Dissecting assessment: A paradigm shift towards technology-enhanced assessments

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Abstract

This study proposes a framework for making a paradigm shift from traditional (teacher-centred) to technology-enhanced (student-centred) assessment, using an example of an intelligent tutor. Informed by Situated Learning Theory that addresses students' needs and concerns in timely learning experiences, the proposed 'dissecting assessment' framework has two primary variables: *Students' Expectations* and *Assessment Deliverable* with positive and negative secondary variables such as *inbuilt fear to handle failures and exposures* and *comparison phobia*. Employing a case study approach, a purposeful sample of 14 U.S. College students were supported by an intelligent tutoring system in monitoring their learning with prompt corrective feedback in their physics course. This formative assessment prepares students for succeeding on their summative assessments, which is the final outcome of learning with feedback. The analysis of the proposed dissecting assessment framework led to the conclusion that concentrating efforts on the positives in the framework, such as *unbiased evaluation*, would eventually reduce the negatives, such as *comparison phobia*.

Keywords: Formative assessment, immediate feedback, intelligent tutoring, self-evaluation, technology-enhanced assessment.

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1. Introduction

Growing technological advancement has prompted a paradigm shift from traditional forms like paper tests to technology-enhanced assessments for the digital natives in our 21st Century classrooms. The integration of information and communication technologies into assessment, to include social media and intelligent tutoring, help to promote universality and self-improvement (UNESCO, 2014). Technology-enhanced assessment requires less teacher-centred and more learner-centred approaches to assessment for achieving goals and learning outcomes in educational programmes. The terms *assessment* and *evaluation* in the literature are used interchangeably (Sweeney et al., 2017) in this paper. Branch (2009) refers to the Level 2 evaluation that measures acquisition of knowledge and skills in the ADDIE approach. Similarly, this measurement also refers to the assessment that measures '... student learning and attainment of learning outcomes at the unit/subject or program level' (Sweeney et al., 2017, p. 2).

Increasing enrollment and access to online courses (Seaman, Allen & Seaman, 2018) would also result in an increase in e-assessments and warrants an exploration of dissecting the student assessment process to better understand how, particularly students, can make the learner-centred shift to technology-enhanced assessments (Thurlow, Lazarus, Albus & Hodgson, 2010). One learner-centred approach found to motivate students and share responsibility for their learning performance is self-evaluation (UNESCO, 2012). Self-evaluation allows for an enhanced ability to empathise with one's unmet goals by making a special effort to meet or surpass these goals through self-correction and autonomous learning. Informed by situated learning theory (SLT), these formative self-assessments take different e-formats, such as digital quizzes, games and intelligent tutoring, in accommodating today's digital natives (Crisp, 2011; Crockett & Churches, 2017). A key tenet of Situated Learning Theory (STL) is to address the student's needs and concerns through specific timely learning experiences, which include collaboration with experts on authentic tasks (Stein, 1998). The current paper is informed by STL and uses an example of real-life intelligent tutoring to extrapolate a proposed framework for dissecting assessment in making a paradigm shift to technology-enhanced assessment.

2. Methods

Using a case study design that allows for studying phenomenon in context (Baxter & Jack, 2008), the second author created an intelligent tutor using Carnegie Mellon University's award-winning Cognitive Tutor Authoring Tools. This intelligent tutor supported a purposive sample of 14 students in a college level introductory physics course at a North Eastern college in the United States. Trends in attrition rates in Science, Technology, Engineering and Math programmes are of concern to educators and efforts to curb this trend are ongoing (Chen, 2013). Intelligent tutoring was used to scaffold students' learning. Students were required to enter their calculated answers, and if the answer was correct, the student proceeded to the next step of the solution. If the answer was incorrect, the student was provided with immediate feedback stating why the answer was incorrect. At this point, students could either re-try entering their answers or ask for a hint. Hints were provided in three stages—the first was a soft hint, steering students in the correct direction, and giving general formulas; the second hint was more direct, guiding them to the correct formula to use in the context and the third was a bottom-out hint, giving students the correct answer to enter. The bottom-out hint intended to minimise student frustration and accommodate those challenged in figuring out the correct answer. It was anticipated that the bottom-out hint would help them reconcile and work their way backwards to understand how to arrive at the correct answer. Students' intelligent tutor interactions were recorded anonymously and streamed to the world's largest educational data repository, 'Datashop' (Koedinger et al., 2010). The data were later analysed using descriptive statistics represented in graphs to measure student learning and improvement and also identify patterns in student errors that could reveal underlying student misconceptions or common calculation errors.

3. Results and discussion

Interesting data that help us visualise student learning is the amount and extent of help students need with every successive opportunity to arrive at a correct answer. An 'opportunity' refers to a chance that students have to demonstrate their knowledge (Aravind & McConnell, 2018). As Figure 1a illustrates, on their first attempts, students ask for an average of 1.1 hints to solve the problem, indicating that students depend on the hints to solve the problem. However, continuous work shows them learning progressively and towards the end, they only asked for an average of about 0.2 hints, confirming their ability to solve the problem independently. Similarly, in the 'Assistance score in Figure 1b, students initially tend to seek an average, 2.7 hints and feedback messages, while towards the end, they are able to solve the problem with an average of about 0.5 hints and feedback messages'. These learning analytics are very helpful for two reasons: (1) Sometimes, despite several opportunities, the assistance that students need does not level off to a small number, signalling to the teacher that students need more practice and (2) Students may learn concepts and calculations within a few opportunities with little assistance. Knowing when this happens could help prevent over-practice and time could be spent in useful learning events. These data show that improving formative assessment could result in improved student learning, which is consistent with SLT in successfully addressing students' need in a timely learning experience. An extrapolation from these results of the proposed dissecting assessment framework follows in the next section for gaining a better understanding of how, particularly students, can make the paradigm shift from teacher-centred to learner-centred technology enhanced assessments.
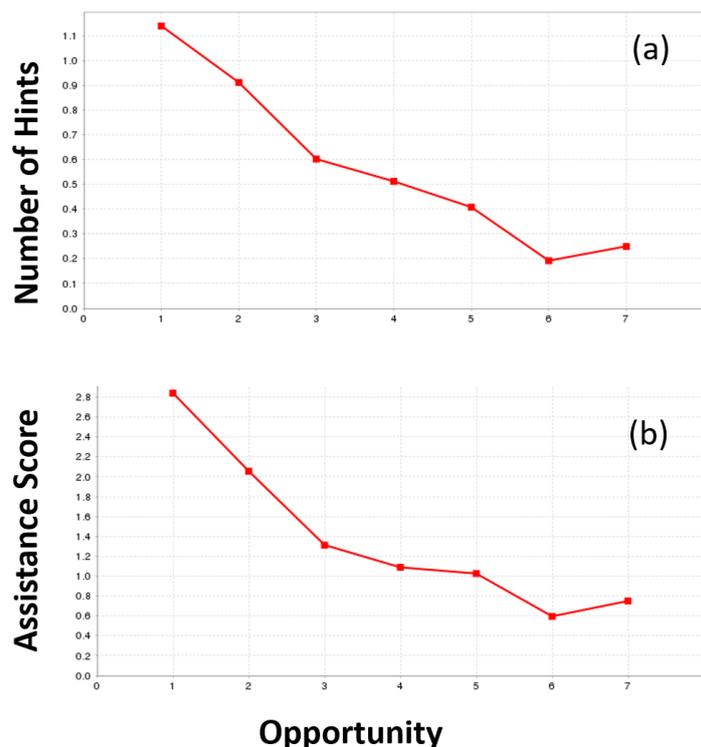

Figure 1. (a and b) Extent of assistance students need with successive opportunities and hints given by intelligent tutor

3.1. Dissecting assessment

While technology-enhanced assessments can take varied formats, the case above of the intelligent tutor is used for the purpose of extrapolating the proposed framework for dissecting assessment. This

'dissection' consists of the primary variables—*Students' Expectations* and *Assessment Deliverable*. The *Assessment Deliverable* consists of four secondary variables: *Self-evaluation and Reports; Stimulated Learning process; Preparation in the beginning and the Comparison phobia*. The *Student's Expectation* variable has three secondary variables: *the Inbuilt fear to Handle Failures and Exposures; Unbiased Evaluation* and *Anytime Assessments*. These primary and secondary variables are dissected by their positive and negative secondary variables as shown in Figure 2. The following sections further elaborate on the primary and secondary variables in proposing this paradigm shift towards technology-enhanced assessment.
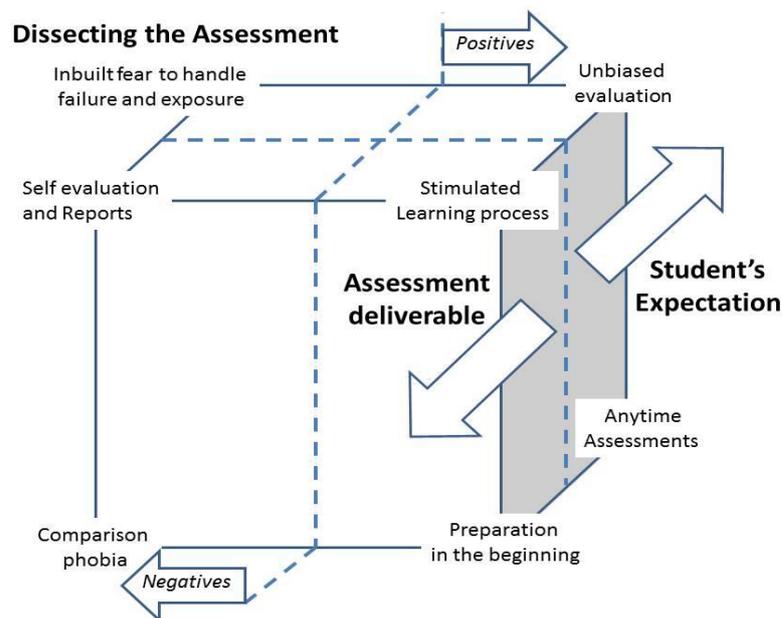

Figure 2. Dissecting assessment framework (*Source*: Umachandran, 2018)

3.1.1. Student's expectation—unbiased evaluation

Clear descriptions of the required assessment and rubrics with the marking criteria are students' expectations and essentials for unbiased evaluation (Sweeney et al., 2017). Notably, traditional assessments (e.g., paper tests) are vulnerable to time constraints for marking and human subjectivity (Ferdinand & Umachandran, 2016). As such, the intelligent as well as other e-formats like online quizzes offer an objective alternative with clear criteria for completing tasks and timely feedback, providing unbiased assessment/evaluation, one of the 'positives' proposed in dissecting assessment as shown in Figure 2. In keeping with the tenets of SLT, any concern students may have about bias assessment/evaluation is also addressed in having the intelligent tutor automatically correct students' answers. Building students' confidence in e-assessments, a growing concern in the current literature, can help them to readily make the learner-centred paradigm shift for sharing in the responsibility of their learning and performance. Digital technologies can meaningfully change evaluation approaches by affording new ways for educators to treat with individual and collective assessments. These evaluation approaches provide the learner with variety in assessments to include self-evaluation and reports as discussed in the following section.

3.1.2. Student's expectation—anytime assessments

The emerging technologies trajectory affords ubiquitous student assessment and is proposed in Figure 2 as *Anytime Assessments*. These e-assessments involve '... the use of digital devices to assist in the construction, delivery, storage or reporting of student assessment tasks, responses, grades or feedback' (Crisp, 2011, p. 5). These digital formats are learner-centred and attractive to digital natives in 21st Century classrooms by offering variety and engagement with multimedia. Similarly, students' formative assessments were automated in using the intelligent tutor and providing immediate digital feedback in meeting their expectations. These instantaneous feedback enable students to correct their misunderstandings early, allowing them to progress at a faster pace (Ferdinand & Umachandran, 2016). Furthermore, there is growing attention to formative assessment (Crockett & Churches, 2017) that can help learners to be better prepared to succeed at their summative assessment. Nevertheless, many students and teachers have yet to make this learning paradigm shift. As Crips (2011, p. 6) noted, '... students often view their performance in summative tasks as a measure of how much they have learnt within a course'. Regrettably, summative assessments may not always reflect success and students' awareness of their inbuilt fear to handle failure and exposure should be harnessed as discussed in the next section.

3.1.3. Student's expectation—inbuilt fear to handle failure and exposure

Success is not always attainable on assessments on the first attempt. One consideration is student's inbuilt fear of handling exposure to failure as proposed in Figure 2 for the Student's Expectation variable. Technology-enhanced assessment helps the student to face up to this fear through self-assessment, which shows areas of weaknesses with feedback beforehand that can be self-corrected. In the case of the intelligent tutor, students were given immediate feedback with tiered hints and multiple trials for correcting their answers to challenging physics problems. Even, students who were unable to arrive at the correct answer were given a bottom-out hint to minimise their frustration. The latter intended to help them reconcile in working backwards to understand how to arrive at the correct answer. Any concern of fear of failure would be addressed here, resonating with the tenets of STL. Of note, these formative self-assessments should always be aligned to what was taught and measured by clearly defined evaluation criteria (Sweeney et al., 2017). The latter allows for fair and transparent assessment as expected by the students, while upholding their dignity in the process. Including some qualitative feedback from the facilitator, as done in clicker technologies, affords for further clarification on where improvement is needed and how it can be accomplished (Jacobsen, Brown & Lambert, 2013). As a result, the student develops the ability to reflect and strive for improvement in performance as a controlled endeavour of an inbuilt fear to handle failure, while enjoying exposure to the complete assortment of triumphs that follow improvement. Yet, there is that natural tendency by students to compare performance on assessments among themselves that can be a 'negative' as shown in Figure 2 and discussed in the next section.

3.1.4. Assessment deliverable—comparison phobia

The integration of technology in assessments help to reduce the tendency to compare assessment results between individuals or among groups referred to as Comparison Phobia in Figure 2, a negative secondary variable to consider in the Assessment Deliverable. Technology-enhanced assessments promote self-directed learning as results and feedback are usually personalised through self-assessments (Sweeney et al., 2017) and not compared with any other student. For instance, the 'physics' students were given individual multiple hints as needed by the intelligent tutor that no one else in the class could see. Only the instructor could knew the number of hints students needed through the data analytics generated in Figure 1a and b that were used to understand any misconceptions in students' learning and identify areas for improvements. Similarly, group and peer e-assessments promote collaboration among students, indicative of SLT, so that they do not compete or

compare each other's results as all members in the group receive the same overall mark and feedback (Jacobsen et al., 2013). Alternatively, the use of individual assessments such as e-portfolios that showcase students' skills, knowledge and attitudes gained in their courses can also reduce the 'comparison phobia', a concept not prominently discussed in the current literature. Still, teachers must be properly prepared for designing technology-enhanced assessments in giving the students' the best advantage to showcase their achievements as discussed in the following section.

3.1.5. Assessment deliverable—preparation in the beginning

Technology-enhanced assessment requires initial preparation for making a smooth transition to learner-centred digital assessments as proposed in Figure 2: Assessment deliverable—*Preparation in the Beginning*. Teacher educator programs should prepare teachers to use various formative/anytime assessment methods to afford students the best advantage in their summative assessments. Thus, the Physics instructor was trained for creating the intelligent tutor to scaffold students' learning in physics. Students were also given the necessary orientation for using the intelligent tutor platform. Their e-assessment tasks focused on deeper learning to include critical thinking and problem solving in real-world contexts as needed in the 21st Century workplace (Crisp, 2011; UNESCO, 2012). Yet, developing such skills requires team work, but all too often students struggle in orienting group projects to a successful completion. Therefore, teachers need to ensure that students have acquired teamwork skills before engaging in collaborative tasks and peer assessment with classmates of diverse backgrounds (including the disabled) that are characteristic of technology-enhanced assessments (Jacobsen et al., 2013; Parsons & Taylor, 2011; UNESCO, 2015). Moreover, good e-assessment and feedback practice should be informed by curriculum policies, clarify performance criteria, encourage challenge, deliver feedback for self-correction and be accessible to all the students (Sweeney et al., 2017; Thurlow et al., 2010). However, teachers should be understand the importance of creating a stimulating learning environment for today's digital natives as discussed in the next section.

3.1.6. Assessment deliverable—stimulated learning process

The digital natives in today's classrooms and workplaces are surrounded and stimulated by technological gadgetry as everyday experiences and also expect a similar stimulating learning environment. Hence, a stimulated learning process is proposed as a 'positive' in the Assessment Deliverable in Figure 2. Previously, the students were given immediate feedback to their submitted answers every step of the way through the intelligent tutor's tiered hints and multiple trials to keep them stimulated and motivated. Likewise, using digital games as e-assessments for digital natives also develops students' analytical and problem-solving skills and keep them motivated while playing the game (Gosper & Ifenthaler, 2014). Relating e-assessments to students' interests promotes authentic learning, a reflection of STL. Digital natives who are quite capable of accumulating meaningful evidence of their educational products and achievements are motivated to prepare and submit an e-portfolio for gaining future employment (Chatterton & Rebbeck, 2015). These personalised and flexible approaches to teaching, learning and assessment break down some of the barriers to formal learning in the current literature, resulting in more stimulating self-directed learning. The evaluation reports generated by these e-assessments also provide quick evidence for students' self-correction as discussed in the next section.

3.1.7. Assessment deliverable—self-evaluation and reports

According to UNESCO (2012, p. 4): 'Computer-based tests embedded in the learning environment have proven to be motivating for students who are given the opportunity to self-evaluate and monitor their learning in realistic settings'. As observed in Figure 1a and b informed by the intelligent tutoring system data reporting, with every successive opportunity, students ask for lesser assistance and lesser number of hints, indicating learning and self-correction. Other higher order e-assessments like digital

game-based learning with similar feedback features play a key role in formative assessment, allowing students as well as teachers to gauge what students are 'hitting' or 'missing' during the learning process. This early corrective feedback enhances students' potential for success in their summative assessments (Crockett & Churches, 2017). In meeting, students' need to arrive at the correct answers in a timely manner reflects another tenet of SLT through students' collaboration with the intelligent tutor on authentic tasks. Other forms of collaboration can also be done in e-assessments on social media using Web 2.0 tools such as debating on a societal or global issue (Ferdinand, 2017) that fosters cooperative dispensation among the groups through the mutual benefit of their collective wisdom and knowledge sharing. This collectivity also communicates universality by a code of inquisitiveness, cohesiveness and reciprocity significant to students' improved learning performance as they learn and innovate through the support, evaluative feedback, and tutoring of their more experienced peers (Woods, 2012). In dissecting assessment, self-evaluation and group approaches among professionals are representative of the learning paradigm shift that improve teaching and learning excellence (Coggshall, Colton, Milton & Jacques,).

4. Conclusion and recommendation

The proposed dissection of the assessment process is intended to provide a deeper insight into how students are involved and their expectations that teachers and assessors should consider in making the learning paradigm shift to technology-enhanced assessments. A possible preliminary outcome of this dissection is projected in the Matrix of Assessment shown in Figure 3.

Matrix of Assessment	Student's Expectations	
Assessment deliverable	Stimulated learning process	Unbiased evaluation
	Preparation in the beginning	Anytime Assessment

Figure 3. Projected outcome of dissecting assessment

Extrapolating from the intelligent tutor case study, in every successive opportunity students ask for lesser assistance and lesser number of hints, indicating learning and self-correction. As such, we propose an evolving a 2 × 2 pattern of analysis, in which the primary variables, namely, the *Assessment Deliverable* and the *Student's Expectation* are projected towards the positive secondary variables as shown in Figure 3. The dissection analysis has led to the conclusion that possibly concentrating efforts on the positives in the Dissecting Assessment framework would yield better orientation to the acceptance of the assessment, whereby the negatives (includes *comparison phobia* and *fear of handling failure*) automatically declines. The net outcome of this proposed dissecting process is that the *Assessment Deliverable Variable* needs to be in congruence with the *Stimulated learning Process* and *Preparation in the Beginning*, while the *Student's Expectations* needs to align with *Unbiased Evaluation* and *Anytime Assessment*. While these insights are not absolute, they can be used as a sounding board to begin the shift in thinking to learner-centred assessments employing digital technology for today's 21st Century digital natives. We recommend that future research can examine the use of different types of assessments apart from the intelligent tutor for further analysing the proposed dissecting assessment framework.

Said, M. M. T, Aravind, V. R., Ferdinand-James, D. & Umachandran, K. (2019). Dissecting assessment: A paradigm shift towards technology-enhanced assessments. *World Journal on Educational Technology: Current Issues*. *11*(2), 24-32.

References

Aravind, V. R. & McConnell, M. K. (2018). A computer based tutor for learning energy and power. *World Journal of Educational Technology: Current Issues, 10*(3), 174–185. doi:10.18844/wjet.**v10i3**.3558

Baxter, P. & Jack, S. (2008). Qualitative case study methodology: study design and implementation for novice researchers. *The Qualitative Report, 13*(4), 544–556.

Branch, R. M. (2009). *Instructional design: The ADDIE approach*. New York, NY: Springer.

Chatterton, P. & Rebbeck, G. (2015). *Technology for employability: FE and skills case studies: Study into the role of technology in developing student employability*. JISC. Retrieved from https://kosovo.britishcouncil.org/sites/default/files/using_digital_technology_to_enhanceteaching_and_learning.pdf

Chen, X. (2013). *STEM attrition: college students' paths into and out of STEM fields.* National Center for Education Statistics (Statistical Analysis Report. NCES 2014-001, Vol. 102). Retrieved from https://nces.ed.gov/pubs2014/2014001rev.pdf

Coggshall, J. G., Colton, A., Milton, J. & Jacques, C. (2012). *Generating teaching effectiveness: the role of job-embedded professional learning in teacher evaluation, a research & policy brief.* National Comprehensive Center for Teacher Quality. Retrieved from https://gtlcenter.org/sites/default/files/docs/GeneratingTeachingEffectiveness.pdf

Crockett, L. W. & Churches, A. (2017). *Mindful assessment: the essential fluencies of innovative learning*. Bloomington, IN: Solution Tree Press.

Crisp, G. (2011). *Teacher's Handbook on e-Assessment: a handbook to support teachers in using e-assessment to improve and evidence student learning and outcomes*. Retrieve from http://transformingassessment.com/sites/default/files/files/Handbook_for_teachers.pdf

Ferdinand, D. & Umachandran, K. (2016). Online assessment: product development in academic writing. *Maha Journal of Education, 2*(1), 73–78.

Gosper, M. & Ifenthaler, D. (2014). *Curriculum models for the 21st century: using learning technologies in higher education*. New York, NY: Springer.

Jacobsen, M., Brown, B. & Lambert. D. (2013). *Technology-enhanced learning environments in higher education: a review of the literature*. Werklund School of Education, University of Calgary. Retrieved from https://prism.ucalgary.ca/bitstream/handle/1880/52244/TechnologyEnhanced_Learning_Environment_Literature_Review.pdf?sequence=1

Koedinger, K. R., Baker, R. S. J. D., Cunningham, K., Skogsholm, A., Leber, B. & Stamper, J. (2010). A data repository for the EDM community: the PSLC DataShop. In C. Romero, S. Ventura, M. Pechenizkiy & R. S. J. D. Baker (Eds.), *Handbook of educational data mining*. Boca Raton, FL: CRC Press.

Parsons, J. & Taylor, L. (2011). Improving student engagement. *Current Issues in Education, 14*(1). Retrieved from https://cie.asu.edu/ojs/index.php/cieatasu/article/view/745

Seaman, J. E., Allen, I. E. & Seaman, J. (2018). *Grade increase: tracking distance education in the United States*. Babson Survey Research Group. Retrieved from https://onlinelearningsurvey.com/reports/gradeincrease.pdf

Stein, D. (1998). *Situated learning in adult education.* Retrieved from http://www.ericdigests.org/1998-3/adult-education.html

Sweeney, T., West, D., Groessler, A., Haynie, A., Higgs, B. M., Macaulay, J., & Yeo, M. (2017). Where's the transformation? Unlocking the potential of technology-enhanced assessment. *Teaching and Learning Inquiry, 5*(1), 1–16. doi:10.20343/5.1.5

Thurlow, M., Lazarus, S. S., Albus, D. & Hodgson, J. (2010). *Computer-based testing: practices and considerations (Synthesis Report 78)*. Minneapolis, MN: University of Minnesota, National Center on Educational Outcomes.

UNESCO. (2012). *Policy brief: technology-enhanced assessment in education*. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000220235

UNESCO. (2014). *Global citizenship education: preparing learners for the challenges of the twenty-first century*. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000227729

Said, M. M. T, Aravind, V. R., Ferdinand-James, D. & Umachandran, K. (2019). Dissecting assessment: A paradigm shift towards technology-enhanced assessments. *World Journal on Educational Technology: Current Issues*. *11*(2), 24-32.

UNESCO. (2015). *Towards inclusive and equitable quality education and lifelong learning for all, Education 2030: World Education Forum 2015*. Retrieved from https://unesdoc.unesco.org/ark:/48223/pf0000233137

Woods, A. (2012). *Internal service learning: Engaging upper-level students as first year tutors*. Proceedings of the Forty-Second Annual Conference of the International Society for Exploring Teaching and Learning (ISETL), U.S., p. 226.