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A case study in eastern Indonesia for the development of integrated real-time performance assessment on science practicum in universities

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ABSTRACT

The purpose of this study was to collect preliminary data for the design of real-time and integrated performance assessments in science practicum at two public universities and two private universities in Eastern Indonesia. The case study design and quantitative and qualitative approaches were adopted in this study. Cluster random sampling technique was used to select four universities, 376 participants respectively from university students and lecturers, four vice deans, four heads of study programs, four heads of laboratories, and four teaching assistants. Data were gathered through questionnaires, in-depth interviews, and observations. The chi-square test was used to analyze the data descriptively. Findings indicated that a performance assessment was not carried out since standard measurement instruments that provided real-time and integrated feedback had not been developed. There was no significant difference ($p > 0.05$) between public and private universities on the science practicum assessment, implying that both public and private universities still used paper-based practicum assessments. There was also no significant difference between the responses of university students and lecturers on practicum performance assessments ($p > 0.05$). University students' experience in assessing science practicums was similar to those of lecturers', which suggests that practicum of performance assessments was not real-time and integrated with feedback. This study recommends developing a real-time and integrated performance assessment with automated feedback on the science practicum, in order to provide continuous improvement of students and monitoring their learning progress.

Contribution/Originality: This study contributes to developing the integration of real-time feedback into an Android-based application for performance assessment in science practicum. It identified students' needs for automated feedback on science learning in monitoring their self-improvement on an ongoing basis.

1. INTRODUCTION

Performance assessment is a systematic, formal, and evaluative description of the quality of work, with criteria for the strengths and weaknesses of individual and group students (Mohan, Bergner, & Halpin, 2020; Muniasamy, Ejlani, & Anadhavalli, 2019). The purpose of performance assessment is to measure student learning needs, guide and control student work behavior, set and measure goals (Crook, 2022), set or determine rewards (Liu, Liu, Lai, &

Li, 2021; Suggate & Lenhard, 2022), predict student progress in education, and provide feedback to students directly and periodically to improve their understanding.

This performance assessment is in line with the Indonesian Minister of Education and Culture Regulation Number 23 of 2016 concerning standards and principles for evaluating learning processes and outcomes, namely educative principles, authentic principles, objective principles, accountable principles, and transparent principles.

Assessment of performance is an assessment process that relies on student activity. Operationally, performance assessment is defined as a process of collecting data through systematic observation using various methods as a basis for making decisions regarding the abilities of individual students through a continuous process, one of which is digital or online learning assessment (Ramdani, Purwoko, & Yustiqvar, 2021).

Online assessment has been implemented through summative assessment, formative assessment, and instructional design methods in various disciplines such as engineering, biology, medicine, and the social sciences (Chemsi, Sadiq, Radid, & Talbi, 2020; Hussain & Jaeger, 2018). Recent studies highlight the benefits of online assessment and students' positive attitudes toward it (Aljawarneh, 2020). These benefits include increasing student motivation, increasing understanding and active learning, and preventing cheating in taking tests (Peter-Cookey & Janyam, 2019). Prevent student plagiarism by randomizing questions and responses, providing time limits, and providing password-protected logins for multiple assessment attempts with an automatic evaluation process (Poce, Amenduni, Re, & De Medio, 2019; Schweighofer, Taraghi, & Ebner, 2019).

The integration of technology in education has led to the recognition of technology-based assessment, specifically formative assessment, as a valuable tool for enhancing the daily educational experience. It serves as a crucial resource for students, providing them with information and feedback to effectively track their academic progress. The acquisition of regular and immediate feedback from test results in formative assessments (Asamoah, Shahrill, & Latif, 2022; Chemsi et al., 2020; Olivera-Aguilar et al., 2022; Popovic, Popovic, Rovcanin Dragovic, & Cmiljanic, 2018; Saqr, Fors, & Tedre, 2017) is considered to be a highly effective strategy for facilitating learning (Araya & Collanqui, 2021; Hattie & Timperley, 2007). While formative assessment is widely recognized as a crucial means of gathering information to enhance teaching and learning in educational research, its effectiveness is hindered by the considerable time investment it requires. This poses a challenge for classroom teachers who are often burdened with heavy workloads, making it difficult for them to dedicate sufficient time to designing and implementing effective formative assessments (Gamage, Ayres, Behrend, & Smith, 2019; Mohiudddin, Rasool, Mohd, & Mohammad, 2019; Sadler, 1989; Valero & Cárdenas, 2017). Therefore, the utilization of automated or real-time assessment is frequently regarded as a solution that balances the requirement for prompt response with the potential burden on teachers' workload.

Automated assessment offers novel opportunities for technology-driven evaluation, such as the ability to promptly evaluate replies in real-time, mitigate the occurrence of errors and biases that may be introduced by human assessors, and optimize the allocation of lecturers' time, financial resources, and exertion (Csapó & Molnár, 2019; Gamage et al., 2019; Olivera-Aguilar et al., 2022; Willmot & Pond, 2012). According to Olivera-Aguilar et al. (2022), the process of automated assessment occurs when a student's response to a created response item is evaluated and assigned a score based on a specified scale (Burgmanis, Namsone, & France, 2023; Gamage et al., 2019; Liu et al., 2014; Olivera-Aguilar et al., 2022). This scale can be established either dichotomously or with several scoring levels. Once a score has been assigned to an answer, the student promptly receives feedback based on the scoring category framework or rubric. Automated text scoring is mostly employed for the purpose of evaluating the substance of a given response (Liu et al., 2014; Olivera-Aguilar et al., 2022) or the caliber of writing (Bridgeman, Trapani, & Attali, 2012).

The Android application platform offers a range of digital technologies that can be utilized for automation in the field of education. These technologies, such as automatic assessment, data processing, and learning analytics, have been implemented in scientific education with the aim of enhancing the overall effectiveness of teaching and learning (Huang, Cheng, & Yang, 2019). Android applications play a crucial role in facilitating the advancement of scientific endeavors by providing a vital technology component. The widespread application of autonomous, adaptive, and efficient Android technology has been observed in numerous academic subjects, owing to the advancements in computer science and computing technology. The interdisciplinary field of education places significant emphasis on the practical application of instructional processes to support teachers, enhance student learning, and drive educational system transformation (Luo, Han, Chen, & Nie, 2022). This approach has the potential to enhance instructional design and pedagogical development by incorporating automated methods for assessing student performance (Schweighofer et al., 2019), monitoring and tracking student learning (Luo et al., 2022), and predicting challenges faced by students in science education (Gamage et al., 2019; Peffer & Ramezani, 2019).

The duties of the lecturer, besides conducting learning, research, and community service, are mandatory activities that must be carried out, so it requires a fast turnaround time to assess learning outcomes. When evaluating the teaching methods used by each lecturer, the head of the study program also needs information on the evaluation of the learning assessment process. Based on the observations, the grades received from lecturers are often late, which has an impact on student satisfaction with academic services.

Based on the above formulation, a learning assessment that is real-time and integrated with one platform allows for continuous learning monitoring and learning feedback between lecturers and university students. To answer this hypothesis, it is necessary to conduct a study by issuing online questionnaires, conducting in-depth interviews, and observing laboratory activities at four universities with the following research questions:

1. What is the current state of science practicum assessment at the four universities?
2. Has the performance assessment of the science practicum been carried out in real-time?
3. Is there a statistically significant difference in the assessment of real-time science practicum based on the responses of respondents (students and lecturers) and types of universities (public and private)?
4. Has the implementation of the performance assessment for the science practicum been carried out in an integrated manner?
5. Is there a statistically significant difference in the integrated science practicum assessment based on the responses of respondents (students and lecturers), university type (public and private), and the experience of science practicums that have been done?

2. LITERATURE REVIEW

2.1. Performance Assessment

Performance assessment is a method of assessing student behavior that involves the process of gathering data through systematic observation to make decisions about an individual (Chafiq, Talbi, & Ghazouani, 2018). It is a long-term process that incorporates various instruments and techniques, as well as systematic direct observation (Popovic et al., 2018; Shdiafat & Obeidallah, 2019). Performance assessment has at least three features: multiple criteria (Chafiq et al., 2018), set quality standards, and subjective (opinion-based) assessment (Saqr et al., 2017). It is a lengthy and time-consuming process, involving progress charts, work sample exams, and portfolios (Chafiq et al., 2018). Performance-based education systems require various types of evidence, such as observation, testimony, authentic work papers, oral inquiries, written assessments, project work, case studies, and field assignments (Popovic et al., 2018). Conducting a performance review involves defining the purpose of the evaluation, determining the concepts, knowledge, and abilities to be evaluated, determining the level of achievement to strive for, and choosing the type of activity (Dimos, Velaora, Louvaris, Kakarountas, & Antonarakou, 2023).

A fundamental definition of performance assessment can be obtained: it is the process of obtaining various activity-based information from a person as an object of evaluation using various methodologies and instruments to determine a person's condition (Saqr et al., 2017). A performance review is a lengthy and time-consuming process.

Performance assessment instruments include progress charts (Chafiq et al., 2018), work sample exams (Popovic et al., 2018; Shdiafat & Obeidallah, 2019), and portfolios (Popovic et al., 2018). Typically, progress reports are graphs that show daily activities, achievement scores, and student names. This graphical progress record cannot be used to directly assess students' abilities. This recording is highly useful for instructors in assessing the learning process that has taken place (Saeki, Segool, Pendergast, & von der Embse, 2018).

A work sample test is a testing environment in which the subject being examined does one or more real job-related tasks. A portfolio is a collection of student work from a given time. This portfolio is extremely helpful for teachers in tracking the development of students' talents regularly (Olivera-Aguilar et al., 2022). Proficiency-based education systems require several types of evidence (sources of evidence) indicating that a student met specified proficiency levels during a given period. According to Saqr et al. (2017), evidence in competency-based education can include observation, testimony (witness testimony), authentic work papers or outcomes, oral inquiries, written assessments, project work, case studies, and field assignments.

2.2. Digital Technology and Assessment

The utilization of digital technology according to Saleh and Salama (2018), it can improve adaptive learning, recommend student-centered learning resources, and diagnose learning gaps. It can also reform education by extending the role of technology, enriching knowledge delivery media, and changing the instructor-student connection (Koneru, 2017; Muthmainnah, Ibna Seraj, & Oteir, 2022; Tai, Ajjawi, Boud, Dawson, & Panadero, 2018). However, according to Valero and Cárdenas (2017), obtaining a high-quality scientific education requires careful consideration of complex social, pedagogical, and environmental factors. Selecting and utilizing digital technologies in science education to adapt to numerous components is a major challenge. This review of digital technology in science education covers higher education, e-learning, mathematics education, language education, medical education, programming education, and special education (Gunning et al., 2022; Hsiung, 2018; Karki & Lamichhane, 2020).

Digital technology has been utilized in various aspects of higher education, including tutoring approaches, mathematics instruction, and science education. It is employed in feedback-based programming teaching, intelligent guidance systems, profiling and prediction systems, and adaptive and personalization systems (Koneru, 2017; Muthmainnah et al, 2022; Tai et al., 2018). However, according to Gunning et al. (2022), there is a lack of literature reviews on the use of digital technology in science education. Digital technology can be used to automate student performance evaluations and generate questions or assignments for lecturers. These automated assessments can assist instructors and students in comfortably learning science. Automated scoring methods, argument grading systems, and question generation can reduce the instructional burden on lecturers in science learning (Araya & Collanqui, 2021; Koneru, 2017; Muniasamy et al., 2019; Ramírez-Noriega, Juárez-Ramírez, Jiménez, Inzunza, & Martínez-Ramírez, 2018; Schweighofer et al., 2019).

The application of digital technology in science education to improve the design, process, and assessment of instructional and science learning. The application of technology in science education focuses on creating and implementing programs like Android to aid in science education. The benefits of digital technology include automated assessment and learning analysis, which have been used to improve the quality of science education teaching and learning (Koneru, 2017; Valero & Cárdenas, 2017). Technological progress can be leveraged for educational assessment by augmenting human capabilities by storing, processing, and mining large amounts of data from various sources. The increasing use of digital technology allows for the collection of new forms of data, revealing new insights into student learning. Sridharan and Boud (2019) propose the refraction of assessment methodologies, ranging from determining test question correctness to documenting a constellation of learning transactions using digital technology to infer student cognition and learning.

Digital performance assessment implementation, according to Dhina et al. (2021), can optimize student performance, which is marked by increasing the average percentage value of student performance in each learning cycle. The application of performance assessment instruments in practicum activities in the laboratory can improve laboratory skills in the aspects of taking and identifying tools and materials according to experimental needs, demonstrating experiments starting from operating, and using tools and materials to observe the results of observations and draw conclusions. According to Dhina et al. (2021) and Aljawarneh (2020), the application of digital Instrument Performance Assessment to laboratory-based science learning affects cognitive ability. There is a significant effect of performance assessment on student cognitive learning outcomes. This is because the application of performance assessment through the experimental method provides opportunities for students to experience the science process through direct observation of the object being studied (Peffer & Ramezani, 2019).

2.3. Real-time Assessment and Feedback

Online tests offer real-time feedback that can be automated and timely, enhancing students' understanding and communication. This feedback, according to Saleh et al. (2022), can help students who struggle with course material or are shy or unwilling to contact teachers directly. Online feedback also increases group understanding and makes learning more dynamic and engaging. The quality and detail of feedback also affect students' learning, and when provided, students' learning is improved and reinforced (Chen, Wang, & Wang, 2022; Nang & Harfield, 2018; Tai et al., 2018).

Automatic and regular feedback is a form of formative assessment that is carried out during the learning process because learning assessment during the ongoing process is the core of learning and is most important in supporting learning achievement (Gunning et al., 2022). One of the obstacles to assessing formative learning is that it takes longer to design and carry out learning assessments compared to summative assessments (Saleh, Abuaddous, Alansari, & Enaizan, 2022; Willey & Gardner, 2009). With real-time performance appraisal and feedback that is integrated into one application and can be accessed by all interested parties, it will change from a learning assessment to a learning assessment that is focused on a process of continuous constructive improvement (Gunning et al., 2022; Hayashi, 2020; Koneru, 2017) and develop student capacity to monitor self-improvement on an ongoing basis and students can reflect on their learning (Willey & Gardner, 2009). Performance assessment with real-time and integrated feedback is an innovation and transformation in learning assessment or technology-based innovation. Learning assessment through performance assessment is one of the solutions for improving process assessment (Asamoah et al., 2022), feedback is a source of information for continuous improvement in developing students themselves (Sridharan & Boud, 2019) and monitoring their learning progress (Conforme, Romero, Romero, & Laz, 2019). The use of technology-based practicum assessments will facilitate the process of sending feedback, according to Koneru (2017) once the results of the assessment are sent to the server, they will immediately be sent back in the form of results or grades with feedback containing notes of improvement or appreciation of the results of student practicum, so that students know practicum material that must be improved or corrected in the next practicum process, thus students can self-improvement before the final evaluation, this is according to Tai et al. (2018) is a form of transparency, accountability or objectivity in assessing performance. Assessment that is integrated with feedback in one system that is accessed by lecturers, students, teaching assistants, and heads of study programs will facilitate the learning process so that it is profitable in terms of assessment effectiveness, time, effort, and cost efficiency.

3. METHODS

3.1. Research Design

The methodology used for this study is a case study method with quantitative and qualitative approaches using the cluster random sample technique.

3.2. Population and Sample

The population of this study included all public and private universities in West Nusa Tenggara Province. The sample was randomly selected by cluster random sampling and obtained from four universities, consisting of two public universities (Mataram University, and Mataram State Islamic University) and two private universities (Universitas Pendidikan Mandalika and Universitas Qamarul Huda Badaruddin Bagu). The sample size was 376 people, made up of 261 university students and 115 lecturers; 101 male, and 275 females, the majority of whom were in the age range of 19 to 25 years (Table 1). To corroborate the data findings and complete the data based on the online survey, in-depth interviews were performed with four academic vice deans, four study program leaders, four laboratory heads, and four assistant lecturers.

3.3. Data Collection

Data was collected by using an online questionnaire survey through a Google form, in-depth interviews, and direct practicum observation from June 26 to July 26, 2023.

3.4. Demographic Characteristics of Respondents

Based on Table 1, the number of respondents of university students was higher (69.4%) than that of lecturers (30.6%). Both students and lecturers were from the Science streams, and most students had attended a previous science practicum.. There were more females (73.1%) than males (26.9%). The largest number of respondents came from the University of Mataram (UNRAM), namely 31.4%, which suggests that UNRAM had the largest number of students compared to other universities in West Nusa Tenggara, especially in the science education cluster study program. Besides that, UNRAM is also one of the favorite universities in Eastern Indonesia.

Table 1. Demographic profiles about respondents (N = 376).

Demographic data	N	%	Mean	SD
Respondents			1.69	0.461
University students	261	69.4		
Lecturers	115	30.6		
Gender			1.73	0.444
Male	101	26.9		
Female	275	73.1		
Age range			26.03	8.350
19-25 years	261	69.4		
26-35 years	41	10.9		
36-45 years	68	18.1		
46-55 years	6	1.6		
University			2.41	1.190
Mataram University	118	31.4		
Mataram State Islamic University	87	23.1		
Mandalika University of Education	69	18.4		
Qamarul Huda Badaruddin Bagu University	102	27.1		
In-depth interview informants				
Vice dean of academic	4	25.0		
Head of the study program	4	25.0		
Head of laboratory	4	25.0		
Assistant lecturer	4	25.0		

3.5. Research Instruments

The instrument comprised three parts: the first part dealt with respondents' profiles, university students, lecturers, gender, age, and university cluster (public and private).

The second part dealt with information that supported online and real-time science practicum assessment, which consisted of 11 question items; the third part was about information that supported integrated science practicum assessment, comprising 18 question items. The instrument used a Likert scale and some questions with yes-or-no answer choices.

3.6. Validity and Reliability Instruments

The research instrument was tested on 102 university students and lecturers at the University of Qamarul Huda Badaruddin Bagu. Based on the results of the item validity analysis using the Pearson correlation $p < 0.05$, it was found that 3 items were invalid, so they were deleted.

The rest of the items with validity above 0.8 were included in the high validity category, meaning all question items were suitable for use as instruments in research. This was reinforced by the results of the reliability analysis using Cronbach's Alpha on all items. The average value of the alpha test scale was above 0.9, which suggested that the value met very good internal consistency and reliability; therefore, it was very feasible to be used as a research instrument.

3.7. Data Analysis

The chi-square statistical analysis technique was used for this study because it included unpaired categorical comparative data with the condition that the type of table was 2x2 and the number of cells in the expected value was less than 5, a maximum of 20% of the number of existing cells.

4. RESULTS

The first question is: What is the current state of science practicum assessment at the four universities?

Based on observations of science practicum activities and in-depth interviews with managers, vice deans for academics, heads of study programs, and heads of laboratories at four universities, it was found that the ways practicums were graded at the four universities, both public and private, were mostly the same, as shown in Figure 1.

Based on the information in Figure 1, the lecturer team created practicum guidelines based on the topic, the completed guidebook was given to the laboratory leader for duplicating to be distributed to the students. The laboratory head and lecturer team cooperated to design a practicum timetable and socialize it with the students. The practicum was carried out in accordance with a predefined timeline, and students were obliged to follow all regulations governing practicum activities. Participants in the practicum were active students who were registered in the academic information system.

Prior to the start of the practicum, lecturers and teaching assistants recommended the materials and equipment to be used. Once the laboratory's head approved the usage of these instruments and materials, they were assigned a laborer who will be in charge of preparing the equipment. Teaching assistants facilitated practicum sessions after all relevant instruments and materials were accessible.

The practicum assessment was carried out by lecturer assistants through the evaluation of the first response (pre-test), final response (post-test), and final report, which was sent after a week of practicum completion. The laboratory head formally approved the assessment results before sending them to the lecturers. According to the observations, the assessment process was still done manually, and no standard instruments for performance assessment were available.

This finding is consistent with the findings of in-depth interviews with the laboratory director, teaching assistants, and deputy academic deans from four universities.

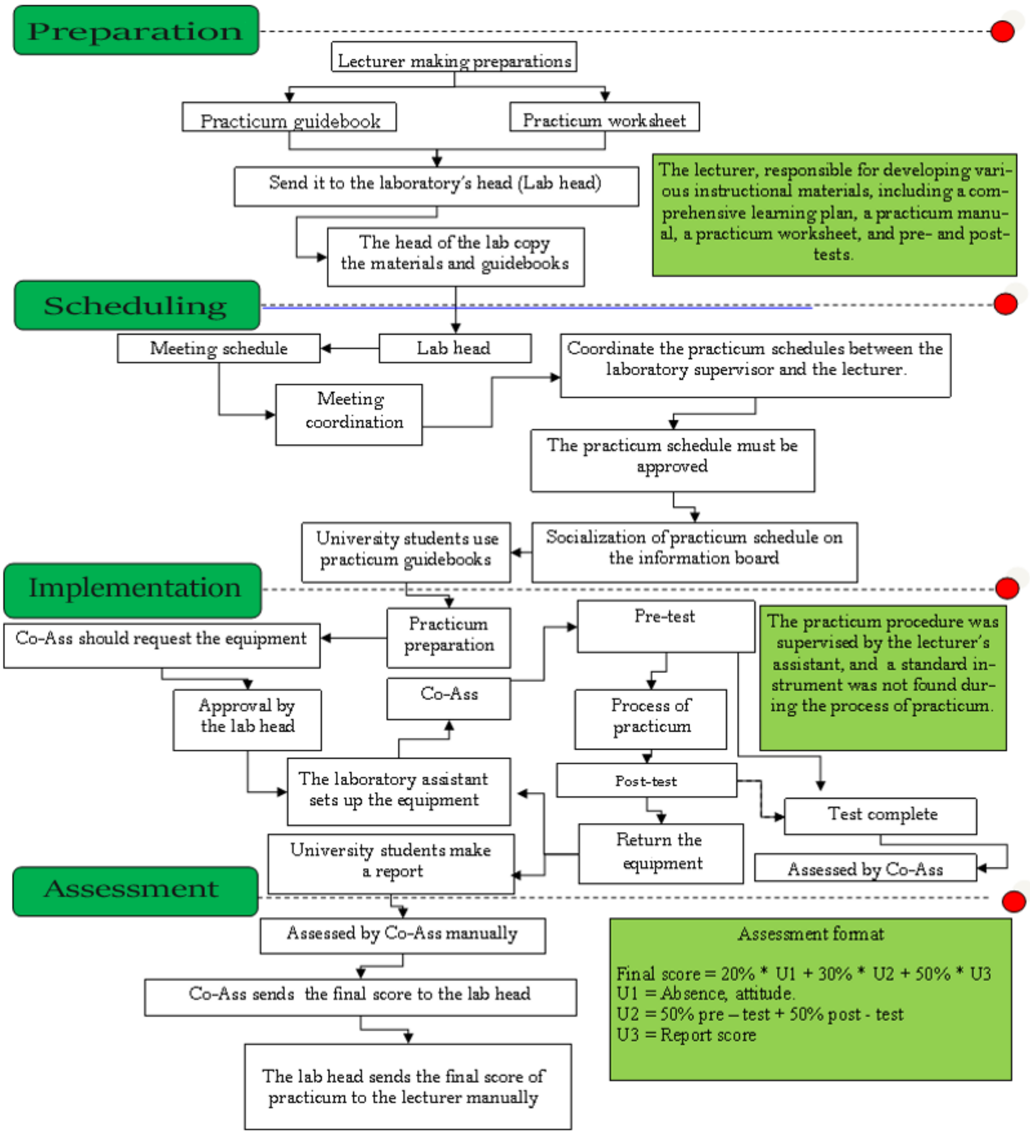

Figure 1. The existing procedures of the science practicum.

The second question: Has the implementation of the performance assessment in the science practicum been carried out in real-time?

Based on the information in Table 2, the four universities still carried out manual practicum assessments, namely 54.0% with an average (M = 2.56) and standard deviation (SD = 2.098). This is reinforced in the fifth and sixth questions, where the assessment has not been carried out online (64.6%) or in real-time (74.7%). Therefore, they want practicum assessments to be carried out online for all courses, and most of them want management to make policies so that assessments are carried out online and in real-time because it will facilitate the assessment process and can be monitored by all parties on time.

University students and lecturers want practicum assessments to use a combination based on Android and the website (47.6%, M = 2.40, SD = 0.632). Most respondents wanted online assessments to be accessible on all devices (51.3%, M = 2.08, SD = 0.971). Practicum assessment has not been carried out in real-time (74.7%, M = 0.25, SD = 0.435), even though, based on the results of the questionnaire survey, students and lecturers opined that they agree on the assessment of practicum learning in all courses where practicum can be accessed online and in real-time (66.2%, M = 2.85, SD = 0.648), and also agree that management makes regulations requiring all lecturers to make practicum learning assessments online and in real-time (48.1%, M = 3.05, SD = 0.757). This desire is quite reasonable because on campus they are supported by the availability of internet access by 92.8% (M = 0.93, SD = 0.259), and most of the internet connections are easily accessible (63.8%, M = 0.64, SD = 0.481), besides that, students and lecturers have laptops and mobile phones that can be used to operate assessment applications (93.4%) and agree to evaluate practicum learning online and in real-time using the application (100%, M = 2.4, SD = 0.632).

Table 2. Supporting data information on science practicum assessment.

No	Data description	N	%	Mean	SD
1	The learning assessment system is still manual.	203	54.0	2.56	2.098
2	Have a guide or guidelines as a basis for practicum performance assessment.	357	94.9	0.95	0.219
3	Internet access is available	349	92.8	0.93	0.259
4	Easily accessible internet connection	240	63.8	0.64	0.481
5	Assessment of practicum learning has not been done online	243	64.6	0.35	0.479
6	Assessment of practicum learning has not been done online and in real-time	281	74.7	0.25	0.435
7	Agree to assess practicum learning for all courses where there is an online and real-time practicum	249	66.2	2.85	0.648
8	Agree that the university management makes it a policy to make practicum learning assessments online and in real-time	181	48.1	3.05	0.757
9	Agree if the practicum learning process assessment is based on performance achievement	272	72.3	3.05	0.562
10	Agree to evaluate practicum learning online and in real-time using the application	376	100	2.40	0.632
	a. Android and web	179	47.6		
	b. Android	167	44.4		
	c. Web	30	8.0		
11	Agree that the online and real-time practicum learning assessment can be accessed via	376	100	2.08	0.971
	a. All devices	193	51.3		
	b. Handphone	163	43.4		
	c. Computer/Laptop	20	5.3		

The third research question is: Is there a statistically significant difference in the responses of respondents (students and lecturers) and type of university (public and private) in the real-time science practicum assessment based on the experience of previous practicum?

Based on the data in Figure 2 and Table 3, If a cross-tabulation is carried out between the respondent variables (university students and lecturers) associated with online and real-time practicum assessments, according to them, practicum performance assessments have not been carried out in real-time, namely 186 out of 261 students (M = 0.29, SD = 0.453) means that it is still relatively high, while the lecturer stated that 95 out of 115 (M = 0.17, SD = 0.381) the practicum assessment had not been carried out online and in real-time. This means that students and lecturers have the same view that practicum assessments have not been carried out online and in real-time based on previous experience when attending practicums at their universities.

Table 3. Online and real-time assessment based on respondent and university variables.

Variables	Category	N	Mean (M)	SD	Sig. Pearson chi-square
Respondents	University students	261	0.29	0.453	0.282
	Lecturers	115	0.17	0.381	
University	Public	205	0.24	0.430	0.669
	Private	171	0.26	0.442	

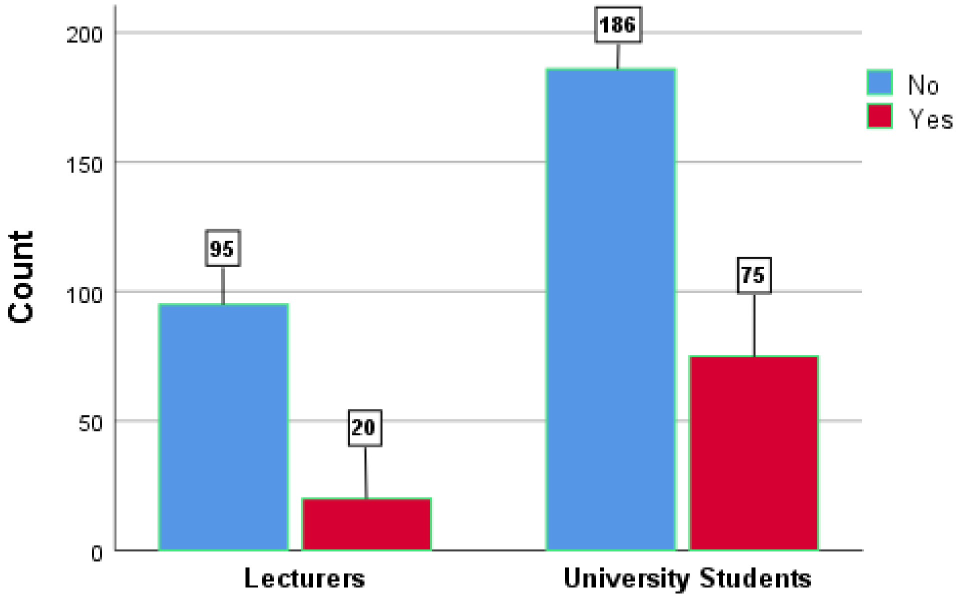

Figure 2. Real-time performance assessment of science practicum response by teachers and students at the university.

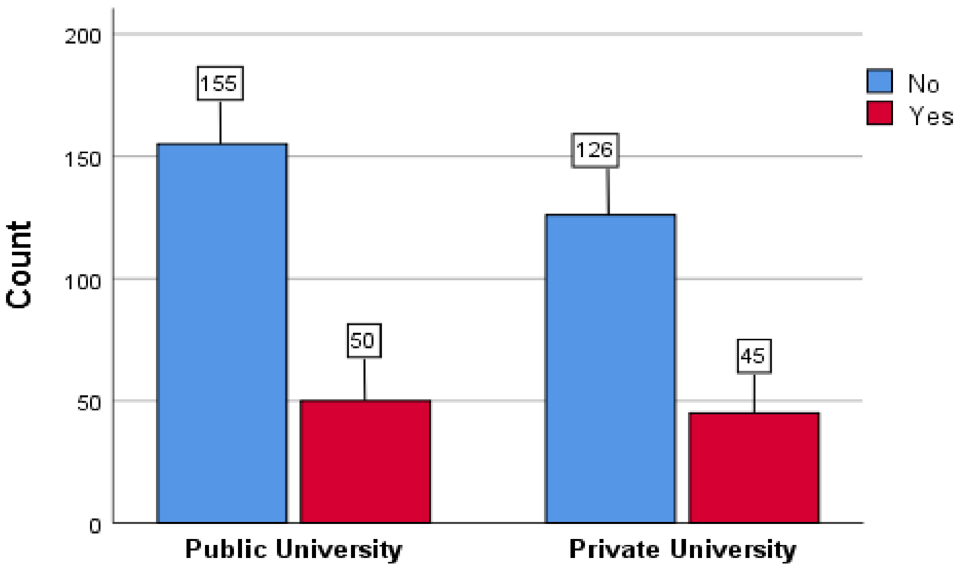

Figure 3. Real-time performance assessment of science practicum based on public and private universities.

Table 4. Chi-square tests on respondent response to real-time assessment.

Chi-square tests	Value	df	Asymptotic significance (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson chi-square	1.159[a]	1	0.282		
Continuity correction[b]	0.683	1	0.408		
Likelihood ratio	1.315	1	0.251		
Fisher's exact test				0.451	0.209

Note: a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.15.
b. Computed only for a 2x2 table.

If further tested with statistics, it is found that there is no significant difference ($p > 0.05$) between students' and lecturers' responses to the assessment of natural science practicum learning in real-time (Table 4), suggesting that the knowledge between students and lecturers is not much different regarding the experience of their practicum activities. Previously, namely, the implementation of practicum assessments had not been carried out online, and in real-time, the average practicum assessment was still carried out manually (54.0%) based on the learning experience that had been passed in the previous semester.

Table 5. Chi-square tests on university type to real-time assessment.

Chi-square tests	Value	Df	Asymptotic significance (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson chi-square	0.183[a]	1	0.669		
Continuity correction [b]	0.095	1	0.758		
Likelihood ratio	0.183	1	0.669		
Fisher's exact test				0.721	0.378
Linear-by-linear association	0.183	1	0.669		
N of valid cases	376				

Note: a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 43.20.
b. Computed only for a 2x2 table.

The results of the cross-tabulation of a data frequency distribution (Figure 3 and Table 3) on university-type variables (public and private) in the real-time practicum performance assessment found that there were 155 out of 205 (M = 0.29, SD = 0.430) in public universities, while at private universities there were 126 out of 171 (M = 0.26, SD = 0.442) which stated that practicum assessments had not been carried out in real-time, suggesting that both public and private tertiary institutions carried out natural science practicum assessments. The rest were still done manually, this was not much different from what was found during in-depth interviews with the deputy dean of academics, head of the laboratory, and teaching assistants and observations of practicum implementation at the four universities where learning assessment was still manual. They stated that there was a pre-test assessment and final response at the end of practicum manually, final grades were sent to the head of the laboratory manually to get approval, and the final practicum scores were sent to each lecturer for entry in the academic information system.

Further analysis with a statistical test (Table 5) of whether there is a difference in the type of university variable on the real-time science practicum assessment found that there is no significant difference ($p > 0.05$). This was confirmed during an in-depth interview with the deputy dean, who said there was no policy at the four universities to conduct real-time performance assessments at their universities. Likewise, during the observation of practicum implementation, the practicum assessment was still carried out manually, even though the facilities and infrastructure or information technology infrastructure available made it possible to carry out a performance assessment during the natural science practicum. In the future, the four universities plan to develop online and real-time performance appraisals to facilitate the assessment process and reduce costs, labor, and time more efficiently.

Fourth research question: Has the performance assessment of the science practicum been carried out in an integrated manner?

Based on Table 6 the assessment has not been carried out in an integrated manner in one system that facilitates the process of evaluating practicum learning. This can be seen in the data from the university student and lecturer response questionnaire results as follows, the lecturer has never returned the practicum assessment results after being examined (74.2%, M = 1.39, SD = 0.733), the lecturer has never returned the results of the practicum assessment after being examined accompanied by feedback for improvement (74.7%, M = 1.40, SD = 0.783). If the lecturer returns the results of the practicum assessment, it is given directly via paper or manually (63.8%, M = 2.33, SD = 2.196), lecturers or teaching assistants never return practicum results to students along with online and real-time feedback (87.0%, M = 1.14, SD = 0.378). Students and lecturers agree if the practicum results are returned to students online and in real-time, accompanied by feedback with an Android-based application (77.9%, M = 0.78, SD = 0.414).

Table 6. Supporting data information on the integration of science practicum assessments.

No	Data description	N	%	Mean	SD
1	Assessment has never been carried out during the practicum process.	257	68.4	1.49	0.816
2	Lecturers or teaching assistants never return the results of practicum assessments after being examined.	279	74.2	1.39	0.733
3	Lecturers or teaching assistants never return the results of practicum assessments after being examined accompanied by feedback for improvement.	281	74.7	1.40	0.783
4	The lecturer returns the results of the practicum assessment, via paper/Manual	240	63.8	2.33	2.196
5	Lecturers never return practicum results to students along with online and real-time feedback.	327	87.0	1.14	0.378
6	Students and lecturers want the practicum results to be returned to students accompanied by online and real-time feedback using an Android-based application.	293	77.9	0.78	0.414
7	Students and lecturers want if the practicum results reviewed to be returned to students along with online and real-time feedback based on Android accessed using mobile phones.	347	92.3	0.93	0.263
8	Agree that the procedures and results of the practicum learning assessment can be accessed by all stakeholders, including students.	276	73.4	3.17	0.519
9	Practicum assessment has not been carried out in an integrated manner in learning and the results can be accessed by all stakeholders with corrective feedback.	298	79.3	0.21	0.406
10	Making a practicum result report by handwriting.	286	76.1	1.44	1.036
11	Delivery of practicum reports submitted directly.	295	78.5	1.56	1.209
12	Have experience assessed in the practicum learning process online and in real-time.	241	64.1	0.64	0.480
13	Do not have experience assessing in the practicum learning process online and in real-time.	206	54.8	0.48	0.500
14	Agree that practicum learning assessment should motivate students to achieve learning outcomes.	223	59.3	3.32	0.596
15	Agree that practicum learning assessment must reflect students' abilities in the ongoing learning process.	283	75.3	3.16	0.496
16	Agree that the assessment of practicum learning is based on agreed standards between lecturers and students.	263	69.9	3.21	0.538
17	Agree that the assessment of practicum learning must be free from the influence of the subjectivity of the assessor and those being assessed.	269	71.5	3.18	0.533
18	Agree that the practicum learning assessment must be carried out by clear procedures and criteria, agreed upon at the beginning of the lecture, and understood by students.	257	68.4	3.24	0.524

Students and lecturers agree if the practicum results are returned to students accompanied by online feedback and real-time use of mobile phones to access it (92.3%, M = 0.93, SD = 0.263). Students and lecturers agree that the procedures and results of practicum learning assessments can be accessed by all stakeholders, including university students (73.4%, M = 3.17, SD = 0.519). Practicum assessment has not been carried out in an integrated manner in learning, and the results can be accessed by all stakeholders with corrective feedback (79.3%, M = 0.21, SD = 0.406). Preparation of practicum results reports using handwritten manual (76.1%, M = 1.44, SD = 1.036). Delivery of practicum reports sent directly to teaching assistants (78.5%, M = 1.56, SD = 1.209). Lecturers and students want the assessment to be carried out during the practicum process (68.4%, M = 1.49, SD = 0.816).

Fifth research question: Is there a statistically significant difference in the responses of respondents (students and lecturers) and university types (public and private) in the integrated science practicum performance assessment based on practicum experience?

Based on the results of the cross-tabulation of the frequency distribution (Figure 4 and Table 7) University students stated that practicum assessments had not been carried out in an integrated manner by 209 out of 261 total students (M=0.23, SD=0.420) this meant that practicum assessments were still carried out separately the assessment among assistant lecturers, university students, and reports, besides that feedback is still done manually through paper even in small quantities, using digital feedback technology it can be integrated into one application automatically so that students get scores information accompanied by direct feedback and also lecturers in charge of courses and heads of study programs can access them directly without waiting for written reports manually to monitor learning progress.

Table 7. Integrated practicum assessment based on the respondent and university-type variables.

Variable	Category	N	Mean	SD	Sig. Pearson chi-square
Respondents	University students	261	0.23	0.420	0.554
	Lecturers	115	0.20	0.400	
University	Public	205	0.13	0.339	0.637
	Private	171	0.30	0.459	

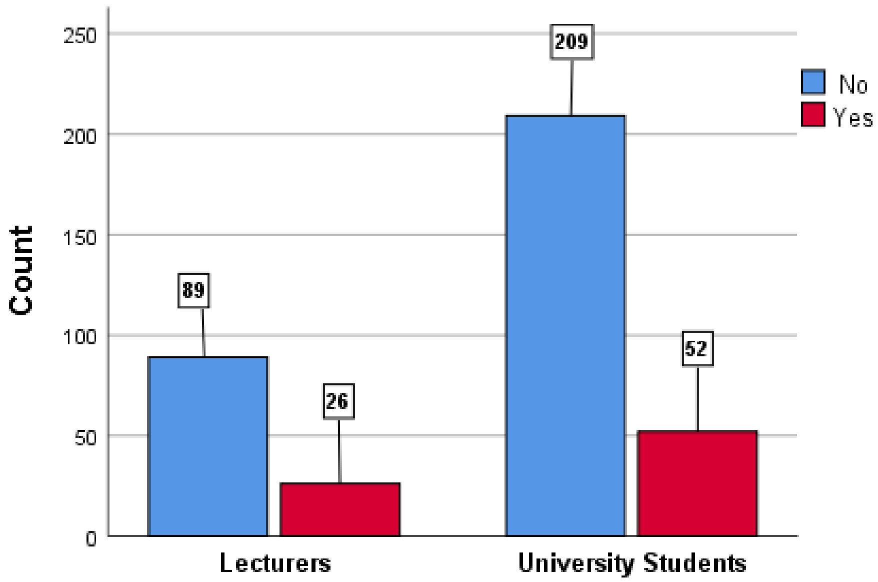

Figure 4. Integrated assessment of science practicum response by teacher and student at the university.

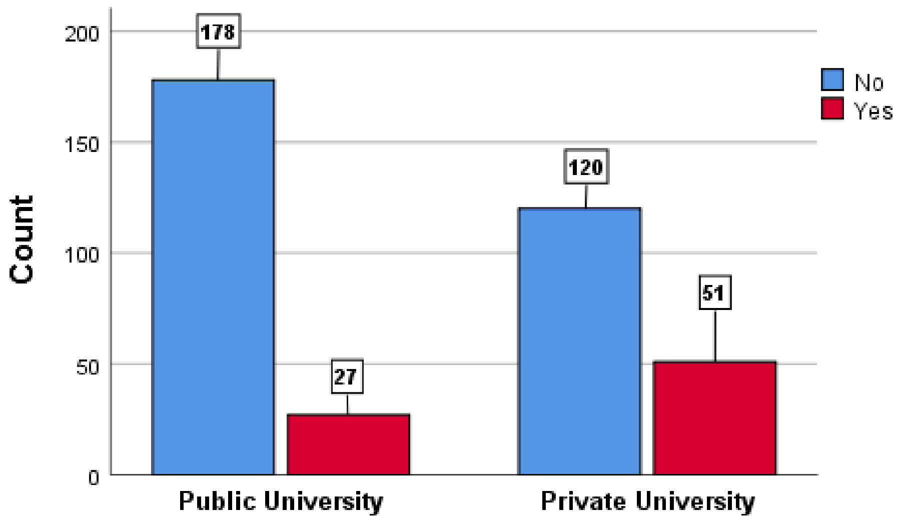

Figure 5. Integrated assessment of science practicum based on type of university.

Table 8. Chi-square tests of university type to integrated performance assessment.

Chi-square tests	Value	Df	Asymptotic sig. (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson chi-square	0.222[a]	1	0.637		
Continuity correction[b]	0.068	1	0.795		
Likelihood ratio	0.216	1	0.642		
Fisher's exact test				0.673	0.386
N of valid cases	376				

Note: a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.88.
b. Computed only for a 2x2 table.

To find out the differences in the statistical analysis of university students and lecturers in the integrated practicum assessment, a statistical test was carried out using chi-square (Table 8). It was found that there was no significant difference ($p > 0.05$) between the responses of university students and lecturers to the performance assessment in an integrated manner, meaning that the responses of university students and university lecturers did not differ significantly regarding the integrated science practicum performance assessment at their university. This result was reinforced by in-depth interviews with the deputy dean for academics, head of the study program, head of the laboratory, and teaching assistant who indicated that practicum assessments had not been integrated with practicum reports and that lecturers and the head of study program did not have access to final grades.

The results of the frequency distribution analysis with cross-tabulation (Table 7 and Figure 5), showed that integration had not been carried out at state universities by 178 out of 205 ($M = 0.13$, $SD = 0.339$). The same thing was also found at private universities by 120 out of 171 ($M = 0.30$, $SD = 0.459$) which states that practicum assessments have not been carried out in an integrated manner. This means that more students and lecturers at public and private universities state that the implementation of assessments at their universities has not been integrated with reporting and feedback for transparency and accountability of learning assessments. The same thing was also found when in-depth interviews and practicum observations were carried out: practicum performance evaluation was still done manually, so the evaluation and reporting processes as well as lecturer feedback were still separate. They wanted in the future to integrate practicum assessment with reporting and lecturer feedback for continuous improvement and could access is not limited by time or place. This will be supported by policies at the management level.

Table 9. Chi-square tests of respondents (Teacher/Students) to integrated performance assessment.

Chi-square tests	Value	Df	Asymptotic significance (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson chi-square	0.350[a]	1	0.554		
Continuity correction[b]	0.206	1	0.650		
Likelihood ratio	0.346	1	0.556		
Fisher's exact test				0.582	0.322
Linear-by-linear association	0.349	1	0.555		
N of valid cases	376				

Note: a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 23.86.
b. Computed only for a 2x2 table.

The results of the further analysis with the chi-square statistical test (Table 9) show that there is no significant difference ($p > 0.05$) between the types of universities for integrated assessment, meaning that both private and public universities have not carried out integrated assessments in one system that can be accessed quickly by all interested parties so that monitoring of learning developments, including practicum assessments, can be carried out. This is following the responses of students and lecturers who want the procedures and results of practicum learning assessment to be accessible to all stakeholders, including students, lecturers, and heads of study programs ($N = 73.4\%$), the assessment process should ideally be devoid of any subjective biases from both the assessor and the assessed individuals ($N = 71.5\%$). It should also serve as a source of motivation for students to attain the desired learning outcomes (N = 59.3%). Furthermore, the assessment should accurately reflect the ongoing learning progress of students (N = 75.3%). To ensure fairness and consistency, the assessment should be based on mutually agreed standards between lecturers and students (N = 69.9%). Additionally, it is crucial that the assessment is conducted using clear procedures and criteria that are established at the beginning of the lecture and are comprehensible to students (N = 68.4%).

Based on the results of questionnaires, in-depth interviews, and observations, the weakness in the science practicum assessment is that the performance assessment has not been carried out because it does not have valid and reliable instruments. Access by authorized parties is recommended to monitor the practicum assessment process using the Android platform through smartphones and laptops or computers. The Integrated Realtime Performance Assessment (IRPA) model can be designed as shown in Figure 6.

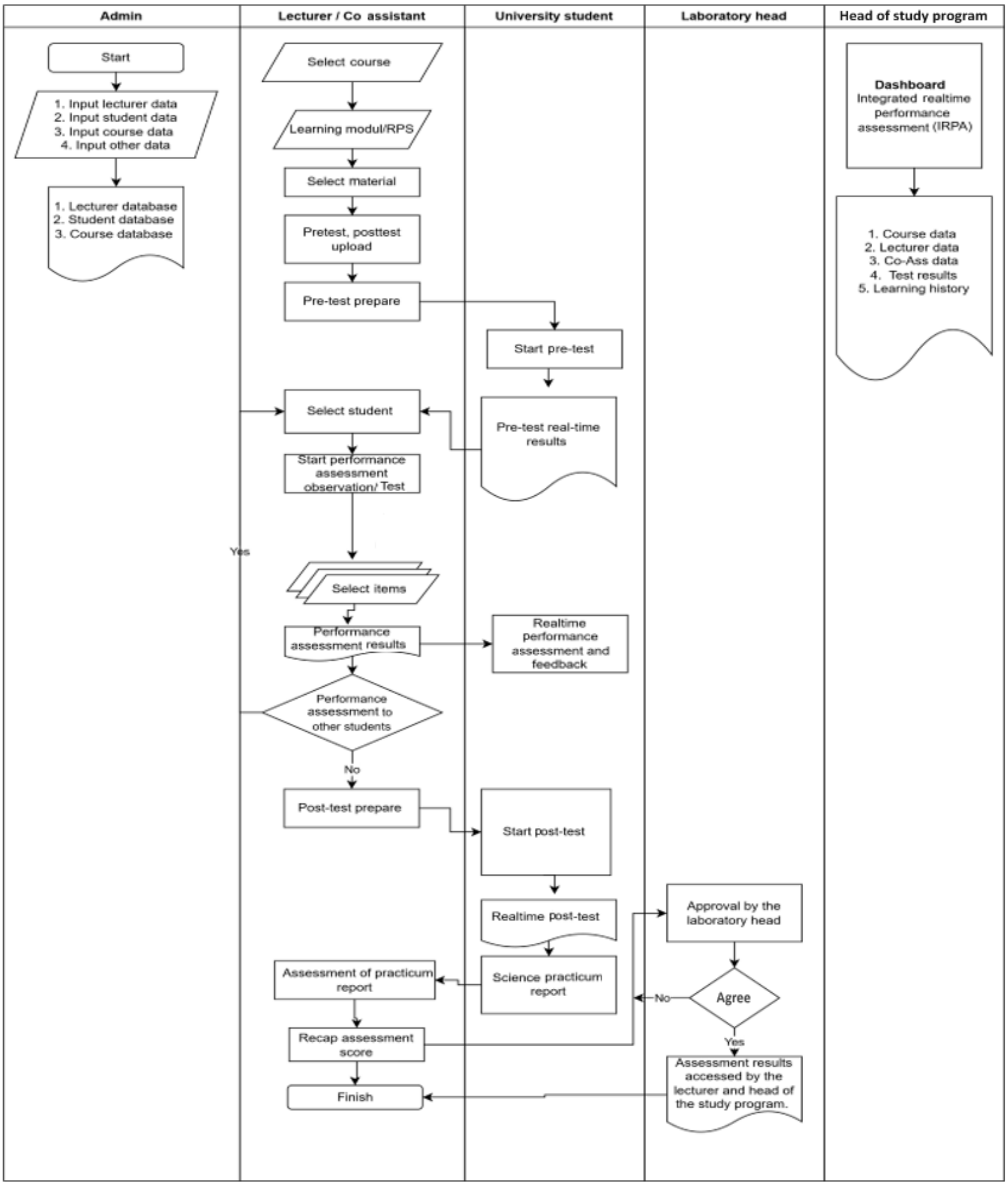

Figure 6. Design of the integrated real-time performance assessment (IRPA) model.

5. DISCUSSION

5.1. The Current Science Practicum Assessment

Based on Table 1, in-depth interviews were conducted at four universities at the management level with vice deans for academics, heads of laboratories, and teaching assistants. The purpose of conducting in-depth interviews was to confirm findings, complete data, or obtain additional data that was collected through a questionnaire. Based on the results of in-depth interviews, it was found that the practicum assessment procedures at the four universities, both public and private, were not much different.

Teaching assistants carried out practicum assessments by evaluating the initial response (pre-test), final response (post-test), and final report. The head of the laboratory approves the assessment results before manually submitting them to the course lecturer. Observations show that the evaluation is still done manually, and no performance assessment instrument was found. Therefore, it is necessary to develop valid and reliable performance assessment instruments to assess the practicum implementation process. These results follow the findings during the in-depth interview with the head of the laboratory, assistant lecturer, and deputy of the academic dean; a performance assessment was carried out, which is considered to be limited activeness, collaboration without using valid standardized instruments, and reliability.

Based on the results of interviews at the four tertiary institutions, the practicum implementation has not been supported by a performance assessment process, so the practicum implementation is less effective (Bensley, Masciocchi, & Rowan, 2021; Kruit, Oostdam, van den Berg, & Schuitema, 2018; Riantini, Suastra, & Adnyana, 2018). Skills are an important part of practicum activities that are not monitored or measured, most assessments are carried out a week after the practicum ends through reports. Therefore, we need performance assessment instruments that can be accessed digitally and assessed quickly as valid, consistent, and reliable instruments to reduce effort, time, and costs (Tseng, 2016). Lecturer assistants tend to use their memory when giving assessments, so it is recommended to develop a performance assessment instrument during the practicum (Dhina, Hadisoebroto, Mubaroq, & Gustiana, 2021).

According to Kruit et al. (2018), most lecturers evaluate the student practicum process at the end of the practicum activities. The assessment should not only be carried out at the end of the practicum activities but measurements are made from the start of the practicum until the activities are completed, meaning that the assessment is carried out comprehensively at all stages of the practicum and monitoring all aspects, namely cognitive, psychomotor and affective (Bensley et al., 2021; Yan, 2020). Furthermore, Kruit et al. (2018) added that performance assessment was not only carried out to measure students' abilities in the cognitive domain but is also required to carry out skills and attitude assessments. To carry out this measurement, a performance assessment instrument is needed that is easy to understand, valid, and reliable.

5.2. Real-Time Performance Assessment on the Science Practicum

The four universities are still manually conducting practicum assessments; therefore, this study recommended that performance assessments be carried out digitally, Chemsi et al. (2020) indicate that the application of technology in science education has the advantage of providing an adaptive environment or learning resources, helping lecturers understand student learning patterns and behavior, and automatically assessing the performance of learning science (Alharbi, 2022). Furthermore, according to Cadaret and Yates (2018), apart from performance assessments, other authentic assessments such as project assessments, portfolio assessments, peer assessments, and self-assessments can be used for digital competency achievement assessments to make it easier for students in laboratory practice, so that digital assessments have an important role in measuring student learning outcomes in the assessment of science learning, including in the assessment of learning during practicum (Chemsi et al., 2020).

Recent studies emphasize the benefits of digital assessment and students' positive attitudes (Aljawarneh, 2020). These benefits include increasing student motivation, increasing understanding and active learning, and preventing cheating in taking tests (Peter-Cookey & Janyam, 2019). Prevent plagiarism by randomizing questions and responses and providing time limits and password-protected logins for multiple assessment attempts with an automatic evaluation process (Poce et al., 2019; Schweighofer et al., 2019).

5.3. Responses of Respondents and Types of Universities on Real-Time Science Practicum Assessment

Based on the statistical analysis, performance assessment is still done manually for both types of university and respondent variables, so they cannot yet carry out practicum performance assessments in real-time. To carry out online and real-time assessments, according to Hayashi (2020), they must switch to using performance assessment with digital technology as a medium for measuring student learning outcomes and acting as student learning material or assessment for learning (assessment for learning). So according to Cadaret and Yates (2018), online performance assessment refers to assessment for learning as a learning instrument to help improve the quality of their abilities in the practicum learning process.

Furthermore, Thienpermpool (2021) stated that the application of performance assessment instruments with digital technology in practicum activities can improve students' psychomotor skills in indicators of paying attention to phenomena related to material, identifying experimental tools and materials, formulating hypotheses, demonstrating experiments, writing down observations, analyzing observation results, making conclusions, and communicating the results of observations. This is according to Dhina et al. (2021) because the digital performance assessment instrument contains observation sheets of student performance observations along with other tools needed in assessments using instruments such as learning scenarios, instrument grids, rubrics, and scoring guidelines as a final grade recapitulation and refers to assessment for learning so that each learning stage allows for online feedback on improvements. This is following the results of research that the learning science in the psychomotor domain using performance assessment instruments based on a scientific approach is higher than conventional performance.

5.4 Integrated Performance Assessment on Science Practicum

Based on the description of the research data, practicum performance assessment has not been integrated. This is because, based on the finding of the existing science practicum, most assessments are still carried out manually. According to Muniasamy et al. (2019), one of the benefits of switching to a digital technology system is the ability to automate and standardize learning assessment, which facilitates data integration. Data filled in via smartphone is automatically synchronized with the reporting module so that you can access assessment reports anytime and anywhere, not limited to time and place (Sudirman, Sarjan, Rokhmat, Hamidi, & Fauzi, 2022).

Study program supervisors will receive reports that are accurate, valid, and consistent because the statistical analysis process is carried out automatically by the system so that it reflects the provision of fast learning services to serve student needs (Muniasamy et al., 2019); thus, digital reporting significantly saves time (Habig & Gupta, 2021). Assessment by students and lecturers as well as monitoring by the head of the study program will be included in one integrated application, namely a centralized information system and data platform on Android that is accessed via a tablet PC, cellphone, or laptop using a password-protected login. This system also allows offline security storage that can automatically connect to servers when a network connection is available (Sudirman, 2021). Direct data entry through the application, according to Tai et al. (2018) will provide real-time data reports that can be accessed by lecturers and by supervisors and allows integration with feedback from lecturers to students regarding learning progress so that it is possible to monitor learning progress by students themselves, to prevent misuse of data, access will be limited by a secure login system (Sudirman, 2021).

5.5. Responses of Respondents and University on Integrated Science Practicum Assessment

Practicum assessment has not been integrated with lecturer feedback to students; feedback is still done manually. Providing direct feedback to students regarding practicum performance through feedback is a form of early anticipation for students regarding material that must be improved to achieve learning outcomes (Csapó & Molnár, 2019; Saleh et al., 2022). Knowing information about a student's deficiencies at the outset allows lecturers to prepare improvements or enhancements for each student, and it also provides material for students to track the advancement of their learning achievements (Csapó & Molnár, 2019; Koneru, 2017; Tai et al., 2018). Conversely, if information is not conveyed to students from the start, they feel that they have achieved learning outcomes even though some material has not been completed or has not been achieved, so material that is not achieved accumulates (Smolyaninova & Bezyzvestnykh, 2019).

Based on the results of questionnaires, in-depth interviews, and observations that practicum reports and final grades are made manually, meaning that the practicum performance assessment has not been integrated with reports, practicum reports can be uploaded in one application and assessed by a teaching assistant. To speed up the final grade process, old practicum reports will be assessed. impact on student satisfaction in academic services Koneru (2017). The Head of the study program as a supervisor also complained about delays in sending final grades, one of which was the delay in recapitulating practicum assessments because it was done manually with paper. Using digital technology, students could work on reports on the system so that they were immediately checked by teaching assistants through the application and could degenerate the scores together with the response values. initial, final response, and performance (Fan, Song, & Guan, 2021).

In addition, based on the results of the interviews, the reports collected were in different formats, and some were incomplete. According to Koneru (2017), One of the benefits of digital technology is standardizing reports and printing them automatically so that it does not take a long time to get the practicum assessment results, and students have time to check the final grades and provide feedback on the grades given (Shavelson, Zlatkin-Troitschanskaia, Beck, Schmidt, & Marino, 2019). By using automatic reporting, the data entered will be immediately generated in the form of a compilation of practicum results reports (Hume & Coll, 2009), which consist of initial test scores, practicum process scores, final responses, and practicum reports. If a lecturer, head of the study program, or head of the laboratory wants to print a report, they can log in with a protected password and access it directly so that they can monitor the implementation of the practicum according to schedule. They do not need to submit reports manually at a higher level, in this case, the head of the laboratory, lecturers, and the heads of the study programs, thereby saving time and money and making it easier to check the progress of learning practicum. In addition, by using digital technology, the value calculation is not done manually but is filled in automatically in a standardized report format, so the results are valid and consistent (Varela & Mead, 2018).

6. CONCLUSION

This study found that the assessment should not only be carried out at the end of the practicum activities but measurements are made from the start of the practicum until the activities are completed, assessments were not carried out comprehensively at all stages of the practicum and monitoring all aspects, performance assessment was not only carried out to measure students' abilities in the cognitive domain but it is also required to carry out skills and attitude assessments. Performance assessment has not been carried out since measurement instruments are not available, therefore it is recommended to develop instruments to measure the practicum performance assessment in real-time utilized digital technology and integrated with feedback for improvement. Integration of practicum performance assessment with reports, feedback, and monitoring in one Android-based application that is potentially easily accessible with smartphones and laptops.

Our study also reveals that students and lecturers want the practicum results to be returned to students accompanied by online and real-time feedback using an Android-based application and accessed using mobile phones. The use of technology-based practicum assessments will facilitate the process of sending feedback, the integration of real-time feedback into an Android-based application for performance assessment is a process of continuous constructive improvement that develops student capacity to monitor self-improvement on an ongoing basis and allows students to reflect on their learning. The integration assessment with feedback in one system will facilitate the learning process so that it is profitable in terms of assessment effectiveness, time, effort, and cost efficiency.

7. POLICY SUGGESTIONS

In order to improve the assessment of students' performance in real-time with integrated feedback, it is recommended to utilize Android-based digital technology that can be accessed through multiple devices for all science practicum courses. This approach would allow lecturers, program study heads, and laboratory heads to easily verify the timely implementation of practice sessions according to the established timetable. They would have the ability to access grades and feedback conveniently, regardless of their current time and place. This unrestricted access is made possible by a single user interface that requires a password for protection.

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Institutional Review Board Statement: The Ethical Committee of Mataram University, Indonesia has granted approval for this study (Ref. No. 134/E5/PG.02.00.PL/2023).
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

REFERENCES

Alharbi, B. (2022). Saudi teachers' knowledge of critical thinking skills and their attitudes towards improving saudi students' critical thinking skills. *Problems of Education in the 21st Century*, *80*(3), 395–407. https://doi.org/10.33225/pec/22.80.395

Aljawarneh, S. A. (2020). Reviewing and exploring innovative ubiquitous learning tools in higher education. *Journal of Computing in Higher Education*, *32*(1), 57-73. https://doi.org/10.1007/s12528-019-09207-0

Araya, R., & Collanqui, P. (2021). Are cross-border classes feasible for students to collaborate in the analysis of energy efficiency strategies for socioeconomic development while keeping CO2 concentration controlled? *Sustainability (Switzerland)*, *13*(3), 1–20. https://doi.org/10.3390/su13031584

Asamoah, D., Shahrill, M., & Latif, S. N. A. (2022). A review of formative assessment techniques in higher education during COVID-19. *Qualitative Report*, *27*(2), 475–487. https://doi.org/10.46743/2160-3715/2022.5145

Bensley, D. A., Masciocchi, C. M., & Rowan, K. A. (2021). A comprehensive assessment of explicit critical thinking instruction on recognition of thinking errors and psychological misconceptions. *Scholarship of Teaching and Learning in Psychology*, *7*(2), 107-122. https://doi.org/10.1037/stl0000188

Bridgeman, B., Trapani, C., & Attali, Y. (2012). Comparison of human and machine scoring of essays: Differences by gender, ethnicity, and country. *Applied Measurement in Education*, *25*(1), 27-40. https://doi.org/10.1080/08957347.2012.635502

Burgmanis, G., Namsone, D., & France, I. (2023). Towards a development of automated feedback and diagnostic assessment system in support of literacy teaching and learning. *International Conference on Computer Supported Education, CSEDU - Proceedings*, *2*(Csedu), 296–305. https://doi.org/10.5220/0011858100003470

Cadaret, C. N., & Yates, D. T. (2018). Retrieval practice in the form of online homework improved information retention more when spaced 5 days rather than 1 day after class in two physiology courses. *Advances in Physiology Education*, *42*(2), 305-310. https://doi.org/10.1152/ADVAN.00104.2017

Chafiq, N., Talbi, M., & Ghazouani, M. (2018). Design and implementation of a risk management tool: A case study of the Moodle platform. *International Journal of Advanced Computer Science and Applications*, *9*(8), 458–461. https://doi.org/10.14569/ijacsa.2018.090858

Chemsi, G., Sadiq, M., Radid, M., & Talbi, M. (2020). Study of the self-determined motivation among students in the context of online pedagogical activities. *International Journal of Emerging Technologies in Learning*, *15*(5), 17-29. https://doi.org/10.3991/IJET.V15I05.11392

Chen, G., Wang, X., & Wang, L. (2022). Developing assessment literacy among trainee translators: Scaffolding self and peer assessment as an intervention. *Assessment & Evaluation in Higher Education*, 1-15. https://doi.org/10.1080/02602938.2022.2142515

Conforme, D. F. I., Romero, A. L. C., Romero, D. C., & Laz, E. M. S. A. (2019). Application of diagnostic assessment on beginning school year. *International Research Journal of Management, IT and Social Sciences*, *6*(5), 53-59.

Crook, C. (2022). CSsCL: The performance of collaborative learning. *International Journal of Computer-Supported Collaborative Learning*, *17*(1), 169-183. https://doi.org/10.1007/s11412-022-09364-y

Csapó, B., & Molnár, G. (2019). Online diagnostic assessment in support of personalized teaching and learning: The eDia system. *Frontiers in Psychology*, *10*, 1522. https://doi.org/10.3389/fpsyg.2019.01522

Dhina, M. A., Hadisoebroto, G., Mubaroq, S. R., & Gustiana, I. (2021). Implementation of digital performance assessment to measure pharmacy physics laboratory skills. *Momentum: Physics Education Journal*, *5*(1), 65-72. https://doi.org/10.21067/mpej.v5i1.5146

Dimos, I., Velaora, C., Louvaris, K., Kakarountas, A., & Antonarakou, A. (2023). How a rubric score application empowers teachers' attitudes over computational thinking leverage. *Information*, *14*(2), 1-21. https://doi.org/10.3390/info14020118

Fan, T., Song, J., & Guan, Z. (2021). Integrating diagnostic assessment into curriculum: A theoretical framework and teaching practices. *Language Testing in Asia*, *11*(1), 1-23. https://doi.org/10.1186/s40468-020-00117-y

Gamage, S. H., Ayres, J. R., Behrend, M. B., & Smith, E. J. (2019). Optimising Moodle quizzes for online assessments. *International Journal of STEM Education*, *6*(1), 1-14. https://doi.org/10.1186/s40594-019-0181-4

Gunning, T. K., Conlan, X. A., Collins, P. K., Bellgrove, A., Antlej, K., Cardilini, A. P., & Fraser, C. L. (2022). Who engaged in the team-based assessment? Leveraging EdTech for a self and intra-team peer-assessment solution to free-riding. *International Journal of Educational Technology in Higher Education*, *19*(1), 38. https://doi.org/10.1186/s41239-022-00340-y

Habig, B., & Gupta, P. (2021). Authentic STEM research, practices of science, and interest development in an informal science education program. *International Journal of STEM Education*, *8*, 1-18. https://doi.org/10.1186/s40594-021-00314-y

Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81-112. https://doi.org/10.3102/003465430298487

Hayashi, Y. (2020). Gaze awareness and metacognitive suggestions by a pedagogical conversational agent: An experimental investigation on interventions to support collaborative learning process and performance. *International Journal of Computer-Supported Collaborative Learning*, *15*(4), 469-498. https://doi.org/10.1007/s11412-020-09333-3

Hsiung, W. Y. (2018). The use of e-resources and innovative technology in transforming traditional teaching in chemistry and its impact on learning chemistry. *International Journal of Interactive Mobile Technologies*, *12*(7), 86–96. https://doi.org/10.3991/ijim.v12i7.9666

Huang, W., Cheng, J., & Yang, Y. (2019). Rolling bearing performance degradation assessment based on convolutional sparse combination learning. *IEEE Access*, *7*, 17834–17846. https://doi.org/10.1109/access.2019.2893277

Hume, A., & Coll, R. K. (2009). Assessment of learning, for learning, and as learning: New Zealand case studies. *Assessment in Education: Principles, Policy & Practice*, *16*(3), 269-290. https://doi.org/10.1080/09695940903319661

Hussain, Y. A., & Jaeger, M. (2018). LMS-supported PBL assessment in an undergraduate engineering program—Case study. *Computer Applications in Engineering Education*, *26*(5), 1915-1929. https://doi.org/10.1002/cae.22037

Karki, D., & Lamichhane, R. (2020). Assessment of efficacy of lab-based learning in enhancing critical thinking and creative thinking among learners. *Westcliff International Journal of Applied Research, 4*(1), 15-28. https://doi.org/10.47670/wuwijar202041dkrl

Koneru, I. (2017). Exploring moodle functionality for managing open distance learning e-assessments. *Turkish Online Journal of Distance Education, 18*(4), 129-141. https://doi.org/10.17718/tojde.340402

Kruit, P. M., Oostdam, R. J., van den Berg, E., & Schuitema, J. A. (2018). Assessing students' ability in performing scientific inquiry: Instruments for measuring science skills in primary education. *Research in Science & Technological Education, 36*(4), 413-439. https://doi.org/10.1080/02635143.2017.1421530

Liu, H., Liu, Z., Lai, Y., & Li, L. (2021). Factors influencing collaborative innovation project performance: The case of China. *Sustainability, 13*(13), 7380. https://doi.org/10.3390/su13137380

Liu, O. L., Brew, C., Blackmore, J., Gerard, L., Madhok, J., & Linn, M. C. (2014). Automated scoring of constructed-response science items: Prospects and obstacles. *Educational Measurement: Issues and Practice, 33*(2), 19-28. https://doi.org/10.1111/emip.12028

Luo, H., Han, X., Chen, Y., & Nie, Y. (2022). Should you become a leader in online collaborative learning? Impact of assigned leadership on learning behaviors, outcomes, and perceptions. *Plos One, 17*(4), e0266653. https://doi.org/10.1371/journal.pone.0266653

Mohan, K., Bergner, Y., & Halpin, P. (2020). Predicting group performance using process data in a collaborative assessment. *Technology, Knowledge and Learning, 25*(2), 367-388. https://doi.org/10.1007/s10758-020-09439-5

Mohiudddin, K., Rasool, A. M., Mohd, M. S., & Mohammad, R. H. (2019). Skill-centered assessment in an academic course: A formative approach to evaluate student performance and make continuous quality improvements in pedagogy. *International Journal of Emerging Technologies in Learning (Online), 14*(11), 92-106. https://doi.org/10.3991/IJET.V14I11.10275

Muniasamy, V., Ejlani, I. M., & Anadhavalli, M. (2019). Student's performance assessment and learning skill towards wireless network simulation tool–Cisco Packet Tracer. *International Journal of Emerging Technologies in Learning (Online), 14*(7), 196. https://doi.org/10.3991/ijet.v14i07.10351

Muthmainnah, Ibna Seraj, P. M., & Oteir, I. (2022). Playing with AI to investigate human-computer interaction technology and improving critical thinking skills to pursue 21st century age. *Education Research International, 2022*. https://doi.org/10.1155/2022/6468995

Nang, H., & Harfield, A. (2018). A framework for evaluating tablet-based educational applications for primary school levels in Thailand. *International Journal of Interactive Mobile Technologies, 12*(5), 126–139. https://doi.org/10.3991/ijim.v12i5.9009

Olivera-Aguilar, M., Lee, H. S., Pallant, A., Belur, V., Mulholland, M., & Liu, O. L. (2022). Comparing the effect of contextualized versus generic automated feedback on students' scientific argumentation. *ETS Research Report Series, 2022*(1), 1-14. https://doi.org/10.1002/ets2.12344

Peffer, M. E., & Ramezani, N. (2019). Assessing epistemological beliefs of experts and novices via practices in authentic science inquiry. *International Journal of STEM Education, 6*, 1-23. https://doi.org/10.1186/s40594-018-0157-9

Peter-Cookey, M. A., & Janyam, K. (2019). Skill performance in informal economy workers: Multilevel perceptual assessment. *Kasetsart Journal of Social Sciences, 40*(2), 271-280.

Poce, A., Amenduni, F., Re, M. R., & De Medio, C. (2019). Automatic assessment of university teachers' critical thinking levels. *International Journal of Advanced Corporate Learning, 12*(3), 46. https://doi.org/10.3991/ijac.v12i3.11259

Popovic, N., Popovic, T., Rovcanin Dragovic, I., & Cmiljanic, O. (2018). A moodle-based blended learning solution for physiology education in Montenegro: A case study. *Advances in Physiology Education, 42*(1), 111-117. https://doi.org/10.1152/ADVAN.00155.2017

Ramdani, A., Purwoko, A. A., & Yustiqvar, M. (2021). *Improving scientific creativity of teacher prospective students: Learning studies using amoodle-based learning management system during the COVID-19 pandemic*. Paper presented at the In International Joint Conference on Science and Engineering 2021, Atlantis Press.

Ramírez-Noriega, A., Juárez-Ramírez, R., Jiménez, S., Inzunza, S., & Martínez-Ramírez, Y. (2018). Ashur: Evaluation of the relation summary-content without human reference using rouge. *Computing and Informatics*, *37*(2), 509–532. https://doi.org/10.4149/cai_2018_2_509

Riantini, N. L. R., Suastra, I. W., & Adnyana, P. B. (2018). *Development of science practicum performance assessment in junior high school*. Paper presented at the In SHS Web of Conferences, EDP Sciences.

Sadler, D. R. (1989). Formative assessment and the design of instructional systems. *Instructional Science*, *18*(2), 119-144. https://doi.org/10.1007/BF00117714

Saeki, E., Segool, N., Pendergast, L., & von der Embse, N. (2018). The influence of test-based accountability policies on early elementary teachers: School climate, environmental stress, and teacher stress. *Psychology in the Schools*, *55*(4), 391-403. https://doi.org/10.1002/pits.22112

Saleh, A. M., Abuaddous, H., Alansari, I. S., & Enaizan, O. (2022). The evaluation of user experience of learning management systems using UEQ. *International Journal of Emerging Technologies in Learning*, *17*(7), 145–162. https://doi.org/10.3991/ijet.v17i07.29525

Saleh, M., & Salama, R. M. (2018). Recommendations for building adaptive cognition-based e-learning. *International Journal of Advanced Computer Science and Applications*, *9*(8), 385-393. https://doi.org/10.14569/ijacsa.2018.090850

Saqr, M., Fors, U., & Tedre, M. (2017). How learning analytics can early predict under-achieving students in a blended medical education course. *Medical Teacher*, *39*(7), 757-767. https://doi.org/10.1080/0142159X.2017.1309376

Schweighofer, J., Taraghi, B., & Ebner, M. (2019). Development of a quiz–implementation of a (Self-) assessment tool and its integration in Moodle. *International Journal of Emerging Technologies in Learning*, *14*(23), 141-151. https://doi.org/10.3991/ijet.v14i23.11484

Shavelson, R. J., Zlatkin-Troitschanskaia, O., Beck, K., Schmidt, S., & Marino, J. P. (2019). Assessment of university students' critical thinking: Next generation performance assessment. *International Journal of Testing*, *19*(4), 337-362. https://doi.org/10.1080/15305058.2018.1543309

Shdiafat, A., & Obeidallah, R. (2019). Quiz tool within moodle and blackboard mobile applications. *International Journal of Interactive Mobile Technologies*, *13*(8), 32–42. https://doi.org/10.3991/ijim.v13i08.10552

Smolyaninova, O., & Bezyzvestnykh, E. (2019). Implementing teachers' training technologies at a Federal University: E-portfolio, digital laboratory, PROLog module system. *International Journal of Online & Biomedical Engineering*, *15*(4), 69–87. https://doi.org/10.3991/ijoe.v15i04.9288

Sridharan, B., & Boud, D. (2019). The effects of peer judgements on teamwork and self-assessment ability in collaborative group work. *Assessment & Evaluation in Higher Education*, *44*(6), 894-909. https://doi.org/10.1080/02602938.2018.1545898

Sudirman, S. (2021). Online system on monitoring and feedback for education. *Journal of Informatics and Science*, *4*(1), 73-79. https://doi.org/10.31326/jisa.v4i1.900

Sudirman, S., Sarjan, M., Rokhmat, J., Hamidi, H., & Fauzi, I. (2022). Multidimensional science education on performance assessment comprehensively with collaborative project learning based model: Philosophy perspective. *Journal of Science and Science Education*, *3*(2), 96-102.

Suggate, S., & Lenhard, W. (2022). Mental imagery skill predicts adults' reading performance. *Learning and Instruction*, *80*, 101633. https://doi.org/10.1016/j.learninstruc.2022.101633

Tai, J., Ajjawi, R., Boud, D., Dawson, P., & Panadero, E. (2018). Developing evaluative judgement: Enabling students to make decisions about the quality of work. *Higher Education*, *76*(3), 467-481. https://doi.org/10.1007/s10734-017-0220-3

Thienpermpool, P. (2021). Teachers' practice and perceptions of self-assessment and peer assessment of presentation skills. *English Language Teaching*, *14*(12), 183-188. https://doi.org/10.5539/elt.v14n12p183

Tseng, J.-J. (2016). Developing an instrument for assessing technological pedagogical content knowledge as perceived by EFL students. *Computer Assisted Language Learning*, *29*(2), 302-315. https://doi.org/10.1080/09588221.2014.941369

Valero, G., & Cárdenas, P. (2017). Formative and summative assessment in veterinary pathology and other courses at a Mexican veterinary college. *Journal of Veterinary Medical Education*, *44*(2), 331-337. https://doi.org/10.3138/jvme.1015-169R

Varela, O., & Mead, E. (2018). Teamwork skill assessment: Development of a measure for academia. *Journal of Education for Business*, *93*(4), 172-182. https://doi.org/10.1080/08832323.2018.1433124

Willey, K., & Gardner, A. (2009). Improving self-and peer assessment processes with technology. *Campus-Wide Information Systems*, *26*(5), 379-399. https://doi.org/10.1108/10650740911004804

Willmot, P., & Pond, K. (2012). Multi-Disciplinary Peer-Mark Moderation of Group Work. *International Journal of Higher Education*, *1*(1), 2-13. https://doi.org/10.5430/ijhe.v1n1p2

Yan, Z. (2020). Self-assessment in the process of self-regulated learning and its relationship with academic achievement. *Assessment & Evaluation in Higher Education*, *45*(2), 224-238. https://doi.org/10.1080/02602938.2019.1629390