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THE INTERDISCIPLINARY JOURNAL OF PROBLEM-BASED LEARNING

SPECIAL ISSUE: UNPACKING THE ROLE OF ASSESSMENT
IN PROBLEM- AND PROJECT-BASED LEARNING

The Triple Jump in Problem-Based Learning: Unpacking Principles and Practices in Designing Assessment for Curriculum Alignment

Monaliza M. Chian, Susan M. Bridges, and Edward C. M. Lo (University of Hong Kong)

ABSTRACT

Assessment validity, reliability, and constructive alignment to planned learning outcomes are less understood in the context of integrated, problem-based curricula. This conceptual paper examines a Triple Jump Assessment (TJA) employed as a formative and summative assessment system in the first year of an undergraduate dental program. Specifically, we deconstructed this instantiation of a TJA in terms of management and co-ordination; assessment design and item development; assessment administration; and assessment review, refinement and modification. Four core principles of TJA design for constructive alignment in an integrated, problem-based curriculum were identified as: (a) viewing the assessment design process as a collaborative and collective faculty endeavor; (b) recognizing the assessment design process as dependent on faculty and students' shared understandings of learning, teaching, and assessment; (c) highlighting the centrality of ongoing review and monitoring to ensure validity and reliability; and (d) prioritizing student learning in the development of the TJA as an assessment system.

Keywords: problem-based learning, curriculum design, constructive alignment, assessment, assessment design

Introduction

Across higher education institutions, faculty have been grappling with the challenges of redesigning curricula to prepare learners to adapt and compete in a dynamic society (Khan & Law, 2015; Kouwenhoven, 2009). The increasing demands to promote interdisciplinarity, innovation, and internationalization require curriculum and course designers to construct learning opportunities for students that support development of deeper levels of disciplinary knowledge and skills as well as academic and generic skills in self-directed learning and communicative competencies (Cazden, 2017; Kouwenhoven, 2009; Yew, Chang, & Schmidt, 2011). These challenges are further compounded when curriculum, teaching, and assessment are misaligned. Writing separately and jointly, John Biggs and Catherine Tang (Biggs, 1996; Biggs &

Tang, 2007, 2011) proposed that a curriculum model should systematically align learning activities, the intended learning outcomes, and assessment, referred to as “constructive alignment.” Significantly for this paper, they also indicated that problem-based curriculum models provided an example of well-aligned curricula (ibid.).

Grounded in constructivist theory, Biggs and Tang (2007) explained that “constructive” refers to the notion that learners construct knowledge and outcomes through their own activity (i.e., learning activities) and “alignment” attributes to the assurance that the “intended verb in the outcome statement is present in the teaching/learning activity in the assessment task” (p. 52). In the context of “constructive alignment” and assessment in professional and especially problem-based curricula, Biggs and Tang (2007) proposed that “professional knowledge and skill are the intended outcomes,

the professional practice comprises the teaching/learning activities, and professional knowledge and skills are what are assessed (among other things)” (p. 157). Problem-based learning (PBL) has been regarded as a philosophy, pedagogical approach, and integrated curriculum that takes a learner-centered approach that guides learners to collaboratively (co)construct deep understanding of the complex issues of a “wicked problem” to an ill-defined problem by analyzing the problem, generating potential solutions, integrating theory and practice, conducting research, and applying knowledge and skills (Moallem, Hung, Dabbagh, 2019; Savery, 2015; Lu, Bridges, & Hmelo-Silver, 2014; Ritchey, 2013). While Biggs and Tang’s recommendations may be viewed as a simplistic and formulaic solution to assessment design, given the structural complexities of an integrated, problem-based curriculum, designing an assessment system at scale remains a complex challenge (Doubleday et al., 2015).

This conceptual paper, therefore, aims to explore the issues raised above by unpacking the design of a local adaptation of the “triple jump,” referred to as the Triple Jump Assessment (TJA) with a designer of the assessment system. The specific context is a long-standing TJA employed as an integrated assessment system administered to first-year students in a Bachelor of Dental Surgery (BDS) program at a university in Hong Kong. Through the process of reconstructing the preparation, administration, and refinement of this integrated assessment task, this paper aims to present the underpinning conceptual and pragmatic considerations employed by the curriculum team in their goal of designing a valid and reliable assessment system in the context of constructive alignment in a problem-based curriculum.

In considering the core concepts of validity and reliability, for this paper, a “valid” assessment is considered an appropriate, substantive, relevant, and useful measurement tool to assess the learning and teaching outcomes (Hopkins, 1998; Linn & Miller, 2005; Sadler, 2009). In other words, the assessment tasks and the content of the assessment materials must be appropriate to measure what they are intended to measure. Further, the content of the assessment materials must be substantive and relevant to the intended learning outcomes. The assessment tasks must be congruent with the learning and teaching activities within the program. For student learning, the results of the assessment should be considered as not only informing students’ current performance but also supporting individual goal setting. For faculty curriculum leadership and ongoing curriculum development, the assessment design and its implementation should support designer reflexivity and ongoing modifications in the teaching and learning activities, intended learning outcomes, or assessment tasks.

Sadler (2009) also argued that validity is connected to the issue of “fidelity,” a precondition of integrity in grading achievement, echoing the need to have the activities required for the students to perform during the test closely resemble the students’ performances in class. Reliability is another central tenet of assessment practices and design. For the purpose of this paper, reliability refers to the replicability and consistency of the administration process as well as the assurance of fairness, free from biases and distortion (Hopkins, 1998; Linn & Miller, 2005). In other words, the administration procedure must be easily understood by both the test administrators and the students, and the procedure of the same assessment must be similar for the preceding administration. A set of standardized guidelines during the examination must be provided and communicated to the students and the test administrators. The central premise of this paper, therefore, is that the attainment of constructive alignment is a precondition of a valid and reliable assessment system, in this case at the scale of the first year of a five-year undergraduate program. In what follows, we use the Triple Jump Assessment as an illustrative case to unpack these concepts as they are evidenced in practice.

The remainder of the paper is structured in three main sections. The first section consists of a brief literature review of PBL assessment including a background of the Triple Jump Assessment. The second section unpacks the Triple Jump Assessment. A brief description of the local adaptation of PBL as a learning design is followed by the reconstruction of the Year 1 TJA design with regard to its preparation, administration, and refinement in the context of constructive alignment. The challenges encountered by the assessment designers over the course of development and implementation and how they addressed these to achieve the goals of validity and reliability of the assessment system are also presented. The third section offers some principles of assessment design at the curriculum/program level in higher education, which are particularly relevant to those seeking to design assessments for constructive alignment in integrated, problem-based curricula.

Assessment in Problem-Based Learning

The adoption of PBL as a philosophy, pedagogical approach, and integrated curriculum design continues to expand and evolve across disciplines in higher education (Lu, Bridges, & Hmelo-Silver, 2014; Samuelson, Lundeborg, & McAllister, 2012) and a range of subject areas at primary and secondary levels (Merritt et al., 2017; Toulouse, Spaziani, & Rangachari, 2012). Furthermore, studies focusing on the situated and interactional nature of PBL to seek emic perspectives are

gaining momentum (see Imafuku & Bridges' (2016) Special Issue in this journal), adding to the body of quantitative studies adopting psychometric analyses of learning outcomes and self-reported perceptions (Yew & Schmidt, 2009). Central to the recent growth in ethnographically informed studies is the goal of gaining deeper understanding of the relationship between cognitive development–building processes and social (co)construction of knowledge across contexts and over time (Green & Bridges, 2018). Specifically, the uniting focus of these research studies is the exploration of how students learn within the context of the PBL process and how the PBL processes support and/or constrain learning development. These growing interests in the micro-ethnographic dimensions of PBL parallel the growing calls for more studies of the design of valid and reliable assessment items that align with integrated, problem-based curriculum designs (Bridges, Yiu, & Botelho, 2016; Doubleday et al., 2015).

The argument remains that if one of the fundamental aspirations of PBL is to foster learners' capabilities to conceptualize the dimensions of real-life scenarios and integrate their prior and newly acquired knowledge to generate hypotheses and/or solutions to complex, ill-defined problems, then developing a repertoire of appropriate formative and summative assessments is essential to assessing students' deep learning of foundational knowledge and skills as well as mastery of the problem-solving processes (Allareddy, Havens, Howell, & Karimbux, 2011; Lu et al., 2014). However, how and in what ways to develop such a comprehensive assessment system remains something of an enigma for teachers, curriculum designers, and researchers.

One of the challenges encountered by assessment designers in PBL programs is the issue of validity and reliability of the assessment design and implementation (Walker, Leary, & Lefler, 2015). An enduring concern is the use of traditional assessment methods in integrated, inquiry-based curriculum designs, leading to misalignment between intended learning outcomes, students' learning activities, and assessment tasks (Biggs & Tang, 2007, 2011). The tension between norm-referenced assessment versus criterion-referenced assessment, the imbalance between formative and summative assessment, and the conflict of assessing declarative versus functional knowledge, as well as learning processes or products, all contribute to the complexity of assessment design, particularly in PBL curricula (Macdonald & Savin-Baden, 2004; Biggs & Tang, 2007).

Another challenge is the lack of focus appropriated for assessment design, which is often left to the end of the curriculum design process. This can lead to fragmentary, inappropriate, and incompatible assessment tasks that do not align with the lessons' objectives or learning outcomes (Shuler, 2012). Consequently, several types of assessment have been

developed with their own limitations in design and in the implementation process in order to maintain validity and reliability of the outcomes. Examples of these assessments, although not exclusively adopted for PBL, include but are not limited to group and individual oral and poster presentations, tripartite assessments, case-based scenarios, portfolios, self- and peer assessments, reflective journals, reports, capstone projects, VIVA voce examinations, facilitator/tutor assessments, and triple jump (Kramer et al., 2009; Toulouse et al., 2012). In this paper, we make an in-depth examination of the triple jump assessment with a view of its role in “constructive alignment” (Biggs & Tang, 2007, 2011).

The Triple Jump Assessment

The triple jump assessment is a three-part assessment system originally designed by a group of medical students in Vic Neufeld's PBL tutorial group in the early 1970s and administered by the students' tutor in a one-on-one setting (Navazesh, Rich, & Keim, 2014; Smith, 1993; Toulouse et al., 2012). Smith (1983) indicated that McMaster University adopted the triple jump to assess medical students' clinical reasoning ability and self-directed learning abilities in a PBL program. Since its inception, the triple jump model has been adopted in various contexts, particularly in health education programs, and has been modified in diverse forms (Feletti & Ryan, 1994; McTiernan, Leahy, Walsh, Sloane, & Smith, 2007). One variation serves as a formative assessment to assess students' understanding of the processes and/or discipline knowledge within a particular PBL cycle (McDonald & Savin-Baden, 2004). The triple jump approach has also been used on a larger scale as a summative assessment for a particular course or end-of-year assessment in higher education (McTiernan et al., 2007; Toulouse et al., 2012).

Despite these variations, the triple jump examination has been lauded as among the “best practices among newer assessment tools” (Navazesh, Rich, Chopiuk, & Keim, 2013, p. 1315). However, it is seldom used, particularly in dental schools. One possible reason for a limited adoption of the triple jump model is its demand for substantial financial, time, and human resources. The orchestration of teams of interdisciplinary faculty members to collaboratively develop and administer a triple jump assessment at a larger scale is challenging (Macdonald & Savin-Baden, 2004). This paper, therefore, unpacks the design of a long-standing, local adaptation of the triple jump for an undergraduate dental curriculum in order to uncover its role and underlying design principles in an integrated assessment system. Through this process, the paper explores constructive alignment with a focus on issues of validity and reliability in designing the TJA for formative and summative assessment across the first year of an integrated, problem-based curriculum.

Context: The Triple Jump Assessment in an Integrated Curriculum

In the illustrative case presented here, the Triple Jump Assessment is one part of an integrated assessment system administered with first-year students enrolled originally in a five-year and, since 2012, a six-year Bachelor of Dental Surgery (BDS) program. The BDS's integrated PBL program follows the traditional "closed-loop" PBL cycle as represented in Figure 1 (Barrows, 1986; Walker, Leary, & Lefler, 2015).

The PBL model for this dental program had been described in other articles (see Bridges, Green, Botelho, & Tsang, 2014; Bridges et al., 2016; Bridges, Wyatt-Smith, & Botelho, 2017; McGrath, Comfort, Lou, Samaranyake, & Clark, 2006; Yiu et al., 2011; Yiu et al., 2012). As illustrated in Figure 1, in Tutorial 1 (first phase), a trained tutor facilitates a group discussion to generate hypotheses, identify learning issues, and discuss learning resources from their analysis of the presented problem based on their prior knowledge. The second phase is self-directed learning (SDL), whereby students conduct research on the identified learning issues either independently or collaboratively. For Year 1 students, the problem cycle generally spans one to two weeks and so, after two to three days, the group reconvenes for Tutorial 2 to share new knowledge gained from researching the learning issues, synthesize and apply their new knowledge to the problem at hand, and evaluate their performance. The last phase requires students to consolidate their new learning

and collectively prepare a 'product' demonstrating their newly-acquired knowledge. The following section unpacks the design of the TJA in light of the local implementation of PBL to explore the concept of constructive alignment.

Unpacking the Triple Jump Assessment Design in Alignment With the PBL Program

The goals of unpacking the TJA design are to describe the assessment tasks embedded within the TJA and to examine alignment with the PBL cycle in terms of assessing the PBL process. Specifically, this section focuses on the alignment of the required activities within the embedded assessment tasks of the TJA with the learning/teaching activities within the PBL cycle as well as the alignment of the learning outcomes (Biggs & Tang, 2007, 2011). Of particular focus is the resemblance of the assessment tasks in relation to the learning activities within the PBL problem cycle to explore the "fidelity" of the TJA (Sadler, 2009). Further, particular interest on the ease of replicability of the assessment design is also considered to determine its reliability (Linn & Miller, 2005).

As indicated above, the TJA consists of three parts/jumps (see Table 1) with the required activities within each assessment task aligned to the processes of the PBL cycle, and with minor variations required to avoid potential irregularities during administration that would compromise the assessment results. The two assessment tasks within the first "jump" simulate the processes of the first tutorial in the program's

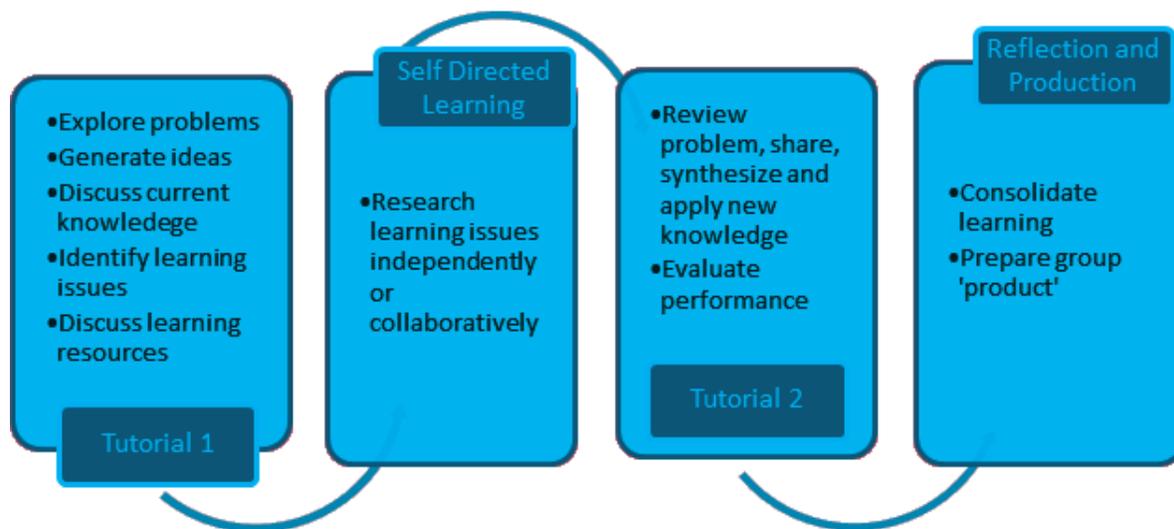


Figure 1. Adopted PBL cycle.

PBL cycle (see Figure 1). The first task is a 45-minute independent written task. The student is required to engage in this process independently and in written form rather than working through the analysis of the problem statement and formulating ideas and key issues/hypotheses through PBL group discussion. This task includes drawing concept maps illustrating an individual students' logic and ability to generate a list of anticipated learning issues drawing from their prior knowledge. The independently-written individual responses are completed simultaneously by the entire cohort who are supervised under formal, timed examination conditions in the PBL seminar rooms. The responses are collected at the conclusion of the first "jump" for independent grading by two calibrated markers.

Immediately following the collection of the individual written task, students are placed into PBL groups. The second task in this first "jump" is a group discussion per their routine PBL Tutorial 1 and the first phase of the PBL cycle (see Table 1). In their groups, students revisit the problem scenario and share their key ideas, concept maps, and anticipated learning issues orally in a PBL group setting. One variation from the PBL tutorial is that the triple jump facilitator is a calibrated facilitator following standardized facilitation guidelines. Students' individual performance during the group discussion is assessed by the facilitator using a standardized rubric based on the following criteria: responsibility for/in the group process; knowledge base; reasoning process; and communication skills. During this process, the internal

Table 1. Triple Jump Assessment in alignment with PBL processes.

Part of Task	Conditions	Required Activities	Alignment to PBL Cycle
Triple Jump Part 1: Task 1	Individual— Timed, written responses under formal examination conditions	<ul style="list-style-type: none"> • Read the problem statement • Explore the problem and inquiry material • Generate ideas about the problem scenario • Organize and represent ideas in a concept map • Identify learning issues 	PBL Tutorial 1 <ul style="list-style-type: none"> • Explore problems • Generate ideas
Triple Jump Part 1: Task 2	Group— Examiner-facilitated discussion	<ul style="list-style-type: none"> • Participate in the discussion of the problem • Provide ideas and prior knowledge • Ask relevant questions • Critically assess data • Generate and identify learning issues • Discuss learning resources 	PBL Tutorial 1 <ul style="list-style-type: none"> • Discuss current knowledge • Identify learning issues • Discuss learning resources
	Individual— Allocation of learning issue	<ul style="list-style-type: none"> • Examiner/ facilitator explains the instructions for TJA Part 2 and Part 3 • Randomly allocates one learning issue to each student to study as an "expert" 	PBL Tutorial 1 <ul style="list-style-type: none"> • Identifying and assigning/distributing learning issues for research
Triple Jump Part 2: Task 3	Individual or collaborative group	<ul style="list-style-type: none"> • Research the assigned "expert" learning issue • Research the other five learning issues 	Self-directed learning (SDL) <ul style="list-style-type: none"> • Student-led study researching topics independently or with peers
Triple Jump Part 3: Task 4	Individual— Written; formal examination conditions	<ul style="list-style-type: none"> • Provide short answers • Demonstrate acquired knowledge of the new learning issues • Provide short answers incorporating acquired knowledge of new learning issues to previously learned material 	<ul style="list-style-type: none"> • Prepare product • Review problem, share, synthesize, and apply new knowledge • Consolidate learning
Triple Jump Part 3: Assessment Task 5	Individual— Oral; structured viva with two expert examiners	<ul style="list-style-type: none"> • Demonstrate the depth of knowledge acquired in relation to the allotted "expert" learning issue 	<ul style="list-style-type: none"> • Share new knowledge

chief examiner and an external (international) examiner also randomly audit the groups and observe the group discussion in order to monitor the facilitation and grading processes.

The facilitator/examiner halts the discussion at a common, specified time and then randomly assigns students the preset learning issues to be studied during the self-directed learning (SDL), the second “jump.” This process is congruent with the close of the first tutorial within the PBL cycle and parallels the self-directed learning (SDL) component of the regular PBL cycle in which students undertake research of the identified learning issues. One deviation is that students are randomly assigned only one particular learning issue to research in order to become an “expert.” After three days of independent study, students are required to independently demonstrate their level of “expertise” in their assigned learning issue. This third and final “jump” consists of three assessment tasks aligned to Tutorial 2 of the PBL cycle but performed individually. The first two tasks are written and the third is oral. The first written task requires students to provide short answers demonstrating their newly acquired knowledge based on the problem statement from the first jump. The second written task requires students to incorporate prior learned content in the newly acquired knowledge from the identified learning issues in their short responses to assigned questions. Both written tasks involve re-evaluating the problem and sharing new knowledge. The written assessments are graded independently by two markers/ examiners referring to a standardized grading scheme and model answers provided by content experts (usually in anatomy, physiology, biochemistry, pharmacology, pathology, periodontology, and dental public health).

The third assessment task is a structured oral examination conducted by two disciplinary content experts. Students are expected to answer a series of leveled questions of increasing complexity within 15 minutes. The disciplinary content experts begin with the most basic question corresponding to basic content knowledge. Both disciplinary content

experts must agree to move on to the next level of complexity until the allotted time is completed. This examination is monitored by the chief internal examiner and an external (international) examiner. The structured oral *viva voce* examination assesses the depth of knowledge gained by the students during the SDL in relation to the student’s allotted “expert” learning issue. This assessment task aligns with the reflection and production phases of the PBL cycle.

As illustrated, the local enactment of the TJA consists of a complex set of multimodal individual and group assessment tasks aligned with the PBL cycle. The next section explores the alignment of the intended learning outcomes with the TJA in order to establish “constructive alignment” (Biggs & Tang, 2007, 2011).

The Triple Jump Assessment in Alignment With Institutional Intended Learning Outcomes

The Triple Jump Assessment is one part of an assessment system for the first-year dental students; hence, it is expected that the assessment tasks align with some, not all, of the year-level and program-level intended learning outcomes (Table 2) as inscribed in the faculty handbook (Faculty of Dentistry, 2014). As indicated in Table 2, both the yearly learning outcomes in the first year of the BDS program align with the goals of the integrated PBL curriculum. Further, the “verbs” (i.e., analyze, identify, handle, evaluate) are explicitly inscribed in both the learning outcomes, which are also present in the teaching/learning activities, as well as in the assessment tasks in the Triple Jump Assessment.

As discussed earlier, the achievement of constructive alignment is a precondition of a valid and reliable assessment. In the next section, the issues of validity and reliability are contextualized in the light of the following three phases. Before reconstructing the three phases, the management and coordination for alignment is presented.

Table 2. TJA in alignment with faculty yearly learning outcomes, BDS program-level learning outcomes.

Yearly Learning Outcomes (First-year)	BDS Program-Level Learning Outcomes
ILO 1.14 <i>Analyze</i> ill-defined problems through student-centered, collaborative, interactive learning processes	<i>Identify</i> key issues related to a newly encountered clinical dental situation, activate prior knowledge, and interrogate new information in order to manage the situation
	<i>Handle</i> unfamiliar problems in a confident and professional manner
	<i>Evaluate</i> their own and their team’s strengths and weaknesses in their professional situation as health care providers

Reconstructing the Phases of TJA: Uncovering the Challenges of Assessment Design

TJA Management and Coordination for Alignment

The design of the TJA as an aligned assessment system requires three iterative and complex phases requiring the coordination and collaboration of many interdisciplinary

Year 1 curriculum committee members responsible for particular tasks within a particular phase(s) as represented in Table 3. There are seven different committees involved throughout the phases of the TJA representing different levels across the institution. Table 3 also makes visible that both internal and external actors are responsible for ensuring quality assurance and fairness in the preparation, administration, and refinement phases of the TJA. Further, Table 3

Table 3. Committees involved in the preparation, administration and refinement of TJA.

Committees	Responsibilities
Faculty Curriculum Development Committee (FCDC)	<ul style="list-style-type: none"> - Reports to the Faculty Board - Oversees the planning and administration of the integrated PBL curriculum
Faculty Teaching and Learning Quality Committee	<ul style="list-style-type: none"> - Upholds quality assurance of undergraduate program
Problem Development Group—consists of a chair and five or six discipline representatives	<ul style="list-style-type: none"> - Works closely with year directors to sequence problems across the year and support knowledge construction across the curriculum - Addresses problem feedback, makes revisions to existing problems, and develops new problem/case scenarios
BDS Year Directors	<ul style="list-style-type: none"> - Manage year-level curriculum development, who report to the associate dean for undergraduate education - Coordinate teaching and learning activities across the context within that year and contribute to curriculum development for each BDS year. - Work with the Problem Development Group and discipline representatives. - Are members of the Faculty Curriculum Development Committee
Problem Review Group	<ul style="list-style-type: none"> - Provides quality enhancement and quality assurance - Ensures newly developed problems align with the particular year's learning outcomes and are appropriately and academically stimulating and challenging
Assessment Group (AG)	<ul style="list-style-type: none"> - Writes problem/case scenarios for the TJA - Collaborates with disciplinary content experts
Disciplinary content experts	<ul style="list-style-type: none"> - Work with AG in writing and refining problem/case scenarios - Devise short-answer questions and provide model answers - Administer the timed oral examination in the third jump
Internal Chief Examiner (CE)	<ul style="list-style-type: none"> - Involved in all of the stages of preparation, administration, and reflection/review/modification - Oversees the administration of the TJA - Ensures fairness and standardization of the examination procedures and live grading during group discussion - Meets with students as a group, with individual students below expectations, and/or by students' requests to provide feedback
External Examiner (EE) as an international supervisor	<ul style="list-style-type: none"> - Assists the CE to supervise and monitor the examination process to ensure standardization and fairness in live grading during group discussion - Writes a report to the vice chancellor
Calibrated Facilitators/Assessors	<ul style="list-style-type: none"> - Facilitate the PBL discussion following standardized facilitation guidelines - Report to the CE - Grade the students' group discussion performance

also reveals the level of collaboration among the curriculum developers, disciplinary content experts, and practitioners during the preparation phase of the TJA in order to align the assessments tasks with learning and teaching activities and intended learning outcomes at the program level.

What is made clear is that the multiple levels of decision-making undertaken by the assessment designers are central to achieving validity and reliability across an integrated assessment system. Reconstructing the preparation, administration, and refinement phases of the TJA for Year 1 of a problem-based program identified challenges in terms of the substantial demands of time, financial, and human resources in designing, implementing, and refining a large-scale integrated system at a program level.

The TJA Development Phase

The preparation phase is composed of series of actions and considerations undertaken by multiple committee members representing the different facets of the dental program (see Table 4). First, the Faculty Curriculum Development Committee formulates a list of learning issues expected to

be learned by first-year students in the program. Members of the Problem Development Groups and the Assessment Group review the list and decide what particular learning issues are to be used for the formative and summative assessments, respectively, based on the students' learning experiences, expected acquired content knowledge, and the targeted learning issues to be learned prior to the administration of the Triple Jump Assessment.

Based on the chosen learning issues, the Assessment Group writes the problem scenario ensuring that the problem statement is new and has never been used in previous years. The writing process involves multiple iterative steps involving reviews and refinements of the problem leading to an internal confirmation process. The final draft is then forwarded to the external (international) examiner for review and approval.

The actions outlined above and in Table 4 support the principles of validity and reliability in that the interdependent collaboration of multiple levels of committees responsible for various facets of the integrated curriculum and the Triple Jump Assessment ensure the attainment of constructive

Table 4. Actions and considerations in the preparation of the TJA.

Actions	Considerations
The Faculty Curriculum Development Committee (FCDC) reviews the scope of the knowledge acquired by first-year students	The FCDC must review the appropriateness of the learning issues to be assessed for formative and summative purposes
The FCDC identifies appropriate new learning issues to be assessed at the onset of the academic year	The target learning issues to be assessed must be separated from the list of learning issues to be used in a regular PBL problem cycle
The Problem Development Group is invited to design a particular "problem template"	The problems for TJA are written by the Assessment Group to ensure the secrecy of the learning issues to be assessed
Appropriate disciplinary content experts from different departments liaise with the Assessment Group	The disciplinary content experts consult with the Assessment Group, which involves - Reviewing the problem statement and suggesting problem refinement if necessary - Providing additional inquiry materials
The Writing Group revises and refines the "problem" and confirms learning issues based on feedback from content experts	The disciplinary content experts and the Assessment Group must closely work together through this iterative process
After final review and confirmation, the Assessment Group sends the final version of the problem and learning issues to the external examiner	The external examiner reviews for appropriateness, provides comments and suggestions, or signs off and approves the proposed problem and learning issues
Disciplinary content experts create short-answer questions and provide model answers and grading scheme	The model answers are used to evaluate students' answers The grading of the papers may not be done by the disciplinary content expert, which is part of the standardization to minimize subjectivity
Assessment Group compiles the assessment tasks	

alignment (Bridges, Yiu, & Botelho, 2016). With respect to validity, the iterative review-revise-refine process undertaken by disciplinary content experts and the Assessment Group ensures the relevance and the appropriateness of the assessment materials. The involvement of the external examiner in reviewing and approving the assessment materials provides quality assurance, thereby affirming the validity of the assessment. Having the disciplinary content experts develop model answers and a grading scheme provides standardization and calibration in the grading process, addressing the issue of reliability.

The TJA Administration Phase

The Triple Jump Assessment is a formal standardized examination administered twice a year for different purposes. The first round serves as a formative assessment given to the students at the end of the first quarter as a “tryout” assessment to familiarize and prepare students in the TJA assessment format and process. As a valid assessment, the results of this formative assessment serve three purposes: (1) to indicate students’ midyear performance, (2) to determine whether any facilitation strategies or curriculum components require modification, and (3) to guide appropriate student feedback.

The second round of the Triple Jump Assessment functions as a summative assessment administered at the end of the first year. Like the formative assessment iteration, the structure and administration process are similar; however, the differences are in the increase of learning issues and allotted time for the oral examination. The TJA as a summative assessment aims to determine the students’ competence as learners within a PBL learning context and to derive a final grade in the first year of the program. The second round of TJA administration addresses the issue of reliability, providing consistency not only in the administration process but also in the similarities of the assessment tasks and questions with a different problem or case scenario. Although the decision to use TJA to function as a formative and summative assessment presents demands of time, financial, and human resources, it addresses the issues of validity and reliability.

The Triple Jump Assessment covers a five-day formal examination period, commencing on a Monday morning and ending on a Friday, which places a demand on curriculum time. The first day involves a briefing by the chief examiner to the whole group of calibrated facilitators before the first jump commences. The first day concludes with explanations and instructions on the next two parts, the second and third jumps. The second jump simulates the SDL within a typical PBL cycle to conduct research on the assigned learning issues. The third jump consists of two parts; the first part is administered on a Friday morning, lasting three hours. The second part is an individual structured oral examination scheduled on the Friday afternoon.

The involvement of the internal and external examiners, calibrated facilitators, and the disciplinary content experts during this phase is central in upholding the validity and reliability of the assessment system. The presence of the internal chief examiner and the external (international) examiner in overseeing and monitoring the administration phase (i.e., group discussion, oral examination) aims to ensure fairness in the live, face-to-face grading and further support the reliability of the assessment system. Investing in calibrated facilitators to facilitate the group discussion with standardized facilitation guidelines minimizes any irregularities of the administration process. Having calibrated facilitators to grade the assessment materials alleviates biases and distortion of assessment results. Requiring two disciplinary content experts to conduct the oral examination and achieve satisfactory inter-rater reliability is also central in the assessment design.

The TJA Review, Refinement, and Modification Phase

The examination review process involves a debriefing meeting of up to 30 minutes that includes the calibrated facilitators, the chief examiner, and the external (international) examiner after the first jump. The facilitators report their observations of the process during group discussion, including observed irregularities and other issues during the examination. They may also provide feedback on the appropriateness of the problem. The external examiner is also responsible for submitting a written report directed to the vice chancellor. This final report may include recommendations for modification of the process or the appropriateness of the problem or case scenario, which are then considered by the Board of Examiners. After the third jump, the disciplinary content experts, the chief examiner, and the external (international) examiner meet for up to 30 minutes to debrief and discuss the scope of the learning issues in relation to the problem statement, the depth of knowledge tested, and specific observations on individual or groups of students. They may also compare grades to arrive at consistency in their judgments of students’ responses. These debriefing sessions are key quality assurance measures that support fidelity by ensuring that the assessment materials are designed to measure what they intend to measure.

Discussion

This paper aimed to address the need to explore constructive alignment conceptually and pragmatically in higher education assessment, particularly in the specific context of integrated, problem-based curricula. Inconsistencies and misalignment of the assessment tasks with the teaching and learning activities and the intended learning outcomes have been identified as sources of challenges in assessment design

across higher education. Unpacking the design and reconstructing the preparation, administration, and refinements phases of one adaptation of a detailed enactment of TJA is one approach that illustrates how to address the challenges of designing a valid and reliable assessment with the lens of constructive alignment (Biggs & Tang, 2007, 2011). Insights gained through this process have highlighted some key principles in assessment design in higher education, particularly in assessing PBL.

The first principle is that assessment design is a collaborative and collective endeavor. The condition to achieve constructive alignment is the alignment of the learning and teaching tasks, intended learning outcomes, and assessment tasks. In order to attain this alignment, the characteristics of the assessment design must be appropriate, substantive, relevant, and useful in relation to the curriculum development, a key criterion in a valid assessment system. Therefore, it is essential to involve actors representing different levels across the institution in the assessment design in order to gain input from multiple perspectives.

The second principle is that assessment design is dependent on a shared understanding of the fundamental perspectives on learning, teaching, and assessment. These shared understandings drive the purpose and the goals of the assessment, which then lead to the design of assessment tasks and materials. Collectively, decisions have to be made on whether the purpose of the assessment system is the assessment of learning or assessment *for* learning (Pellegrino, 2018). If the goal is to take inventory of what the students are learning, then a set of assessment materials can be developed for this purpose. If the goal is assessment *for* students' learning, then more appropriate assessment materials that would provide formative feedback are essential for this purpose (Pellegrino, 2018). The first round of the TJA serves as a formative assessment to inform students of their learning and to guide students' goals and action plans to achieve competency in the summative assessment. The results of the formative assessment serve as guidelines for modifications in the facilitation strategies or curriculum development.

The third principle is that assessment design must require regular review and refinement. Consistent monitoring of the appropriateness of the materials and the administration is critical to the validity and reliability of the assessment system. Modifications of any component of the assessment system must be guided by the assessment results and observations from the prior assessment administration. In the case of the TJA, the reports from the debriefings during the administration phase are the bases for refinement and modification of the assessment system.

The fourth principle is that assessment design must be student-centered. First, the assessment design, process and administration must be clearly communicated to the students, alleviating any elements of surprise. The dates must be scheduled in advance, allowing students to prepare for the assessment. The assessment tasks and materials must be familiar to students with minimal variables. For example, in the case of TJA, the assessment tasks parallel the learning activities within the PBL cycles. The assessment materials and administration procedures are similar during the formative and summative assessment albeit with a new problem statement and concomitant content expressed as learning issues. Finally, the assessment design must create opportunities for students to make progress across the curriculum.

Conclusion

The above deconstruction and reflexive reconstruction with an assessment designer has made visible the often invisible complexities, challenges, and considerations in devising and executing an aligned assessment system that monitors, guides, and assesses what and how students are learning in an integrated, problem-based curriculum. Using Biggs & Tang's (2007, 2011) concept of constructive alignment, the constituent elements and core principles of a valid and reliable Triple Jump Assessment design for problem-based learning were identified as:

1. Viewing the assessment design process as a collaborative and collective faculty endeavor;
2. Recognizing the assessment design process as dependent on shared understandings of learning, teaching, and assessment;
3. Highlighting the centrality of ongoing review and monitoring to ensure validity and reliability; and
4. Prioritizing student learning in the development of the TJA as an assessment system.

This conceptual paper concludes with the hope that by surfacing these principles and practices, it will contribute to the growing understandings of assessment design in higher education and support others in navigating the challenges of assessment design for integrated, problem-based curricula.

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