research has investigated the acceptance of e-learning and

MOOCs, as well as the design of e-learning and MOOCs to suit students and the context of each institute [1][2][3][4][5]. A challenge of online instruction has been identified as measurement and evaluation, which is an important component in learning that results in an effective learning process [6]. The change in instruction has made digital literacy increasingly important. Many organization have defined and provided the scope of the term 'digital literacy'. The report on 'Towards a national digital skills framework for Irish higher education' defines 'digital competency' as a combination of concepts, including information literacy, media literacy and information and communication technology (ICT) literacy. This is in line with the definition of digital literacy provided by the Partnership for 21st Century Skills organization in 2007 which has become widely accepted as one of the development frameworks in the 21st century. The organization advocates and encourages education institutes around the world to incorporate these skills into the educational system. In doing so, this will prepare students to acquire knowledge and skills beyond purely academic applications, including learning and innovation skills, information skills, media and technology skills, as well as life and career skills. Learners can apply and adapt their knowledge and skills to the situation creatively while studying, and after graduation, to the world of work effectively and productively for life [3] [7] [8] [9] [10]. In India, digital instruction has been developed to address the diversity of learners in different areas, using mobile technology adapted for remote areas, context enabled curriculum, along with flexible learning schedules. The results of the interviews showed that 90% of the learners who participated became more confident in using computers and the internet [11]. In Australia, instruction for media literacy and social understanding has been provided through Minecraft. Learning evaluation was conducted in media literacy across four nodes: digital materials, media production, conceptual understanding and media analysis [12]. Digital literacy assessment was done by online data collection through Moodle, self-assessment via Google Forms, and SPSS [13]. There are two types of evaluation and data collection to develop digital literacy framework. The first comprises multiple-choice measurement, Likert scale measurement, and short-answer questions. The second comprises the semi-structured interview [14].

In response to the importance of these issues, Massive Open Online Courses (MOOCs) have played an important role in teaching and learning that promotes lifelong learning, such as edX, Coursera, Udacity, Udemy, P2Pu and Khan Academy. In Thailand, Thai MOOCs have been developed using Open edX, the open source MOOC platform founded in 2012 by Harvard and MIT, as the main platform. Then, Open edX was released as code-sharing software for MOOCs. At present, several educational institutes around the world have installed Open edX for MOOC instruction. For example, edX (https://www.edx.org) has 10,000,000 students. As for Thai MOOC, there are currently more than 65,000 registered users with over 100,000 registered uses. However, the Open edX platform is still limited in terms of measurement as students can only be assessed by quiz.

In order to meet the educational needs of digital learners and the direction of international education with its focus on creating innovators, measurement should be improved to cover both traditional assessment and authentic assessment. It should focus on the well-rounded measurement of knowledge, attitudes, and skills. To be in line

with the concept of open learning and open content, there should be public spaces for exchanging, sharing, adjusting, and extending the evaluation form for instructors who teach similar subjects for the utmost benefit of the measurement. Therefore, this research has developed a research-based Open Online Assessment Management System (OOAMS) an Open edX extension system. It can be used, improved, and extended not only for MOOC, but also as a standalone system for other types of online instructions including e-learning, and blended learning effectively. This has produced MOOC instruction that is complete in terms of learning management, content, and measurement. This research also developed a standardized test that was accepted by using advanced research statistics analysis to test online measurement in accordance with the definition and attributes of those skills. This can be measured accurately and reliably. There are three sets of measurements: (1) information literacy (IL), (2) media literacy (ML), and (3) ICT literacy (ICTL). Both results of the research can help drive higher education institutions to raise teaching and learning to their full potential.

1.1 Research questions

- What areas do the conceptual framework, definition, and features of information literacy (IL), media literacy (ML), and ICT literacy (ICTL) for higher education learners cover?
- What are the specific features of Open Online Assessment Management System (OOAMS) and the evaluation criteria of IL, ML, and ICTL for higher education learners in OOAMS?
- What are the results of the quality testing of online assessment of IL, ML, and ICTL? What are the specific features of the measurement of IL, ML, and ICTL?

2 Methodology

The research was divided into 3 phases based on the research questions.

Phase 1: Development of the conceptual framework, definition, and features of IL, ML, and ICTL for higher education learners by studying the ideas, theories, and research relating to IL, ML, and ICTL for higher education learners to develop the conceptual framework, definition, and features of IL, ML, and ICTL for higher education learners. Then, experts checked the content validity, and the content was revised according to their suggestions.

Phase 2: Development of the online assessment system, the OOAMS, of IL, ML, and ICTL for higher education learners. This is an innovation designed and developed based on the research. There are two specific features:

- The specific features of the system
- The specific features of the measurement

This paper focuses on the specific features of the measurement.

Three initial measurements were developed and published. The three sets of measurements were standardized using advanced research statistics analysis as follows:

- IL
- ML
- ICTL

These comprise one of four important skills for 21st century learning. The system publishes the measurements for students in the above-mentioned three areas.

Phase 3: Testing of the quality of the OOAMS by testing the three measurements with a sample group of 2,300 higher education learners through three various means. The first was through an online test via an online assessment system (n=150) to test the quality of each item of the measurement using the item total correlation (IOC) method and selecting items with IOC above .20. The second (n=150) tested the initial quality of each item of the measurement by finding the correlation between the score of an item and the total score of each area of the measurement (IOC) and conducting an initial reliability test with Cronbach's alpha coefficient. The third tested higher education learners (n=1,000). The data was analyzed by exploratory factor analysis (EFA). Then the three measurements were tested again (n=1,000) using confirmation factor analysis (CFA).

3 Results

In the following section, the research findings are aligned with the research questions as follows.

3.1 The result of the development of the research-based assessment system

The result of the development of the research-based assessment system and online rubric that provides testing and evaluation for higher education learners is that it is compatible with the Open edX platform. The system is compatible with the MOOCs Open edX platform or can be used as a stand-alone application.

As mentioned above, the result of this research proves that the OOAMS system has two specific features:

- The specific features of the system
- The specific features of the measurement

The layout of the system was used to develop the system with the following features:

- An evaluation creation system for an Open edX platform which is compatible with the Open edX platform and that can also be used as a stand-alone application;
- The system can create, share, copy or extend an evaluation form with both Likert scales and rubrics, which instructors can apply to other subjects;
- It can be used for traditional assessment and authentic assessment for self-assessment, peer assessment, and instructor assessment;

- It was developed with PHP and MySQL databases and a user interface was designed with the responsive UI framework; and
- It can generate reports in both CSV and PDF formats [3].

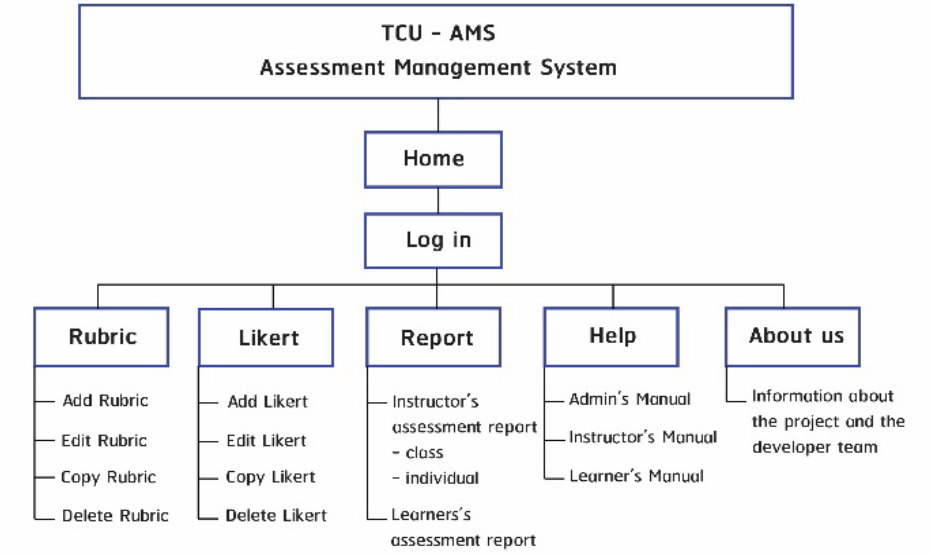

Fig. 1. Layout of OOAMS, referred to as TCU-AMS

Fig. 2. Special features of the system that can create, modify, share, copy, and extend Likert scale and rubric evaluation forms

Fig. 3. TCU-AMS (Likert page)

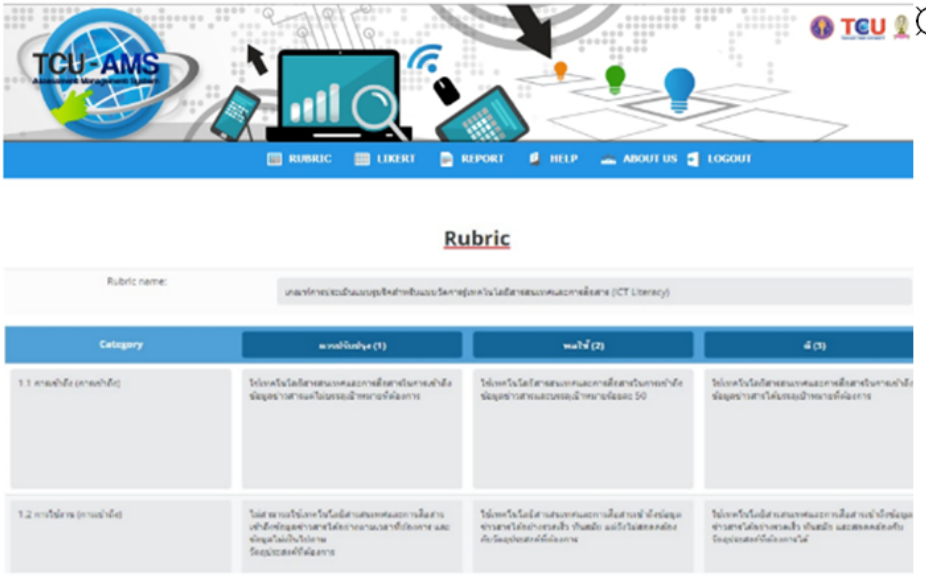

Fig. 4. TCU-AMS (Rubric page)

3.2 The results of the development of an online research-based standardized test on the IL, ML, and ICTL for higher education learners

This paper focuses on the specific features of the measurement. The three sets of measurements have been developed and published. These are standardized by using advance research statistics analysis. The measurements comprise:

- Information literacy
- Media literacy
- ICT literacy which constitute one of four key areas for 21st century learning

The system publishes the measurements that assess students in three dimensions. These were developed from the conceptual framework, definition, and features of information literacy, media literacy and information and communication technology literacy for higher education learners. The consistency and definition of the 21st century skills on information literacy was validated by the experts, with the media tested on 2,300 learners. The definition, scope, features of information literacy, media literacy, and ICT literacy for higher education learners were found to be appropriate. The criteria of behavior level are:

- Means having the behavior/ability as stated in the question at the lowest level
- Means having the behavior/ability as stated in the question at a low level
- Having the behavior/ability as stated in the question at a medium level
- Having the behavior/ability as stated in the question at a high level, and 5 having the behavior/ability as stated in the question at the highest level.

Table 1. Information Literacy : Definition, scope, and measurement

Information Literacy (49 items)	
Definition: Level of knowledge and understanding in using existing information accurately and that matches the needs. [15] [16] [17] **Scope:** Important features: (1) Ability to identify the needs for information (6 items) (2) Ability to access information (3 items) (3) Ability to manage information (9 items) (4) Ability to apply information (6 items) (5) Ability to have ethics in using information (13 items) **Rating Scale:** Score Ability Level Higher than 246 Highest 209-245 High 168-208 Medium 131-167 Low Lower than 130 Lowest	1. You can select the information source by yourself. 2. You can set the searching words for information by yourself. 3. You regularly keep up to date on the information source. 4. You can classify the type of information source. 5. You set the method before searching for information. 6. You set the period for searching for information. 7. You understand the components of the information source. 8. You perform the search according to the goal. 9. You consider the information you receive before using it. 10. You can organize the information you receive. 11. You consider the information you receive before trusting it. 12. You can explain the difference between information sources. 13. You can evaluate the value of each type of information source. 14. You can analyze the good and bad effects of information.

	15. You can organize the information you receive into categories. 16. The information source provides the information that meets your needs. 17. You know which information source is a quality source. 18. You always develop yourself to be up-to-date on information. 19. You understand the information you gain. 20. You know how the information is useful. 21. You can tell what kind of information cannot be searched from which source. 22. You recognize when information is needed. 23. You can create a system and structure to manage information. 24. You can utilize the information. 25. You can apply the information to work. 26. You can summarize ideas from the information. 27. You can use the information to develop yourself. 28. You can create a new information source by yourself. 29. You can ask a question from the information you find. 30. You can set the strategies for accessing information. 31. You understand the process of disseminating information. 32. You can discuss the information you receive. 33. You can write a reference for the information sources. 34. You can integrate information sources to access the information you need. 35. You can decide how to use the information by yourself. 36. You only search for useful information and knowledge. 37. You do not pass on illegal information. 38. You do not use an information source for commercial purposes. 39. You do not use the information obtained for illegal purposes. 40. When you find illegal information, you will notify the authorities. 41. You can recommend the right sources to others. 42. You consider the ethics in accessing information. 43. You respect the privacy of accessing personal information. 44. You are aware of the cultural context before disseminating information. 45. You are aware of the social context before disseminating information. 46. You consider the economic impact of disseminating information. 47. You do not corrupt the file during use. 48. You are careful not to have a computer virus spread. 49. You comply with requirements, laws, and act legally in accessing information.

Table 2. Media Literacy: Definition, scope, and measurement

<table>
<tr><th colspan="2">Media Literacy (63 items)</th></tr>
<tr><td>
Definition:
Ability to access, analyze, evaluate and create the content in a variety of contexts. Aware of the impact of media exposure. Choose to receive useful content and avoid unwanted content that the media offers. [18] [19] [20]
Scope:
Important features:
(1) Assessing the media (15 items)
(2) Analyzing the media (22 items)
(3) Evaluating the media (6 items)
(4) Creating the media (14 items)
(5) Accessing the media from various sources (3 items)
(6) Using the media creatively (3 items)
Rating Scale:
<table>
<tr><th>Score</th><th>Ability Level</th></tr>
<tr><td>Higher than 296</td><td>Highest</td></tr>
<tr><td>255-295</td><td>High</td></tr>
<tr><td>203-254</td><td>Medium</td></tr>
<tr><td>159-202</td><td>Low</td></tr>
<tr><td>Lower than 158</td><td>Lowest</td></tr>
</table>
</td><td>
1. You access to the media by yourself.
2. You receive information of accessing to the media from your family.
3. You receive information of accessing to the media from friends.
4. You receive information of accessing to the media from school/university.
5. You study the characteristics of the media every time before access
6. You can access the media quickly.
7. You can use various media skillfully.
8. The media you choose to access is up-to-date and universal.
9. You access to the media at the right time.
10. You are in the area that is convenient to access to the media.
11. You participate in more than one social media.
12. You understand the meaning of vocabulary from the media.
13. You understand the mechanisms and techniques of the media used in the presentation.
14. You allocate your time to use the media.
15. You understand the motivation of the media producer.
16. You can differentiate the type of media.
17. You can interpret the hidden connotation in the media.
18. You can understand the sequence of the events from the media content.
19. You understand the content of the media.
20. You gain the idea from media exposure.
21. You can distinguish the fictional and fantasy stories in the media.
22. You can comment on the content of the media.
23. You use the pre-existing knowledge to access media.
24. You always compare the information received from the media.
25. You can analyze what is a passive advertisement in the media.
26. You know what the producer wants to communicate with the audience.
27. You can analyze whether the media is appropriate for the audience.
28. You can analyze whether the media is presented on the basis of democracy.
29. You can analyze the social values reflected in the media.
30. You can analyze the component of the media.
31. You can ask a question from the media.
32. You can analyze who or what the media fails to present.
</td></tr>
</table>

	33. You think the internet media is easy to access. 34. You think that language skills are needed to access the media. 35. You think the skills in using the media are important to access the media. 36. You can understand the meaning of the content effectively. 37. You think age is an important factor in accessing the media. 38. You think education level is an important factor in accessing the media. 39. You consider the content of the media before deciding to act. 40. You think reading and interpretation skills are necessary for media consumption. 41. You select the media to match your needs. 42. You can use the media for yourself. 43. You can use the media for others. 44. You use the correct written language to present information. 45. You use the knowledge from the media to develop yourself. 46. You use an audio to create the content of the message. 47. You offer an opportunity for others to participate in creating the media. 48. You consider the ethics in using the media. 49. You can build relationships with others through the media. 50. You can organize the information gained from the media. 51. You motivate yourself from the media. 52. You use the media to convey your knowledge. 53. You protect yourself from internet privacy violations. 54. You help the society through media channels. 55. You use social media to communicate and transfer knowledge among friends. 56. You use communication technology to structure the content. 57. You can create your own media. 58. You create the media that interacts with others. 59. You can create the media that promotes learning. 60. You have changed your behavior from the media. 61. You can use the media in creative ways. 62. You can associate the content of the message with a personal experience. 63. You can tell the limitations of each media.

Table 3. ICT Literacy: Definition, scope, and measurement

<table>
<tr><th colspan="2">ICT Literacy (69 items)</th></tr>
<tr><td>Definition:
Ability to use digital technology, communication tools, and/or networks to access, manage, integrate, evaluate, and create information for learning society. [21] [22] [23] [24]
Scope:
Important features:
(1) Accessing ICT
(5 items)
(2) Communicating ICT (7 items)
(3) Managing ICT
(6 items)
(4) Integrating ICT
(6 items)
(5) Evaluating ICT
(23 items)
(6) Creating ICT
(22 items)
Rating Scale:
<table>
<tr><th>Score</th><th>Ability Level</th></tr>
<tr><td>Higher than 323</td><td>Highest</td></tr>
<tr><td>278-322</td><td>High</td></tr>
<tr><td>226-277</td><td>Medium</td></tr>
<tr><td>177-225</td><td>Low</td></tr>
<tr><td>Lower than 176</td><td>Lowest</td></tr>
</table>
</td><td>1. You can find information from an ICT source.
2. You can collect information from an ICT source.
3. You can retrieve information from an ICT source.
4. You can use a variety of ICT tools.
5. The ICT that you use is quick for accessing information.
6. You understand the system of each type of ICT.
7. You understand the language and symbols used in ICT.
8. You can describe the use of ICT to others.
9. You know the laws and regulations concerning the use of ICT.
10. You use ICT in electronic transactions.
11. You can create an ICT manual.
12. You use ICT to solve problems in learning/working.
13. You think that ICT results in integrating various media types.
14. You can use ICT to compare information.
15. You can use ICT to present arguments of information.
16. You can use ICT for research purposes.
17. You can use ICT to evaluate information.
18. You can use ICT for corporate management.
19. You can use ICT to synchronize information systems.
20. You can use the e-learning system to learn about ICT.
21. You think ICT is necessary in today's society.
22. You think that ICT enables broader access to information.
23. You think that ICT enables more rapid dissemination of information.
24. You think that ICT contributes to participation in information and information content.
25. You can identify the benefits of ICT.
26. You think that ICT can reduce travel costs.
27. You think ICT is a key factor in economic growth.
28. You consider ICT in making decisions before doing activities.
29. You use ICT to analyze the relationships of information.
30. You can use digital and communication technology to connect useful information.
31. ICT improves your thinking skills.
32. You think that ICT is an important factor in economic development.
33. You think that ICT is an important factor in the educational development of the country.
34. ICT enables communication without borders.
35. ICT creates learning outside the classroom.
36. ICT reduces the costs and time to travel.
37. You can distinguish the virtual world and the real world while using ICT.
38. You understand the results from what you have learned from and your use of ICT.</td></tr>
</table>

ICT Literacy (69 items)	
	39. You analyze and evaluate the impact of using ICT. 40. You think that ICT improves the efficiency of ICT development. 41. You can adjust the ICT format. 42. You can design ICT by yourself. 43. You can use ICT to respond to cultural differences. 44. You can invent ICT by yourself. 45. You can use ICT to express your position. 46. You can develop an ICT system or program. 47. You can use ICT to develop yourself. 48. You can use ICT to develop your organization. 49. You can develop ICT to meet the needs of users. 50. You may use ICT in accordance with the specific features of the media. 51. You can use ICT to respond to individual differences. 52. You can use ICT to create interesting information. 53. You use ICT to present information that is different from others. 54. You can use ICT to present propaganda information. 55. You can use ICT to link your devices for increased efficiency. 56. You use ICT to apply to your work. 57. You can use ICT for designing. 58. You can use ICT to develop software packages. 57. You have the ability to apply ICT in a specific way. 60. You can use ICT to build community learning resources and information. 61. You can use ICT to present information to others. 62. You can use ICT to express your own opinions. 63. You understand how to use ICT to produce media that meet your goals. 64. You can use ICT to create social networking. 65. You can use ICT to present easy-to-understand information. 66. You understand the rules and ethics of communication through information technology. 67. You are aware of the impact on individuals and society when using information technology to communicate. 68. You provide opportunities for others to exchange information on ICT. 69. ICT allows you to do multiple activities at the same time, such as a smartphone or a tablet, which can be used to call, take a photo, send an email and record work schedules.

The measurement method of the three tests comprises the following:

- Determining the date and time to measure information literacy, media literacy, and information and communication technology literacy for higher education learners,
- Preparing the measurement via an online system,
- Learners must study the test guidelines and test method to take the test correct ly,
- Taking an online test, and
- Collecting and interpreting the score.

4 Discussion

It can be seen that at present several organizations in many countries have focused on information literacy, media literacy and ICT literacy, and have developed a learning framework to develop these skills [11] [12] [14]. However, there is still a lack of a standardized test, especially for an online assessment system, which is compatible with Moodle LMS and Open edX platform used in MOOCs. Previous studies have designed assessment systems in Moodle platforms [13]. However, the assessment criteria are not compatible for both platforms. This study realized the importance of designing the measurement for current use in various online learning systems. The developed system can be used as an add-on to Open EDX and stand-alone applications.

The results of this research support the idea that an online assessment system is an important component of online teaching and learning. It can evaluate and return immediate results. Thus, it reduces the burden on the instructor. The system can create a variety of question types. It is a great challenge to create an assessment tool other than the traditional multiple-choice questions and one that can score automatically [3] [25] [26]. This is in accordance with [27] who studied online self-assessment system, which helped learners to learn better compared to offline assessment, which requires substantial time to prepare a test and analyze the results. The online test system plays an important role in helping learners get automatic scores and recommendations. In addition, the system supports the different levels of learning among the learners. The development of current technology helps to create a learning system and test that is suitable for each student. The results of the test can be evaluated and results compared immediately [28].

In addition, relevant research developed a test system for online learning that is consistent with this research. For example, the study of the development of an online assessment system by using an interactive test found that the test can evaluate a learner's real ability. The system has a special feature that enables the user to edit the test, test the system, automatically grade the score, share a template and test. This allows instructors to develop and use the test according to their needs and context [29]. One study looked at a web-based adaptive testing system to classify the learning ability of students.

The system consists of:

- An administrator mode for organizing test items, student information and instructor information,
- An instructor mode for student management and analyzing test trends
- A student mode for an online test and reporting the results [30].

As regards the consistency and benefits of the system development and standardized test, research has focused on the measurement of knowledge and skills in digital literacy. Self-assessment enables learners to become aware of their efficacy in a concrete and specific context [31]. The rubric-based model emphasizes the assessment of real conditions. The results show that the rubrics are a useful assessment and can identify potential learners to promote self-efficacy and self-development. This is because the criteria are clearly described and this helps to understand the behavior and ability in each dimension [32].

5 Conclusion

This research was developed in accordance with the 21st century educational framework of information literacy (IL), media literacy (ML) and ICT literacy (ICTL) in the online learning context. This is an important foundation for learning management at the present. The results of this research are divided into two main areas:

- The development of a research-based Open Online Assessment Management System (OOAMS). It can provide a test and evaluation for higher education learners. It is compatible with Open edX platform, which is a popular open source MOOC platform for higher education institutions around the world. Since it is an open source system, users can add or modify the source code according to the needs of each organization. It can also be used as a stand-alone system for other forms of online instruction
- The development of a research-based online-standardized test on IL, ML, and ICTL for higher education learners.

This is very useful in learning management in higher education. The suggestion for future research is to study the development of this assessment system by enhancing the effectiveness in processing and displaying learning results in a concrete and dynamic way to create a challenging learning process.

6 Acknowledgement

This paper was based on the research study titled “Development of Online Testing and Rubric Scoring System for Information, Media, and ICT Literacies for Higher Education Learners” which was conducted by the authors of this paper during 2016-2017. The research was first published at the 10th International Conference on Education and New Learning Technologies (2018). This research paper has added and fo-

cused on the results of the final stage to provide a more useful and concrete insight for further usage. The authors would like to express our sincere appreciation to the Thailand Cyber University Project, the Office of Higher Education Commission, Ministry of Education in supporting this research study. Our appreciation also extends to Educational Invention and Innovation research unit, the experts and subjects involved in the study for their advice and support. The authors hope that the findings in this research can be expanded to and widely used in ICT utilization in HEIs.

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Article submitted 2018-12-02. Resubmitted 2019-01-15. Final acceptance 2019-01-16. Final version published as submitted by the authors.