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

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Abstract-Validity, reliability, and constructive alignment of assessments with planned learning outcomes are less examined in the context of integrated, problem-based learning (PBL) curricula. This paper analyzes the Triple Jump Assessment (TJA), implemented as both a formative and summative evaluation tool in the first year of an undergraduate dental program. The analysis deconstructs TJA across critical domains, including management and coordination, assessment design and item development, administration, and ongoing review for refinement and modification. Four core principles for designing TJA to ensure constructive alignment in a PBL curriculum are identified: collaborative assessment design as a collective faculty effort; fostering shared understanding of learning, teaching, and assessment between faculty and students; emphasizing continuous review to uphold validity and reliability; and prioritizing student learning throughout the assessment process. These insights highlight the potential of TJA to align assessments with curriculum goals effectively, supporting meaningful student learning outcomes in problem-based educational settings.

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

1. 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 Problem-Based Learning (PBL) as a pedagogical philosophy and integrated curriculum design continues to expand across disciplines in higher education and various subject areas at primary and secondary levels. This evolution has been documented in studies highlighting the interactional and situated nature of PBL processes, offering emic perspectives on its implementation (Lu, Bridges, & Hmelo-Silver, 2014; Samuelson, Lundeborg, & McAllister, 2012; Merritt et al., 2017; Toulouse, Spaziani, & Rangachari, 2012). Additionally, ethnographically informed studies are increasingly supplementing the quantitative research tradition, deepening the understanding of cognitive development and the social co-construction of knowledge within PBL contexts (Green & Bridges, 2018; Imafuku & Bridges, 2016).

This growing body of research underscores a shared goal: understanding how students learn in PBL and how its processes support or constrain cognitive and social learning. At the heart of this effort is the need to align assessments with integrated curriculum designs to evaluate foundational knowledge, problem-solving abilities, and skills that PBL fosters (Bridges, Yiu, & Botelho, 2016; Doubleday et al., 2015). While fostering learners' capacity to integrate prior knowledge with newly acquired insights to address complex, ill-defined problems is a central aspiration of PBL, developing valid and reliable assessment systems for this purpose remains a challenge (Allareddy et al., 2011; Lu et al., 2014).

Challenges in Designing PBL Assessments

One of the key challenges in PBL assessment design is ensuring the validity and reliability of assessment tools in integrated, inquiry-based curricula. Traditional assessment methods often lead to misalignment between learning outcomes, students' activities, and assessment tasks (Biggs & Tang, 2007, 2011). This misalignment can result in assessments that fail to capture the depth and complexity of students' learning processes and problem-solving skills.

Additional complexities arise from the tensions between:

- **Norm-referenced and criterion-referenced assessments:** The former focuses on comparing students to peers, while the latter evaluates them against predetermined criteria.
- **Formative and summative assessments:** Striking a balance between these is essential for supporting learning and measuring outcomes.
- **Assessing declarative versus functional knowledge:** The conflict between evaluating content knowledge and its application in problem-solving contexts.

Moreover, assessment design is often treated as an afterthought in curriculum development, leading to disjointed and incompatible tasks that fail to align with the intended learning outcomes (Shuler, 2012). This approach limits the ability to design assessments that capture the holistic and integrative nature of PBL learning.

Current Assessment Practices in PBL

In response to these challenges, a range of assessment formats has emerged. These include:

- Group and individual oral or poster presentations
- Tripartite assessments

- Case-based scenarios
- Portfolios and reflective journals
- Self- and peer assessments
- Capstone projects and VIVA voce examinations
- Facilitator or tutor evaluations
- The **Triple Jump Assessment (TJA)**

Each of these approaches has its strengths and limitations in achieving alignment with PBL's integrative goals. Among these, the Triple Jump Assessment stands out for its potential to address the multifaceted demands of PBL assessments, particularly in fostering "constructive alignment" with curriculum objectives (Biggs & Tang, 2007, 2011).

Focus on the Triple Jump Assessment

This paper examines the Triple Jump Assessment (TJA) as a pivotal tool in assessing students' learning in PBL curricula. Through its unique design, the TJA aims to capture students' ability to integrate foundational knowledge, demonstrate problem-solving skills, and reflect on their learning processes. By analyzing the principles and practices underlying TJA, this paper explores its potential for achieving alignment between learning outcomes, teaching methods, and assessment tasks, contributing to a deeper understanding of assessment in PBL contexts.

The Triple Jump Assessment

The Triple Jump Assessment (TJA) is a structured, three-phase evaluation system initially conceived in the early 1970s by a group of medical students participating in Vic Neufeld's problem-based learning (PBL) tutorial group. It was first implemented in a one-on-one setting by their tutor (Navazesh, Rich, & Keim, 2014; Smith, 1993; Toulouse et al., 2012). McMaster University subsequently adopted this method to evaluate medical students' clinical reasoning and self-directed learning abilities within a PBL framework (Smith, 1983). Since its inception, the Triple Jump model has undergone various adaptations and has found applications in numerous contexts, particularly within health education programs (Feletti & Ryan, 1994; McTiernan, Leahy, Walsh, Sloane, & Smith, 2007).

One variation of the Triple Jump serves as a formative assessment tool, enabling students to demonstrate their grasp of processes and disciplinary knowledge during specific PBL cycles (McDonald & Savin-Baden, 2004). Another prominent adaptation employs it as a summative assessment, either for individual courses or as an end-of-year evaluation in higher education settings (McTiernan et al., 2007; Toulouse et al., 2012).

Despite these variations and its recognition as a best practice among innovative assessment tools (Navazesh, Rich, Chopiuk, & Keim, 2013), the Triple Jump Assessment remains relatively rare in dental education. One reason for its limited use may be the significant financial, temporal, and human resources required to implement it effectively. Coordinating interdisciplinary faculty teams to develop and administer a Triple Jump at scale is particularly demanding (Macdonald & Savin-Baden, 2004).

This paper delves into the design and application of a long-standing adaptation of the Triple Jump Assessment for an undergraduate dental program, revealing its role and core design principles as part of an integrated assessment system. The discussion emphasizes constructive alignment, focusing on validity and reliability in designing the TJA for formative and summative assessment purposes across the first year of an integrated, problem-based curriculum.

Context: The Triple Jump Assessment in an Integrated Curriculum

The illustrative case examined here features the Triple Jump Assessment as a component of an integrated assessment system administered to first-year students in a Bachelor of Dental Surgery (BDS) program. Originally structured as a five-year program, the BDS has been offered as a six-year program since 2012. Its integrated PBL framework follows the "closed-loop" PBL cycle, as outlined by Barrows (1986) and Walker, Leary, & Lefler (2015), and is depicted in Figure 1.

The PBL approach in this dental program has been detailed extensively in prior studies (e.g., Bridges, Green, Botelho, & Tsang, 2014; Bridges et al., 2016; Bridges, Wyatt-Smith, & Botelho, 2017; McGrath, Comfort, Lou, Samaranayake, & Clark, 2006; Yiu et al., 2011; Yiu et al., 2012). The model typically unfolds in three phases.

1. **Tutorial 1 (Initial Phase):** A trained tutor facilitates group discussions to analyze a presented problem, enabling students to generate hypotheses, identify learning issues, and propose relevant resources for further exploration. Discussions draw on the students' existing knowledge.
2. **Self-Directed Learning (SDL) Phase:** Students independently or collaboratively research the identified learning issues. In the first year, this phase spans two to three days during a one- to two-week problem cycle.
3. **Tutorial 2 (Synthesis and Application Phase):** The group reconvenes to share and synthesize their new knowledge, apply it to the problem, and evaluate their performance.

In the final phase of the cycle, students consolidate their learning and collaboratively produce a tangible output that reflects their acquired knowledge.

The following section examines the design and local implementation of the TJA, exploring how it aligns with the principles of constructive alignment and contributes to the program's integrated PBL curriculum.

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

The Triple Jump Assessment (TJA) is a comprehensive evaluation tool that integrates seamlessly with the Problem-Based Learning (PBL) cycle, focusing on assessing the alignment of activities and outcomes with intended learning objectives. It is structured into three sequential parts or "jumps," each reflecting the stages of the PBL process while maintaining fidelity to its collaborative and inquiry-driven nature.

The first phase begins with a task that requires individual students to analyze a problem statement, independently generating ideas and concept maps under formal examination conditions. This activity mirrors the exploratory nature of the first PBL tutorial, where students initially engage with the problem and identify potential learning issues. These written responses are collected and graded by calibrated markers to ensure consistency. Following this, students regroup for a facilitated discussion in their PBL groups, sharing their analyses and collaboratively refining their understanding. The facilitator assesses individual contributions based on criteria such as reasoning, communication, and knowledge, ensuring that students' engagement aligns with the principles of collaborative inquiry.

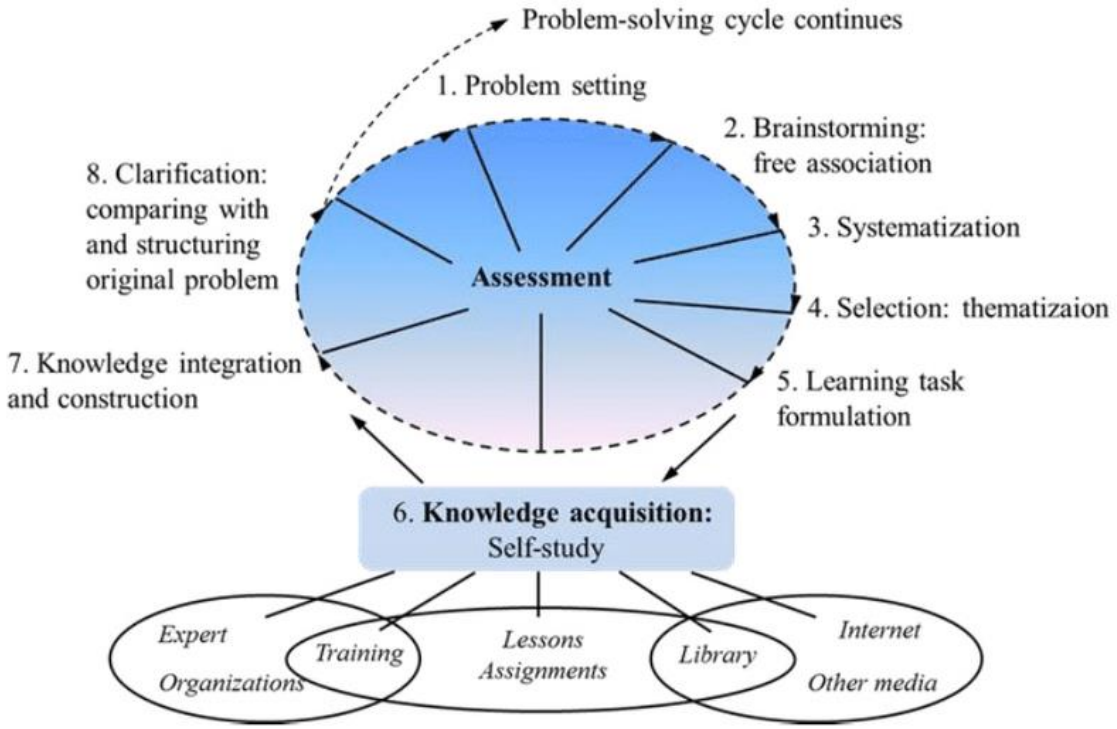

Figure 1 illustrates the adopted PBL cycle, highlighting its alignment with the TJA phases.

Figure 1. Adopted PBL Cycle

At the conclusion of the first jump, students are assigned specific learning issues to research independently during the self-directed learning (SDL) phase, which constitutes the second jump of the assessment. This phase emphasizes the development of deep, autonomous understanding as students explore their assigned topics in depth. In the third and final jump, students are required to demonstrate their knowledge through written and oral assessments. The written component involves responding to questions that integrate their newly acquired insights with prior learning, allowing them to showcase their ability to synthesize and apply knowledge. The oral component is a structured viva voce, where students answer leveled questions of increasing complexity posed by content experts. This task assesses the depth and integration of their understanding, aligning with the reflective and consolidative stages of the PBL process.

Table 1 provides a detailed overview of the TJA's tasks, their alignment with the PBL cycle, and the specific required activities.

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	Read the problem statement, generate ideas, organize into concept maps, identify learning issues	Explore problems, generate ideas
Triple Jump Part 1: Task 2	Group—Facilitated discussion	Discuss the problem, share knowledge, critically assess data,	Discuss current knowledge, identify learning issues

		identify learning issues, discuss resources	
Individual—Learning Issue	Facilitator allocates learning issue	Instructions for SDL phase, random allocation of learning issues	Assigning/distributing learning issues
Triple Jump Part 2: Task 3	Individual/Collaborative—SDL	Research the assigned and other learning issues independently or in groups	Self-directed learning
Triple Jump Part 3: Task 4	Individual—Written responses	Demonstrate new knowledge through short answers, integrate new with prior knowledge	Review problem, apply knowledge, consolidate learning
Triple Jump Part 3: Task 5	Individual—Oral structured viva voce	Demonstrate depth of knowledge on assigned "expert" issue through leveled questions	Reflect and share knowledge, demonstrate mastery

The design of the TJA ensures alignment with the PBL cycle, embedding assessment tasks that reflect the exploratory, self-directed, and reflective nature of PBL. Each component of the TJA is meticulously aligned to intended learning outcomes, providing a clear structure for evaluating student progress and mastery of both content and process.

By incorporating individual and group assessments, as well as written and oral evaluations, the TJA upholds principles of validity and reliability, ensuring it remains a robust and effective tool for integrated curriculum assessment. Further, the fidelity of the TJA to the PBL process highlights its strength in fostering constructive alignment, creating a seamless integration of learning, teaching, and assessment in a manner consistent with the goals of PBL. The figures and tables presented complement this discussion by visually detailing the alignment and design process inherent to the TJA.

The Triple Jump Assessment in Alignment with Institutional Intended Learning Outcomes

The **Triple Jump Assessment (TJA)** plays a crucial role in aligning the first-year dental students' assessments with both year-level and program-level intended learning outcomes (ILOs). The alignment ensures that the assessment tasks are consistent with the educational goals set by the faculty, as outlined in the faculty handbook (Faculty of Dentistry, 2014). As shown in **Table 2**, the learning outcomes of the first year of the BDS (Bachelor of Dental Surgery) program align well with the goals of the integrated **Problem-Based Learning (PBL)** curriculum. These goals focus on active student engagement through collaborative learning and problem-solving.

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

To ensure alignment, the TJA system involves **three critical phases**: preparation, administration, and refinement. These phases are **interdisciplinary** in nature, requiring collaboration among several committees (see **Table 3**) that manage the assessment's design, execution, and ongoing improvement.

TJA Management and Coordination for Alignment

The alignment process for the TJA requires careful planning and coordination across various levels within the institution. **Table 3** outlines the key committees involved in the preparation, administration, and refinement of the TJA, highlighting their responsibilities in ensuring that the assessment aligns with the learning outcomes.

These committees include the **Faculty Curriculum Development Committee (FCDC)**, **Problem Development Group**, and **Assessment Group**, all of which work together to ensure that assessment tasks are valid and reliable. Key roles also include disciplinary content experts, the internal Chief Examiner, and external examiners who provide oversight to maintain the quality of the assessment system.

The TJA Development Phase

The **preparation phase** is essential to ensuring the validity of the assessment. It involves various actions, such as the formulation of **learning issues**, the creation of **problem scenarios**, and the involvement of **disciplinary content experts** to develop questions and model answers. A key feature of this phase is that the **problem scenarios** used in TJA are **new** each year, ensuring that the assessment remains relevant and challenging.

Table 3 Activity and underlying actions of each stage and gate within the original Stage-Gate® process (source: In allusion to Cooper, 2011, 2001, 1997, 1990).

Stage/Gate	Activity	Actions
Start	Discovery	Generation and collection of promising new product ideas.
Gate 1	Idea screen	Selection and prioritisation of product ideas for NPD project within a dynamic process with high uncertainty.
Stage 1	Scoping	Rough market and technology analysis such as assessment of basic financial values.
Gate 2	2nd screen	Decision on project´s progress based on profound conditioned information collection and analysis.
Stage 2	Build business case	Conceptualization of business case including detailed development and market launch plan.
Gate 3	Go to development	Decision on project´s profitability and release of exalted resources.
Stage 3	Development	Technological development and evaluation of marketing and fabrication activities.
Gate 4	Go to testing	Assessment of project's technical feasibility and control of R&D spending.
Stage 4	Testing and validation	Evaluation of customer acceptance, validation of financial planning and technological achievements.
Gate 5	Go to launch	Approval of market launch.
Stage 5	Launch	Market launch and product commercialization.
Post-launch review	Monitoring	Evaluation of launch process.

Table 3 further breaks down the actions and considerations during the development phase, emphasizing the collaboration between the FCDC, Problem Development Group, and Assessment Group. This **iterative process** of reviewing and refining the assessment materials is crucial in maintaining **constructive alignment**, ensuring that the assessment accurately measures the intended learning outcomes.

The TJA Administration Phase

The **administration phase** involves the formal, **standardized** examination process, which is conducted twice a year. The first round serves as a **formative assessment**, allowing students to familiarize themselves with the assessment format. The second round is **summative**, serving to evaluate students' overall performance.

The role of **calibrated facilitators**, **internal** and **external examiners**, and **disciplinary content experts** is essential in maintaining the fairness, consistency, and reliability of the assessment process. The **live grading** during group discussions and oral examinations ensures that the assessment is conducted in a fair and standardized manner, while also providing valuable **feedback** for students.

The TJA Review, Refinement, and Modification Phase

The **review and refinement phase** plays a crucial role in maintaining the validity and reliability of the TJA system. After each assessment, a debriefing meeting is held where facilitators, examiners, and content experts evaluate the process and identify areas for improvement. This continuous **feedback loop** ensures that the assessment system evolves in response to **observed challenges** and the effectiveness of the assessment tasks.

Regular **reviews** and **modifications** are essential in keeping the TJA aligned with the intended learning outcomes and ensuring its continued validity and reliability.

Discussion

This paper has explored the process of achieving **constructive alignment** in higher education assessments, particularly in the context of integrated PBL curricula. Several principles were highlighted through the analysis of the TJA system:

1. **Collaboration in Assessment Design**: Achieving alignment requires a **collaborative effort** from multiple stakeholders across the institution. Each group's input ensures the assessment's relevance and appropriateness for the curriculum.
2. **Shared Understanding**: The success of the TJA system relies on a shared understanding of the **goals** of learning, teaching, and assessment. This common framework guides the design and execution of the assessment tasks.
3. **Regular Review and Refinement**: Continuous feedback from the administration phase ensures that the assessment system is always evolving to meet the needs of the students and faculty.
4. **Student-Centered Assessment**: Clear communication of the assessment process and expectations ensures that students are prepared and can perform effectively during both formative and summative assessments.

By implementing these principles, the **Triple Jump Assessment** system successfully addresses the challenges of assessment design in a **problem-based learning** environment, ensuring both **validity** and **reliability** across all phases.

Conclusion

In this paper, we have provided a comprehensive analysis of the Triple Jump Assessment (TJA) within the context of a Problem-Based Learning (PBL) curriculum. The primary goal was to unpack the design

and implementation of TJA, examining its alignment with the PBL process and its role in achieving constructive alignment of curriculum, learning outcomes, and assessment practices.

The TJA, with its structured three-part assessment design, serves as a formative and summative evaluation tool that closely mirrors the stages of the PBL cycle. Each phase of the TJA—the individual written task, group discussion, self-directed learning, and final oral and written assessments—supports key aspects of the PBL process: the exploration of complex problems, the development of collaborative inquiry, the deepening of knowledge through independent study, and the synthesis and application of new knowledge. This alignment is crucial to ensuring that the assessment tasks are not only aligned with the curriculum but also with the intended learning outcomes, thereby enhancing the validity and reliability of the assessment system.

The TJA's role in assessing both the process and the product of learning makes it a valuable tool in integrated, problem-based curricula. By incorporating both individual and group assessments, as well as written and oral components, the TJA provides a holistic evaluation of student learning. This multifaceted approach ensures that students' cognitive development, collaborative skills, and depth of knowledge are all evaluated in a manner that reflects real-world problem-solving processes.

Moreover, the collaborative nature of the TJA design process—where faculty work together to design and calibrate assessments—ensures consistency in the assessment process and enhances the quality of feedback students receive. The continuous review and refinement of the TJA also ensure that it remains relevant and reliable, adapting to evolving educational needs and maintaining its alignment with the goals of the PBL curriculum.

In conclusion, the TJA represents an effective and adaptable assessment system that can be applied across various disciplines, particularly those employing problem-based learning. It addresses the challenges of maintaining validity, reliability, and constructive alignment in assessment while fostering deep learning and problem-solving skills in students. By integrating assessment tasks with the PBL cycle, the TJA not only evaluates students' acquisition of knowledge but also their ability to engage in critical thinking, collaboration, and independent learning—skills essential for success in both academic and professional contexts. Moving forward, further research and refinement of the TJA can contribute to the broader discourse on assessment in integrated, inquiry-based curricula, with potential applications in other fields of education.

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