

REVIEW ARTICLE

Imagineering Anatomy Assessment Amidst COVID-19: Turning Obstacles into Achievements

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ABSTRACT

A well-designed assessment has beneficial impacts on students' learning and competency attainment. Failure in obtaining psychomotor learning competency, lack of understanding of assessment principles among instructors, un-optimized information and technology facilities, and difficulties in ensuring the integrity of online examination are among the threats to validity of online anatomy assessment during the COVID-19 pandemic. To ensure the validity of anatomy assessment during the pandemic, it is important to adopt several educational principles into the assessment design. We solidify the input discussed in the Malaysian Anatomical Association webinar 2021, on the challenges of anatomy online assessment and proposed six solutions to the challenges, namely adopting the programmatic assessment design, conducting small group in-person high stake examination, modifying assessment policy, utilizing question bank software, upgrading ICT facilities, and offering the ICT training to the students and instructors. It is envisioned that anatomy assessment are future ready are adaptive to change.

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INTRODUCTION

Assessment is an integral component of a curriculum because it determines the students learning progress and how they are certified (1). Assessment, in its broadest sense, refers to the procedures used to make judgments on students' performance throughout a study (2). A well-designed assessment imposes a positive influence on learning, as it communicates what we consider to be significant and serves as the most effective incentive for student learning. Hence, it is critical to acknowledge

the stakes involved in evaluations, while designing the assessment (3). Given the fact that assessment drives students learning, assessment needs to be carried out with a specific goal in mind. There are three ultimate goals of assessment in medical education: (i) to optimize the attainment of students' competencies, (ii) to ensure competent graduates for safe clinical practice, and (iii) to provide the basis for advanced training (4).

Likewise, in the anatomy context, assessment is performed to evaluate the attainment of anatomy competency, namely comprehension of anatomy theory knowledge, clinical application of anatomy knowledge, and three-dimensional (3D) visualization of anatomical structures (5). Anatomy assessment also aims to evaluate anatomy related competency for safe-clinical practice

and ensure the mastery of anatomy knowledge and skills for advanced postgraduate training (6). Prior to the outbreak of the Coronavirus disease 2019 (COVID-19), anatomy assessments were mainly conducted through a face-to-face approach using multimodal instruments (7). The summative exam-based assessment was given more emphasis rather than formative assessment, particularly because summative assessment is more objective and provides a clear platform for making an informed decisions about students' performance (8).

Nevertheless, the COVID-19 pandemic has changed the paradigm of assessment practice in anatomy, whereby assessment was mainly conducted online. Indeed, anatomy educators are facing significant challenges while designing and implementing online assessments, which contributed to the threats of assessment validity. In addition, generic challenges of online assessment, such as integrity and security of online assessment, unoptimized information and communication technology (ICT) facilities, and stakeholders' readiness in practising online assessment had affected the implementation of online assessment in anatomy (9). In this paper, we elaborate on the threats to online anatomy assessment during COVID-19 and discuss methods to convert these threats into opportunities through the lens of assessment principles.

Threats to Online Anatomy Assessment During COVID-19

Several threats were identified on anatomy assessment during the COVID-19 pandemic. Among the major concern of anatomy educators are the attainment of psychomotor learning competency, as it could be minimally captured through the online Objective Structured Practical Examination (OSPE) (10). Without access to cadavers and anatomy specimens, there were limited areas that could be assessed in the online OSPE. Hence, anatomy educators need to be vigilant in finding alternatives to psychomotor and affective skills assessments.

The rapid needs to offer alternative assessment have left the anatomy educators with insufficient time and experience to prepare for a robust anatomy assessment. Anatomy educators especially those without prior experience in blended learning struggled when it comes to designing assessments or understanding the different aspects and needs of assessment following the online teaching delivery. The lack of experience and understanding of assessment principles become the first barrier for anatomy educators to conduct evaluations on students' performance. The unprecedented adjustment for remote and digital assessment throughout the COVID-19 period also impacted students and educators because they were ill prepared for the technical and the digital mastery needed for online assessment. Poor internet connectivity, lack of suitable devices, and

inexpert anatomy educators to deliver technology-based teachings and/or assessments are amongst the identified threats that could impact the students' engagement based on the Strength, Weakness, Opportunity, Threat (SWOT) analysis in a previous report (11).

Despite the extensive effort and attractive schemes from the Malaysian government to provide internet accessibility for the citizen, data from the Internet Users Survey 2020 (IUS-2020) conducted by the Malaysian Communications and Multimedia Commission reported only a 1.3% increase in internet users since 2018 (12). This slow growth of internet users in Malaysia, despite the demanding needs of technology-enhanced learning during COVID-19 time, means that internet accessibility is a potential threat to anatomy online examinations. There is also a global concern on internet security, which could be another potential threat to online assessment; however, the IUS-2020 report shows that only a small percentage of internet users in Malaysia were worried about internet security while most of them trusted the government to protect their data.

Moreover, a credible online anatomy assessment requires reinforcement of academic integrity and the security of the whole process of assessment and its system. Maintaining high academic integrity is not only fortifying the university's reputation but may also extend beyond the professional and long-term career development for a student. An extensive review paper explores the reasoning behind academic irregularity in online assessment amongst the students, which were contributed by individual factors, institutional factors and medium of delivery (13). The similar review emphasized various methods that could be employed to reduce the dishonest practice, namely the use of online proctoring software, challenge questions and biometric checks (13).

Adapting Assessment Principles into the New Norms

The global COVID-19 pandemic has driven drastic changes to how higher education institutions operate. The mutually exclusive assessment method has been rigorously arranged in the present-day pandemic where the conventional assemblage is ineffective. The curriculum objective must be achieved, which required the governance bodies to work conjointly with the acquirable technologies. With the implementation of numerous preventive measures such as wearing a face mask, stay-at-home restriction, social distancing, and banning public events and gatherings (14, 15); higher education institutions (HEIs) has reformulated new norms in providing education during the pandemic. The most drastic change in the HEIs is the shift to online learning as the primary educational platform, for ease of management during a mobility restrictive pandemic situation (16, 17). However, the shift to online learning pose a challenge for anatomist, especially when face-

to-face practical sessions is considered paramount to anatomy teaching (18). Cadaveric dissection is abominably affected during the pandemic, attributed by fewer donor during pandemics in conjunction with the dispersion of the affliction (19). While most institutions have integrated practical videos to supplement anatomy practical sessions, there were also plans to revisit practical sessions once the pandemic ends, to make up for the lack or compromised practical exposure during lockdown (18, 20). Even so, with the reopening of higher education institutions, face-to-face teaching cannot resume immediately, instead hybrid teaching and learning activities need to be implemented to mitigate the spread of COVID-19 infections among students, staff and local communities.

Consequently, the conduct of anatomy assessment needs to comply with the new norms of higher education. In general, the assessment is conducted through the digital platform, but in conditions when online assessment could not cater for some learning competencies, or when face-to-face assessment is unavoidable, the assessment environment should be conducted in small groups to permit good social distancing with adequate personal space. Despite adapting to these new norm ecosystems, designing anatomy assessment during the COVID-19 pandemic requires proper planning that balances constructive alignment with the utility of assessment. These are important to ensure validity and usability of assessment regardless of the assessment approach.

The constructive alignment is based on the outcome-based education principle, whereby assessment is designed to achieve learning outcomes that are predetermined prior to any teaching and learning activities (21). It is based on two principles: constructivist psychology, where students are the focus to construct their knowledge through learning activities; and curriculum theory, which postulates that optimal learning is achieved when teaching and assessment methods are aligned to the learning outcomes and assessment (22). In medical education, learning outcomes cover the whole spectrum of learning competency, namely cognitive, psychomotor, and affective learning. However, the achievement of psychomotor and affective competency is limited through online digitized examination (23). Hence, educators need to be creative to ensure that the assessment practice during COVID-19 is valid, reliable and imposes significant educational impact (24).

On the other hand, five elements contribute to the utility value of an assessment, namely validity, reliability, practicability, cost-effectiveness, and positive educational impacts (25). Validity and reliability reflect the psychometric properties of an assessment, whereby validity is referred to the ability of the assessment instrument to measure what it supposes to measure, while reliability indicates reproducibility of the assessment result given the same or similar condition

(25). Meanwhile, the practicability of an assessment refers to the feasibility of conducting the assessment in the current context even at the stake of compromising its psychometric rigour (26). Likewise, evaluating the cost-benefits of an assessment is important to outweigh the balance between psychometric credential and resources required by the assessment. Performing a resource-intensive assessment—even though is costly—could be a cost-effective measure to evaluate performance credibility (25, 26). More importantly, assessment practice should impose a positive impact on student learning as this factor contributes to the accuracy of the psychometric component of an assessment (25).

Balancing between constructive alignment and utility of assessment during the COVID-19 pandemic is of utmost importance to ensure successful implementation of assessment practice without jeopardizing its psychometric rigor. This effort could be achieved by synergizing the summative with formative assessment into practice.

A revolutionary concept of summative and formative assessment

Assessment can be divided into formative and summative assessments. Formative assessment guides students for future learning, whereby it provides reassurance, encourages reflection, and moulds values of learning. In general, formative evaluations are used to identify students' strengths and weaknesses, guide future teaching and learning directions and encourage self-motivation to acquire knowledge and skills outside of assessment-driven objectives (27). Therefore, a student's innate motivation to learn may be reinforced, and they can be inspired to set higher goals for themselves (28). On the other hand, the summative assessment allows instructors to make an overall judgement about competence, fitness to practice, or qualification for advancement to higher levels of responsibility (29). It also are used to assess the achievement of student learning and skill acquisition at the end of a period of instruction (30). In anatomy education, summative assessment is given more emphasis, whereby cognitive and psychomotor competencies were assessed during continuous assessment or final examination (31).

To synergise formative and summative assessment into practice, an instructor needs to understand the three categories of assessment purpose, namely the assessment of learning, the assessment for learning, and the assessment as learning (32). These three assessment purpose models are hierarchically arranged in an assessment pyramid based on how much the approaches are being utilized in educational practice (Fig 1(a)) (32). Assessment of learning refers to the summative assessment, which requires grading from the teachers. It is evident from the assessment pyramid that summative assessment dominates the assessment practice as it is

the most utilized form of assessment, either in schools or higher institutions. The second level of the pyramid is occupied by the assessment for learning, a type of formative assessment that requires teachers' evaluation of students' performance, and provision of constructive feedback (32). Assessment for learning incorporates assessment as part of classroom activities, whereby information gathered from this practice is used to modify the teaching process to accommodate student needs (33). While assessment as learning is empowerment of students' role in formative assessment, whereby students are required to critically evaluate their performance (32, 34). However, given its intricacy nature, the assessment as a learning practice is the least favourable option among the three approaches (32).

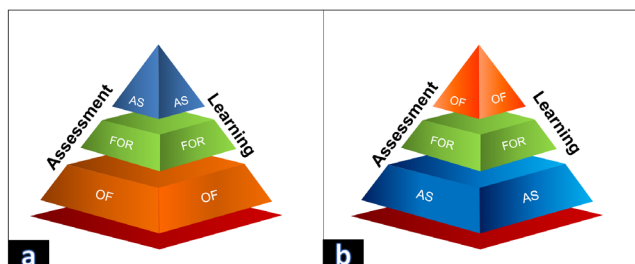


Fig 1 (a) Traditional assessment pyramid; (b) Revised assessment pyramid

Nevertheless, to address the uncertainty of future educational scenarios, Earl (2012) has reconfigured the traditional assessment pyramid by emphasizing more weightage on formative assessment (i.e., assessment as learning, and assessment for learning) (Fig 1(b)). Among the anticipated scenarios include possible future (i.e. situation that could happen although the possibility is low – such as pandemic), probable future (i.e. inevitable event that occurs as a result of no preventive measure), and preferred future (i.e. ideal condition that is favoured due to its educational impact) (32). In view of the positive impact of formative assessment on student learning, there have been significant arguments on changing the merit-based summative assessment to feedback-based formative assessment even before the pandemic struck (35). Indeed, the revised assessment model that enforces the use of formative assessment is more practical in the current pandemic situation, while the summative assessment is reserved only for making the high-stake decisions and certifying students learning. Hence, the limitation of digitized online assessment could be minimized during the COVID-19 pandemic.

The use of assessment for learning and assessment as learning would be able to address the appraisal of psychomotor and affective skills in anatomy education, which are otherwise difficult via assessed in the digitized online examination. Indeed, formative assessment is an effective learning tool that gives the opportunity for students to identify their weaknesses and strength, and learn from their mistakes through constructive feedback without being penalized (36). Consequently,

formative assessment provides information on students performance that can diagnostically modify or improve the teaching methods (37). Examples of formative assessment in anatomy education include problem-based learning (38), activity in interactive virtual anatomy tutorials (39), anatomy quizzes (40), gamification (41), online discussion (42), and virtual body painting (43). From these activities, students would be able to conduct some hands-on activities that can fulfil several functional skills, such as practical, intrapersonal, interpersonal and communication skills. Table I summarizes the description and examples for assessment of learning, assessment for learning, and assessment as learning in anatomy.

Table I: Assessment of learning, assessment for learning and assessment as learning in anatomy

Assessment purpose	Description	Examples in anatomy
Assessment of learning	<ul style="list-style-type: none"> ▪ Summative assessment that requires grading from the teachers/instructors ▪ The grading is used to make high-stake decision on students' performance and certifying students' learning. ▪ It includes final examination and continuous assessment. 	<ol style="list-style-type: none"> 1) Written examination: MCQ, Essay, OSPE, spotter examination. 2) Oral examination: Viva voce 3) Continuous assessment: End of semester examination, PBL, TBL, CBL students' seminar
Assessment for learning	<ul style="list-style-type: none"> ▪ Formative assessment that is incorporated as part of classroom activities. ▪ Students receive immediate and constructive feedback during the assessment. ▪ Teacher/instructor is the assessor ▪ Information on student' performance is used to modify teaching process to accommodate student needs 	<ol style="list-style-type: none"> 1) PBL, TBL, CBL 2) Intra-class quizzes 3) OSPE-based practical 4) Students' seminar* 5) Structured group task*
Assessment as learning	<ul style="list-style-type: none"> ▪ Formative assessment assesses students' cognition about their own learning (metacognition on learning) ▪ It empowers students to self-monitor and self-reflect on their learning and performance ▪ Students is the assessor (students assess their own learning) 	<ol style="list-style-type: none"> 1) Silent mentor programme 2) Portfolio-based assessment 3) All assessments mentioned under assessment for learning as long as it involves metacognition, self-monitoring and self-reflection)

MCQ: Multiple choice questions; OSPE: Objective structures practical examination; PBL: Problem-based; TBL: Team-based learning; CBL: Case-based learning

Designing Holistic Anatomy Assessment Through A Modified Programmatic Assessment Design

A good assessment design should be able to measure learners' competence, which is reflected by the attainment of learning outcomes. It was argued that the summative written assessment alone has some drawbacks in determining learners' competence, namely, its reliability is limited by sampling quality (44), and it is merit-based with binary data points (i.e. pass and fail) (45). Given the arbitrariness of this individual assessment design, this form of assessment is not sufficient to assess learners' competence (45). An ideal assessment of competence should be designed longitudinally, whereby the assessment is done at multiple time points using multiple assessment tools to increase its validity and reliability. In medical education practice, this assessment design is known as programmatic assessment (25).

The concept of programmatic assessment is aligned with the idea of adopting assessment for learning, and assessment as learning, in an attempt to address the limitations of assessment of learning (46). In that sense, programmatic assessment focuses more on guiding student learning, rather than making a decision on students' performance, as it empowers the assessors to give feedback on students' strengths and weaknesses, and instil motivation and insight to make self-evaluation on their own learning needs (46). Programmatic assessment design combines several individual assessments throughout the curriculum, whereby students are being assessed continuously at different time points during their learning process (47). The programmatic assessment model reconfigures the summative and formative assessment types as a continuum measurement, from low to high stakes judgement (25). It allows triangulation of assessment, whereby students' performance is interpreted based on multiple data from different sources. For instance, students' performance during classes are continually observed by several assessors and are combined with the final examination performance to make a decision on the students' competence levels (25). Giving the fact that programmatic assessment utilizes multiple snapshots of assessment data, this assessment model is considered to be robust, valid and reliable. However, given the fact that all assessment data are considered for final decision making, implementation of programmatic assessment was noted to be labour-intensive and time-consuming. Therefore, the programmatic assessment may not be suitable in some educational setting and thus warrant a modified assessment design that is practical, yet valid and reliable.

In the anatomy education context, the concept of programmatic assessment can be applied to create a holistic and longitudinal assessment approach in assessing anatomy competence. However, the assessment for learning and assessment as learning

should be maintained as a formative assessment rather than summative assessment, which means that students' achievement during this assessment time points is not considered for making the final decision. The focus of formative assessment is to provide the students with diagnostic, therapeutic and prognostic information on their learning, which empower them to optimize their strengths and minimize their weaknesses while fulfilling their learning gaps. Indeed, this modified form of programmatic assessment is practical in assessing anatomy competence as suggested previously (5). Anatomy competence encompasses three domains outcomes, namely mastery of anatomy core knowledge, application of clinical anatomy knowledge, and three-dimensional (3D) visualization of anatomy structures (48). Each of these domains overlies a wide spectrum of specific learning outcomes that reflects cognitive, psychomotor and affective skills (49). Hence, it is almost impossible to assess anatomy competence purely through a single summative assessment approach.

In general, there are three domains of anatomy competence, namely anatomy core knowledge, 3D visualization skill, and clinical application of anatomy knowledge (49). To ascertain that both formative and summative assessments measure the whole requirement of competence, multimodal assessment tools need to be utilized during the modified programmatic assessment design (50). For instance, the assessment as learning and assessment for learning can be conducted through intralecture quizzes, students' seminars, structured group tasks, cadaveric dissections, team-based learning, problem-based learning, oral assessment, and students' portfolio, and written assignment (36, 44). Nevertheless, during the COVID-19 pandemic, these forms of formative assessment may require modification to suit the online learning environment (e.g., virtual dissection task, online group discussion and presentation, online team-based or problem-based learning, and online quizzes) (51). Constructive feedback and platform for students to reflect on their learning should be provided during or at the end of each formative assessment to ensure that students would benefit from this assessment practice. On the other hand, the final summative assessment should be reserved for making high stake decisions on students' achievement, especially during this COVID-19 pandemic, when the conventional assessment practice is no longer feasible.

The challenge of conducting written summative assessment during this pandemic era is the inability to efficiently assess for higher-level psychomotor skills, which is crucial in anatomy education (10). However, given the fact that students are only required to develop 3D visualization of anatomical structures as a descriptor of anatomy competence, it is sufficient to highlight that the practical skill can be assessed through online Objective Structured Practical Examination (OSPE) or virtual reality bell-ringer (VRBR) exams, that emphasizes

on the identification of anatomical structures and their 3D relationships. This competency fulfils the minimum level of Simpson Psychomotor Learning Taxonomy (P1- Perception level) that requires learners to use their sensory modality as their response to trigger and stimulus, and translate the input into 3D visualization (7). Likewise, to measure the anatomy core knowledge and applied clinical knowledge, multiple types of assessment questions should be used to cater for a different levels of cognitive competence, as highlighted in the Bloom Taxonomy (7). For instance, Multiple True False (MTF) questions can be used to assess anatomy core knowledge, while, single-best answer questions, open-ended questions, extended matching questions, and modified essay questions can be used to assess the clinical application of anatomy knowledge (52, 53).

Overcoming Challenges of Online Anatomy Assessment

In general, various elements govern a good online assessment environment in anatomy, which requires actions and supports from various stakeholders. In this paper, we proposed six practical approaches to overcome the challenges of online anatomy assessments.

First, the implementation of modified programmatic assessment that allows multimodal assessment approach at multiple assessment points (54). The programmatic assessment offers continuous feedback to both, the students and instructors, in terms of learning gap and progress, and high-stakes decisions can be made based on these low-stakes assessments. Nevertheless, this form of assessment design requires proper planning to ensure holistic attainment of learning outcomes (55).

Second, as an alternative to online assessment, high-stakes examinations can be done in a small group of students with proper social distancing and personal protective gear. Meanwhile, the psychomotor assessment can be delayed and revisited when face-to-face teaching and learning is resumed (55).

Third, modification of current assessment policy and practices is required to embrace digitalized assessment. The HEIs play important roles in providing policies related to digital and online procurement, and professional development supports to academic staff and students (56). Other than top management and faculty representatives, as one of the major stakeholder groups, student involvement in the modification of this policy will also improve transparency and promote engagement (57). Indeed, there is a need for HEIs to develop a digital blueprint that can chart the trajectory of digitized teaching, learning, and assessment at their institutions (58). This effort would provide a clear guideline of digitized assessment for future practice.

Fourth, the development or procurement of examination question bank software helps to safeguard the integrity

and security of the exam questions. Besides that, threats to assessment integrity such as cheating can also be mitigated by designing assessment that evaluates higher-order thinking skills (44). Although it was argued that designing higher-order thinking questions is challenging in anatomy, this task is not impossible as it could be achieved through vertically and horizontally integrated questions (7). The open-book method in assessing the higher-order cognitive skills in anatomy is suitable in assessing the clinical and functional application of anatomy knowledge, or analysis of integrated anatomy knowledge (59, 60). Moreover, the use of open book assessment in anatomy has recently increased ever since the COVID-19 pandemic, as it could alleviate the psychological burden of online assessment (11). Therefore, HEIs should prioritize academic integrity and develop a good system to monitor for assessment irregularities and not be hesitant to impose strict penalties as this will guard against dishonest practices. Various methods have been used to preserve the integrity and security of the online assessment environment which includes online vetting, biometrics-based authentication features, remote proctoring, lockdown browsers, and software like 'TurnItIn' to check for plagiarism.

Fifth, to ensure the fidelity and fairness of online assessment, sufficient funding is crucial for upgrading the existing ICT facility (57) and providing equivalent technological environments for all students and instructors (61). For example, a reliable exam software that is equipped with security features (i.e. lockdown browser and artificial intelligence proctoring) should be used to prevent online cheating (62). It is also recommended to provide a backup online platform, to prepare for any unexpected circumstances. In the anatomy context, it is very crucial to provide anatomy software for teaching, learning and assessment purposes, to cater for the achievement of psychomotor competency. The use of online anatomy software would be able to stimulate students' 3D visuospatial ability, which is one of the anatomy competencies that was outlined by Schoeman & Chandratilake (5).

Sixth, offering ICT training and workshop to students and instructors will equip them with essential skills related to online assessments and, at the same time, boost their confidence and motivation to move from traditional to alternatives assessments (57). Good preparation, which includes secured internet connectivity, and supported devices with the latest software updates will not only secure the confidence level in the student but could also enhance the motivation to sit for the exams. Likewise, the examiners and invigilators are also required to be equally prepared, and that includes their willingness and insight in conducting their roles. They also need to develop familiarity with the online assessment system, have clear expectations, and be able to communicate effectively with the students (63).

Lastly, from the outset of the COVID-19 pandemic, there is a huge concern about the increased levels of student anxiety and mental health issues that emerged as a result of online teaching, learning and assessment (64). Hence, HEIs should provide good pastoral support on top of the technical and academic supports. Table II summarises ways to overcome challenges in anatomy assessment amidst the COVID-19 pandemic.

Table II: Overcoming challenges in anatomy assessment amidst COVID-19

Challenges	Solutions
1) Attainment of psychomotor learning competency is minimally captured through online assessment	1) Synergise formative and summative assessment into assessment practice by optimising the use of assessment <i>for</i> learning, and assessment <i>as</i> learning
2) Impairment of constructive alignment as some learning outcomes could not be achieved through online assessment	2) Adopt the modified programmatic assessment design into assessment practice
3) Lack of policies related to digitized assessment, online procurement, and professional development supports to academic staffs and students	3) Modify assessment policy and practices to embrace digitalized assessment.
4) Security and integrity issues of online assessment (i.e., online cheating, ineffective remote proctoring, poor internet connection, lack of safe exam browser)	4) Improve ICT facilities (i.e., internet network, use exam online browser and exam question bank) to safeguard the integrity and security of online assessment
5) Lack of experience and understanding on online assessment practice, which results in unreadiness to venture in online assessment	5) Offer ICT training and workshop, as well as pastoral support to students and lecturers to improve their knowledge and readiness to online assessment,

ICT: Information and communication technology

CONCLUSION

With the evolvement of anatomy assessment practice amidst the COVID-19 pandemic, it is envisioned that future anatomy assessment would be in hybrid form through synergism between formative and summative assessments, either in digitized or face-to-face approach. The assessment would become more student centred by leveraging the assessment as learning, and assessment for learning, with the emphasis of evaluating both specific and generic competencies. The use of artificial intelligence in assessment practice would be normalized especially for evaluating functional skills competency such as psychomotor skills. Assessment will become more robust as the instructors became more aware of the importance of the multimodal assessment approach and multiple points of measurement. The features of future

assessment practice would ensure the development of future proof assessment, which is aligned with the future industrial revolution 5.0, emphasizing high-technology and high-touch elements.

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