The application of curriculum analytics for improving assessments and quality assurance in higher education

Abhinava Barthakur, Vitomir Kovanović, Shane Dawson, Christopher C. Deneen
Centre for Change and Complexity in Learning, Education Futures, University of South Australia, Adelaide, Australia

Curriculum mapping is a necessary process for establishing evidence of where learning outcomes are taught and assessed in higher education programmes. Mapping ensures the credibility of the institution and programme offerings and provides students with a clear understanding of what they can expect to learn and achieve during their academic studies. Well-mapped curricula that reference relevant standards and articulate aligned assessments are foundational for effective teaching and learning. Curriculum quality assurance measures are commonly accepted as a means of assuring accurate mapping. Assurance processes are, however, resource-intensive, error-prone and reflect human biases. Few studies have adopted an analytical approach to ensure programme quality assurance steps are traceable to a fundamental level of these maps: single courses and their assessment items. In this study, we adopted a novel curriculum analytics methodology to validate the mapping of professional standards to course-based assessments in a higher education degree program. Using an Australian initial teacher education programme as a case study, we applied and analysed results from a structured methodology that may be implemented across other disciplinary programs. Practical implications for quality assurance in higher education and the methodological contributions of this novel approach are further discussed.

Implications for practice or policy:

- Quality assurance mechanisms in higher education serve to demonstrate that specific accreditation standards have been attained or maintained.
- An evidence-based approach is needed to ensure curriculum mapping and quality assurance.
- This study's novel curriculum analytics approach provides a robust foundation for demonstrating assessments' compliance with accreditation standards at the degree program level.
- A data-driven approach for quality assurance presents opportunities for wider and scalable applications across other institutions.

Keywords: curriculum mapping, quality assurance, assessment, degree programs, higher education, curriculum analytics

Introduction

Documentation of curricula that accurately capture students' learning progress throughout their academic studies is a challenging process. Assessment plays a key role in this process through substantiating the achievement of intended learning outcomes. However, the learning process is neither static nor constrained to a single assessment point (Dawson et al., 2019). Accurately assessing students' progress and providing concomitant learning support requires designing and documenting curricula in ways that demonstrate students' learning progressions across an entire degree programme (i.e., a sequence of courses leading to degree completion). These curricular decisions are documented in the form of *curriculum mapping*, which represents the structure and relationships between courses in a degree programme (Archambault & Masunaga, 2015). Curriculum mapping documents learning outcomes, assessments and learning activities, providing an understanding of the structure of the content and sequencing of stated outcomes and standards across all stages of the programme and courses (Archambault & Masunaga, 2015; Komenda et al., 2015).

In higher education, programme curricula must reflect numerous regulatory imperatives. External mandates often govern curriculum mapping within professional degree programmes and, therefore, must demonstrate that learning activities and assessments foster and assess learning outcomes aligned to disciplinary skills and professional specifications (Holmes et al., 2018; Wang, 2015). These come from governing and regulatory bodies, as well as discipline-specific professional associations (Holmes et al., 2018). For example, providers of initial teacher education (ITE) programmes in Australian universities must demonstrate that students have met all accredited teaching standards to graduate and be eligible for registration as professional teachers (Australian Institute for Teaching and School Leadership [AITSL], 2022). This is akin to many other curricula requiring evidence of graduates' meeting professional standards. Internationally, there is increasing government regulatory pressure to explicitly map the curricula and assessments to demonstrate that quality standards are being met (Holmes et al., 2018). This is well reflected in the Quality Assurance Agency in the United Kingdom (Quinlan, 2016) and the Tertiary Education Quality and Standards Agency in Australia (Brawley et al., 2013).

Quality assurance and accreditation are highly complex processes, requiring extensive resourcing to document how learning outcomes are assessed and mapped in a programme (Sumsion & Goodfellow, 2004). Important curricular decisions, including decisions on quality assurance of degree programmes, are, however, often made in an uncoordinated manner by individual teaching staff delivering individual courses (Dawson & Hubball, 2014). Building cohesive and holistic programme curriculum maps requires experts to manually review large volumes of programme and course documentation to examine where accredited standards are taught and assessed across the programme of study (Wang, 2015). Such an approach is not only time-consuming but susceptible to human error and subjective bias. A common limitation of curriculum mapping is the approach to assessment tasks and course-intended learning outcomes that these assessments are meant to activate. A map of the intended or declared curriculum is created, which may substantially deviate from the ways in which learners actually engage and are assessed (Kelly, 2004). It is, therefore, difficult to claim a curriculum map is valid, assuming that the evidentiary basis of validity is what students actually do, experience and achieve. Further, it is important to recognise that curriculum mapping is a temporal representation susceptible to modifications. Assessments and course contents are frequently revised and updated. As a result, it is incumbent upon academic institutions to provide ongoing documentation and evidence that such curricular decisions continue to adhere to the requirements mandated by university regulators or accredited professional organisations. While we acknowledge the significance of academic expertise and autonomy in this process, we also surface the need for more transparent and coordinated approaches to ensure and sustain programmatic coherence.

There is a pressing need to develop efficient approaches to curriculum mapping while enhancing valid, reliable and defensible representations of how learners' achievement relates to attaining professional standards at the course level and across a complete programme of study. The field of learning analytics (LA) has grown in prominence as an area of research used to address complex educational challenges, including an increasing interest in the role of curriculum analytics (CA; Dawson & Hubball, 2014). Curriculum analytics employs advanced statistics or machine learning approaches to facilitate curriculum decision-making and enhance the overall quality of degree programmes. However, much of the CA research has been limited to enhancing and supporting curriculum decisions at the level of a single course (Mendez, Ochoa, & Chiluiza, 2014; Méndez, Méndez, Ochoa, Chiluiza, & de Wever, 2014; Ochoa, 2016). There is a dearth of research dedicated to curriculum analysis, which investigates the dependencies and relationships between several courses within a degree programme.

This study proposes a novel approach to ensuring quality assurance within higher education. Through a case study on an undergraduate ITE degree programme at a large public Australian university, we outline a CA approach addressing identified issues with curriculum mapping. Using the received curriculum in the form of learners' assessment results, we validated existing mapping against relevant professional teaching standards at the level of the degree programme. This represents a significant methodological contribution by demonstrating the impact of an automated approach to enhancing the quality of programmes within higher education.

Background

Curriculum

As noted by Wiles (2008), there is no authoritative definition of curriculum. A commonly accepted view is that curriculum represents the totality of a student's learning experiences in an educational institution (Kelly, 2004). Contemporary understandings of curriculum highlight the importance of learning goals, objectives and outcomes that shape students' learning activities and their overall learning experience (Wiles, 2008). Distinctions are often made between *formal* (i.e., defined curricular activities) and *informal* (e.g., different extra-curricular activities) as well as *declared* curricula (as documented in the syllabus and course outlines) and *received* curriculum, which identifies what learners actually engage in and are assessed on (Kelly, 2004). The design of course and programme curricula is a critical element contributing to learners' attainment of professional standards and academic achievement (Matcha et al., 2020). This includes orchestrating learning experiences in a manner appropriate for developing an understanding of content knowledge and professional competencies (Barthakur et al., 2022).

Educational institutions tend to organise curricula in linear and systematic ways at the level of different study units (e.g., programmes, courses, study topic and lesson plans) (Tyler, 1949; Wiles, 2008). Learning design (LD) plays a significant role in documenting the sequencing of pedagogical practices, learning activities and intentions of various study units (*declared curricula*) and other curriculum-related details (Lockyer & Dawson, 2011) needed for quality assurance purposes. Curricula, as documented in the LD, are typically discussed at two levels of study – programme and course. At the programme level, curricula are intended to structure and order courses, providing a progression of learning towards degree attainment, along with disciplinary skills and knowledge this attainment represents. At the course level, the curriculum organises specific learning engagements and assessments that support and determine the achievement of more granular learning outcomes.

Theoretically, the curriculum at this level creates a holistic learning experience (Lam & Tsui, 2016), with courses designed in relationship to each other and in alignment with programme goals and intended outcomes. Assessments at the course level are meant to determine and advance learning as a progression relative to programme outcomes, leading to degree conferral (Nusche, 2008). It is essential that assessments align with the knowledge and skills at the course level while also supporting and evidencing progression towards broader, programme-level outcomes (Nusche, 2008). Documentation of this alignment and its reliance on valid assessments are essential to evaluating and maintaining programme quality.

Quality assurance (evaluating, enhancing and assuring programme quality)

Quality assurance mechanisms in higher education demonstrate and verify that academic outcomes have been attained and maintained. Quality assurance involves documenting internal quality procedures to ensure the credibility and transparency of the degree programme. This allows a level of comparability and standardisation across programmes and institutions in relation to other higher education qualifications (Jessop et al., 2012). For example, in the Australian context, each university must ensure that courses and programmes comply with the Australian quality framework (Brawley et al., 2013) and are regularly audited by the national regulator of higher education to ensure institutions comply with the higher education standards framework (Brawley et al., 2013). In Australia and elsewhere, government oversight is meant to assure rigour and credibility of university offerings but lacks detailed evidence of student learning and the impact course and programme quality plays on learning outcomes.

For this study, we note that programme quality practices must rely on clearly defined learning outcomes that align with the learning activities and assessments at both the course and programme levels. This aspect of curriculum mapping, with explicit documentation of learning outcomes, assessments and learning activities, is strongly emphasised in Biggs's (1996) constructive alignment theory. Biggs integrates constructivism learning theory with principles of instructional design. Doing so emphasises the

importance of ensuring learning activities and assessments reflect the stated learning outcomes. This initiates design processes by defining the desired learning outcomes for learners and subsequently aligning teaching and learning activities and assessments to support outcome achievement. These practices aid instructors and curriculum designers in crafting more impactful learning experiences that foster academic success, and their implementation has gained widespread acceptance in higher education.

For quality enhancement, curriculum mapping is used to identify potential gaps, redundancies and misalignments between assessments and the stated outcomes so that these can serve as focus points for course and programme improvements (Uchiyama & Radin, 2009). From an assurance perspective, mapping demonstrates that positionality and relationships operate as intended for the programme and its stakeholders. Ultimately, curriculum mapping is critical in creating an integrated whole, enhancing the predicate of programme-level curriculum design.

However, there is a big discrepancy between the theory and practice of curriculum mapping and curriculum design. The current practices used to map programmes and course curricula have failed to impact learners and their overall experience, in large part due to an oversimplification of the mapping process and fragmentation of the curriculum into isolated course-level experiences (Sumsion & Goodfellow, 2004; Wijngaards-de Meij & Merx, 2018). Programmes are structured as a set of discrete courses with limited documentation of dependencies and connections occurring between courses (Jessop et al., 2012). Over time, the lack of awareness and coherence between course coordinators can lead to content duplication and a fragmented learning experience for students as they progress through their programme of study (Jessop et al., 2012). Concerningly, current practices remain predicated on individual data points such as sporadic assessment tasks. This places a significant level of importance on the sequencing of assessment (within and over several courses) as well as the design of the tasks to ensure that the instruments actually do effectively measure the intended outcomes.

This study proceeded from two premises: First, we must create more accessible routes to ensure alignment between course and programme levels, especially in the use of assessment tasks. Second, to perform curriculum mapping requires accurate information. Thus, the implications of our research speak to an agenda for improving programme evaluation processes as well as the potential enhancement of curricula to function as intended: a whole programme experience for students.

Curriculum Analytics

Curriculum mapping is largely informed by qualitative approaches. One of the closest studies related to our research is that by Sumsion and Goodfellow (2004), in which several generic capabilities were mapped to the curriculum in a similar teacher education programme at an Australian university. In accordance with Sumsion and Goodfellow's findings, Holmes et al. (2018) carried out a comprehensive analysis to identify the fundamental generic skills that can be fostered through the current curriculum while identifying potential areas for enhancing the skills. Although such qualitative mapping reveals the different skills and where they are addressed, these approaches cannot establish the extent of learning or identify redundancies within the curricula (Holmes et al., 2018). These approaches focus on the developed curricula while ignoring the received curricula that learners engaged in and responded to.

To mitigate this limitation, there has been an increased interest in using collected data to support students and academics using modern data analytics techniques in higher education. Originally, analytics within the education space was divided into LA, dealing primarily with understanding and supporting student learning, and academic analytics, focusing on supporting institutional decision-making (Siemens & Long, 2011). However, the growing need for understanding and supporting curricular decision-making has resulted in the development of novel analytics techniques, collectively known as CA (Dawson & Hubball, 2014; Greer et al., 2016; Mendez, Ochoa, & Chiluiza, 2014; Méndez, Méndez, Ochoa, Chiluiza, & de Wever, 2014). As described by Dawson and Hubball (2014, p. 63), CA involves the "collection, analysis, and interpretation of key stakeholder data throughout multi-year program offerings in order to enhance curriculum development, implementation, and evaluation processes". CA uses a variety of computational

methods to provide decision-makers with relevant information about curriculum design and programme delivery and thus enable evidence-based decisions on curriculum improvements (Dawson & Hubball, 2014).

It should be noted that the original focus of curriculum analytics was primarily on supporting curriculum redesign and redevelopment. For instance, Komenda et al. (2015) used course descriptions to provide a graph-based visualisation of the medical curriculum, focusing on finding groups of courses clustered around common study topics, as captured by the textual similarity of course descriptions. Aside from course descriptions, the critical data used in the course were students' course enrolment data, including the list of courses taken and corresponding grades. Such data provided insights into students' received curricula rather than curricula that university administrators planned. For example, Dawson and Hubball (2014) used social network analysis techniques to examine course enrolment dependencies, identify the dominant pathways students take in a degree programme and examine curricular differences between student demographic sub-populations. Besides social network analysis, probabilistic topic modelling techniques such as latent Dirichlet allocation have been used to analyse more than a decade of student course enrolment data (Motz et al., 2018), looking for prominent patterns in course enrolments captured by the extracted latent topics. Finally, student course enrolments and grades have been extensively used to provide insights into individual courses (Mendez, Ochoa, & Chiluiza, 2014; Méndez, Méndez, Ochoa, Chiluiza, & de Wever, 2014; Ochoa, 2016), such as examination of course difficulty, their grading stringency and their overall influence on students' final grade point average.

Although CA has been increasingly used to support the (re-)design of the curricula, to date, there have been limited empirical studies researching constructive alignment and, more specifically, the alignment of learning outcomes and professional standards with course assessment across a programme of study. In a recent study, Divjak et al. (2023) proposed a model and examined the effective alignment between a university course's assessment tasks and learning outcomes. In another study, Barthakur et al. (2022) also examined this aspect of constructive alignment, exploring mapping specific skills with assessments in a single professional development massive open online course. At the programme level, Armatas et al. (2022) presented an exploratory study to perform an in-depth analysis of programme curricula and inform programme coordinators about the various aspects of the programme that need to be revised and improved. Gottipati and Shankararaman (2014) proposed a comprehensive framework for utilising analytics in curriculum analysis and evaluation. The framework has proven to be a valuable guide for assessing the strengths and weaknesses of undergraduate degree programmes, such as the one in information systems that was evaluated. In a later study, Gottipati and Shankararaman (2018) proposed a CA tool to analyse the curricula based on course competencies and provide competency scores for various courses within a degree programme. The authors further claimed that the tool can be used to provide valuable support, including recommendations on improving curriculum design. The studies outlined above highlight the dearth of research investigating the constructive alignment between learning outcomes and professional standards with assessments at the study programme level.

Research question

The literature on curriculum mapping research and practice highlights two significant limitations. First, there is a need for more analytics-based approaches that focus on the received curriculum that learners engage in and where learning occurs. Second, analytics-based studies to date have been constrained to the level of a single course. Well-defined learning outcomes are critical for supporting a learner's academic success and evaluating long-term programme effectiveness. Engaging with the learning activities allows learners to develop the outcomes relating to domain specifications and professional capabilities, while assessments provide opportunities for students to demonstrate that outcomes have been met. Trustworthy connections between outcomes and assessment are essential for evaluating and assuring quality (Wang, 2015).

Thus, we do not have an analytics-based view of the overall learning path and curriculum. The exploratory research detailed in this paper aimed to mitigate these limitations by addressing the following research question (RQ):

> RQ: How can curriculum analytics be used to validate the mapping between course assessment grades and professional standards of a programme?

Methodology

Study context and data collection

Similar to the works by Barthakur et al. (2022) and Divjak et al. (2023), this study utilised assessment-related data collected primarily for assessment purposes from an ITE programme at a large Australian university. The programme is an accredited 4-year undergraduate degree required to demonstrate coverage of seven teaching standards (Table 1) through a combination of core and elective courses. The seven teaching standards are grouped into three teaching domains: professional knowledge, professional practice and professional engagement (AITSL, 2022). It should be noted that all these standards incorporated hold equal weightage and bear equal significance in the development and progress of the learners. These seven standards are further categorised into several substandards to enhance understanding and develop teaching practice and expertise (AITSL, 2022). However, these sub-categorisations are not applicable to our study and hence not illustrated in Table 1.

Table 1
Description of the seven Australian teaching standards and their domains (AITSL, 2022, p. 4)

Domain of teaching	#	Standard
Professional Knowledge	1.	Know students and how they learn
	2.	Know the content and how to teach it
Professional Practice	3.	Plan for and implement effective teaching and learning
	4.	Create and maintain supportive and safe learning environments.
	5.	Assess, provide feedback and report on student learning
Professional Engagement	6.	Engage in professional learning
	7.	Engage professionally with colleagues, parents/carers and the community

Assessment-related data was collected from 2019 to 2022 to address the research question outlined in Section 3. We extracted anonymised student assessment grades (N = 178) from the secure university data centre. The assessment data included all students who had completed all core courses of the degree programme. The last recorded grade was included when a student may have undertaken the same assessment multiple times (e.g., previously failed or withdrew from the course). The data set also included a one-to-one mapping between the individual assessments and the standards (Table 2). This mapping provides a detailed view of how learners are assessed across the accredited standards through various assessments in the programme. The standards were mapped onto the assessments of only the core (15) courses as learners enrolled in different combinations of elective courses. The description and the year level of these assessments are outlined in Table 2.

Table 2
Assessment descriptions

Assessment	Year	Description
Standard 1		
1D_Report	1	A 2250-wordsreport reflecting the modes of *production* and *reception* in the Australian Curriculum
2C_Case Study	2	A group assessment presented in a roundtable during the final week
2E_Assessment 2	2	A 2500-word detailed report outlining a lesson or learning experience
3A_Assessment 2	3	A detailed report of a lesson plan for accommodating a student with diversity
3C_Presentation	3	A presentation and written report on applying concepts to real-life situations
4B_Critical Analysis	4	Critical analysis of several evidence-based teaching strategies
Standard 2		
1A_Cont Assessment	1	Documenting the learning journey through each course topic
1A_Pamphlet	1	Designing a pamphlet to introduce a school community to a learning area
1D_Presentation	1	A 4-minute presentation on the final week of the course
1D_Report	1	A 2,250-word report reflecting the modes of *production* and *reception* in the Australian Curriculum
1E_Assessment 1	1	An infographic, presentation and written transcript on how theory informs teaching and learning
2A_Research Folder	2	Compiling a resource folder of practical and theoretical activities suitable for classroom
2C_Project	2	A three-part assessment on writing and text production tasks
Standard 3		
1A_Project	1	A two-part assessment demonstrating a working model of a technical system and an illustrated design folio
1D_Presentation	1	A 4-minute presentation on the final week of the course
1E_Assessment 1	1	An infographic, presentation and written transcript on how theory informs teaching and learning
2B_Assessment 1	2	A presentation and written transcript on a resource used in the classroom
2B_Assessment 2	2	A report on structuring learning experiences through a unit of work
3B_CaseStudy	3	A 1,500-word case study on inclusive literacy teaching
4A_CA Workbook	4	Four reports (ranging between 450 & 900 words) on key learning topics
Standard 4		
1B_Presentation	1	A presentation to peers and providing professional development training
1C_Play Plan	1	Plan a play learning experience for a small inclusive group of young students
2B_Assessment 1	2	A presentation and written transcript on a resource used in the classroom
2B_Assessment2	2	A report on structuring learning experiences through a unit of work
2D_Assessment 1	2	A report on presenting and providing evidence of creating a positive learning experience
2D_Cont Assessment	2	Planning and facilitating a mini-lesson during the course workshop

*Note***.** The assessment names were prefixed by an alphanumeric course code followed by the assessment description (Table 2). The first character refers to the year of study in which the course was delivered, while the second character distinguishes the different courses in that year. For instance, an assessment 1A_Pamphlet was an assessment of creating pamphlets in a first-year course. Of the 21 assessments, few (e.g., 1D_Report, 2B_Assessment 1, 2B_Assessment 2) were linked to more than one standard.

Student assessment grades linked to the first four teaching standards were used in this study. The later three standards (Standards 5–7) were developed and assessed through professional learning courses, and assessments within these courses were graded as pass or fail. Since learners were required to pass all the assessments (sometimes through multiple attempts) to complete the degree requirements, there was significantly less variability in the data about these three standards. As such, these were left out of our analysis, and we focused only on the first four standards.

Data analysis

Figure 1 provides a diagrammatic representation of the data analysis steps undertaken in the study. The analysis consisted of four stages. Although the first step is explained in the previous section, the next steps are outlined below.

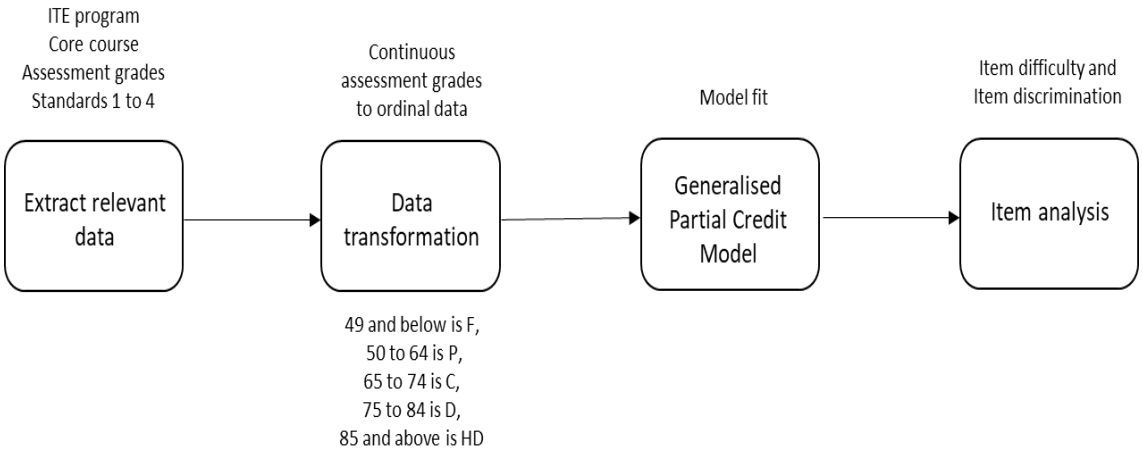

Figure 1. Diagrammatic representation of the data analysis

In the second step, we converted the numerical grades into ordinal values based on the university's grading system. The grades were converted into five distinct levels: 49 and below is fail (F), 50 to 64 is pass (P), 65 to 74 is credit (C), 75 to 84 is distinction (D) and 85 and above is high distinction (HD). This data transformation step is necessary to fit the measurement models.

The third step in the analysis was constructing measurement models crucial to creating valid and reliable educational assessments. The process entails mathematically linking latent constructs to observed variables, allowing evidence accumulation and making inferences about the latent constructs. Although there are different kinds of measurement models, item response theory (IRT) models (Baker, 2001) are of particular interest to the proposed methodology. More specifically, we used a generalised partial credit model (GPCM; Wu et al., 2016) to model polytomous (i.e., correct, incorrect and partially correct) ordered responses. The GPCMs (and IRT models) are used for item analysis (how accurately the observed variables are linked to the latent constructs) and provide inferences about learners' latent abilities. The GPCM provides estimates of *item difficulty* and *item discrimination* and provides information about item analysis relevant to our study. The item difficulty parameter provides an estimation of the degree to which learners get correct answers, while the item discrimination parameter illustrates how the top-scoring learning cohort differs from their low-scoring counterparts (Wu et al., 2016). We also plotted the item information curve, which provides information about each item's quality and refers to an item's ability to accurately estimate the learner's latent trait.

The 21 assessments were considered as unique items as typically used in measurement models. We performed four unidimensional GPCMs to address the RQ and determine assessments' item fit across the four standards, respectively. We used Pearson's X^2 ($S\text{-}X^2$) measure (Kang & Chen, 2008), root-mean-square error of approximation (RMSEA) value and the item discrimination parameter to evaluate the item fit as the final data analysis step. For the $S\text{-}X^2$ measure, a significant value with a p value less than 0.05 is

considered a misfit, in accordance with the existing studies (Kang & Chen, 2008). Investigating item fit through RMSEA, values below or equal to 0.05 are considered a good fit (Maydeu-Olivares, 2013). Although there is no fixed threshold when investigating item fit through item discrimination statistics, we decided on a cut-off of 0.50 to remove assessments measuring a particular standard. We used the mirt package (Chalmers, 2012) in R to implement the GPCM.

Results

In this section, we present the findings of the unidimensional GPCM and examine the quality of assessment that fits with each certain professional standard. We also provide the item information curve for the assessments linking each standard.

Table 3
Statistical measures indicating the assessment fits to the individual standards

Item	S-X^2				Item discrimination	Item difficulty			
	Test value	df	*p* value	RMSEA		(F–P)	(P–C)	(C–D)	(D–HD)
Standard 1									
4B_Critical Analysis	15.05	18	0.66	0.00	0.94	--	-0.59	0.21	1.39
1D_Report	12.89	16	0.68	0.00	1.12	--	0.01	0.86	1.76
2E_Assessment 2	31.06	23	0.12	0.04	0.52	--	-2.35	0.24	3.05
2C_Case Study	15.55	22	0.84	0.00	0.58	--	-2.24	0.77	1.90
3A_Assessment 2	17.78	14	0.22	0.39	1.24	-3.4	0.22	1.14	2.66
3C_Presentation	25.01	16	0.07	0.05	0.63	--	-5.34	-0.67	0.75
Standard 2									
1D_Report	29.28	18	**0.04**	0.06	0.96	--	0.06	0.91	1.85
1D_Presentation	11.17	14	0.67	0.00	0.74	-6.62	0.18	1.24	4.83
1A_Cont Assessment	15.53	14	0.34	0.02	1.17	--	0.33	1.45	3.10
1A_Pamphlet	8.74	09	0.46	0.00	1.05	--	1.37	2.60	--
1E_Assessment 1	25.18	12	**0.01**	0.07	1.18	-4.74	0.31	1.27	2.48
2A_Research Folder	13.92	15	0.53	0.00	0.64	--	-1.95	0.66	3.58
2C_Project	10.79	15	0.77	0.00	1.64	--	-0.92	0.51	1.86
Standard 3									
3B_CaseStudy	18.78	17	0.34	0.02	1.07	--	0.00	1.09	4.59
4A_CA Workbook	26.26	24	0.34	0.02	0.49	--	0.03	-0.34	2.55
1E_Assessment 1	20.02	17	0.27	0.03	0.89	-5.87	0.46	1.40	2.73
1A_Project	16.06	18	0.59	0.00	0.69	--	-1.33	1.41	2.57
2B_Assessment 1	33.15	14	**0.00**	0.08	1.01	-3.97	0.86	1.34	2.49
2B_Assessment 2	14.05	15	0.52	0.00	1.59	-3.45	0.03	0.93	1.67
1D_Presentation	17.92	16	0.33	0.02	0.83	-6.04	0.14	1.18	4.48
Standard 4									
1C_Play Plan	12.48	16	0.71	0.00	0.77	-3.37	0.54	0.91	2.80
2D_Assessment 1	27.8	14	**0.02**	0.07	1.01	--	-0.01	0.85	2.73
2D_Cont Assessment	23.78	25	0.53	0.00	0.27	--	-2.62	-3.35	4.02
2B_Assessment 1	11.15	13	0.60	0.00	1.26	-3.45	0.70	1.26	2.35
2B_Assessment2	15.07	14	0.37	0.02	1.71	-3.32	0.02	0.91	1.65
1B_Presentation	16.53	18	0.56	0.00	0.33	--	0.20	0.61	7.39

Note. The missing values in the Item difficulty column indicate that not all assessment items have all five grade levels. In most cases, the lowest level (F) was missing, so the first column was often empty. Assessment 1108_Pamphlet measuring Standard 2 had three levels and had the first and last column of item difficulty empty.

An exploration of the grades showed that not all the assessments are distributed across all five grading levels (Table 3). Table 3 reveals that most assessments had four grading levels, with the bottom category (F) of grades missing in most assessments. This is not surprising since we considered the last recorded grade for the assessment and learners' need to pass all the courses (and assessments within the courses) to complete their degree. A few of the assessments have all five grading levels. Interestingly, one assessment, 1A_Pamphlet, had only three levels, with the top and bottom-category grades missing. Figure 2 provides a graphical representation of the misfitting and low discriminating items.

The results of the four unidimensional IRT models are also presented in Table 3. We provide the S-X^2 measure, its associated degree of freedom and *p* value the item discrimination (a) and the item difficulty (b_i) statistics for all the items (assessments) measuring the individual standard. It is important to note that when there are five levels of grades, there are four levels of item difficulty. In cases where there are fewer than five levels, the item difficulty calculated by these models will automatically be fewer and are denoted by "--" in Table 3.

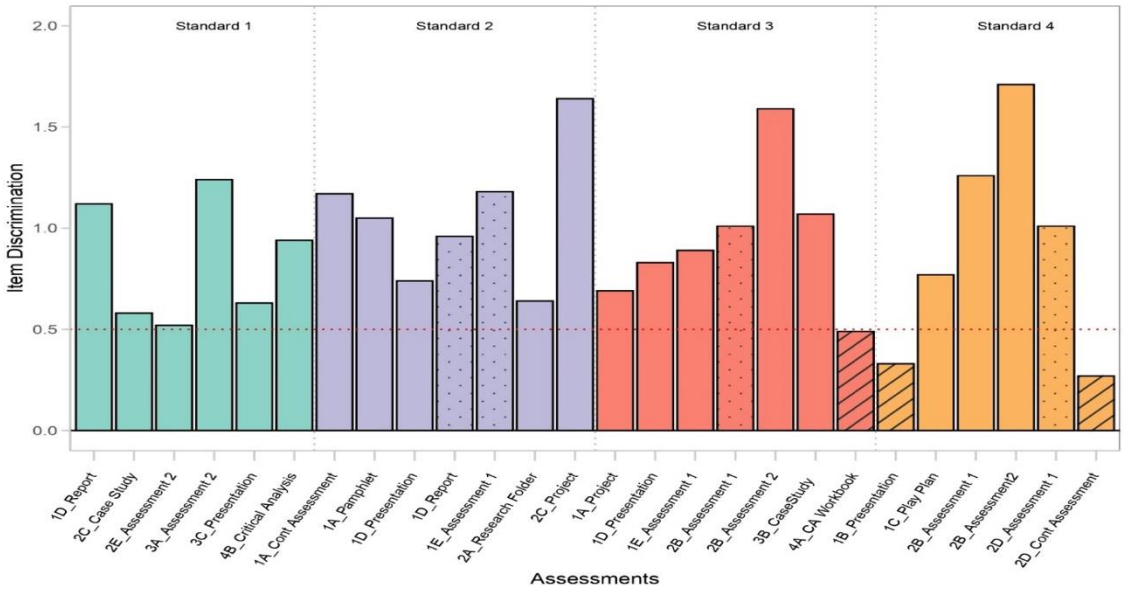

Figure 2. Item discrimination for the individual assessments per standard

Note. The stroked bars represent assessments with item discrimination values less than 0.50, while the dotted bars represent misfitting items (*p* value < 0.05).

For Standard 1, no misfitting assessments were identified based on the S-X2 measure (p value), RMSEA and item discrimination estimates. However, the item information curves plotted in Figure 3 suggest that 2E_Assessment and 4B_Critical Analysis have low item information and may require further investigation.

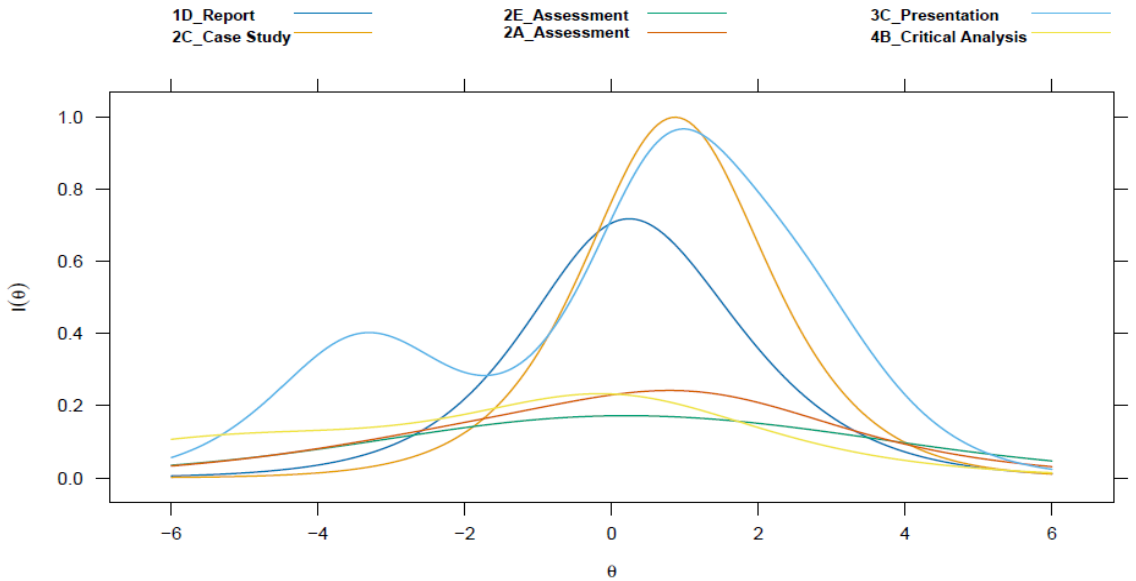

Figure 3. Item information curve for assessments in Standard 1

For Standard 2, two assessments (1D_Report and 1E_Assessment 1) had p alues less than 0.05 and RMSEA greater than 0.05, indicating a misfit. 1D_Report requires learners to provide a self-reflective written artefact and drawing on excerpts from a picture book, while 1E_Assessment 1 infographic presentations. The item information curve (Figure 4) suggests several items have the most information for higher values of theta (latent trait).

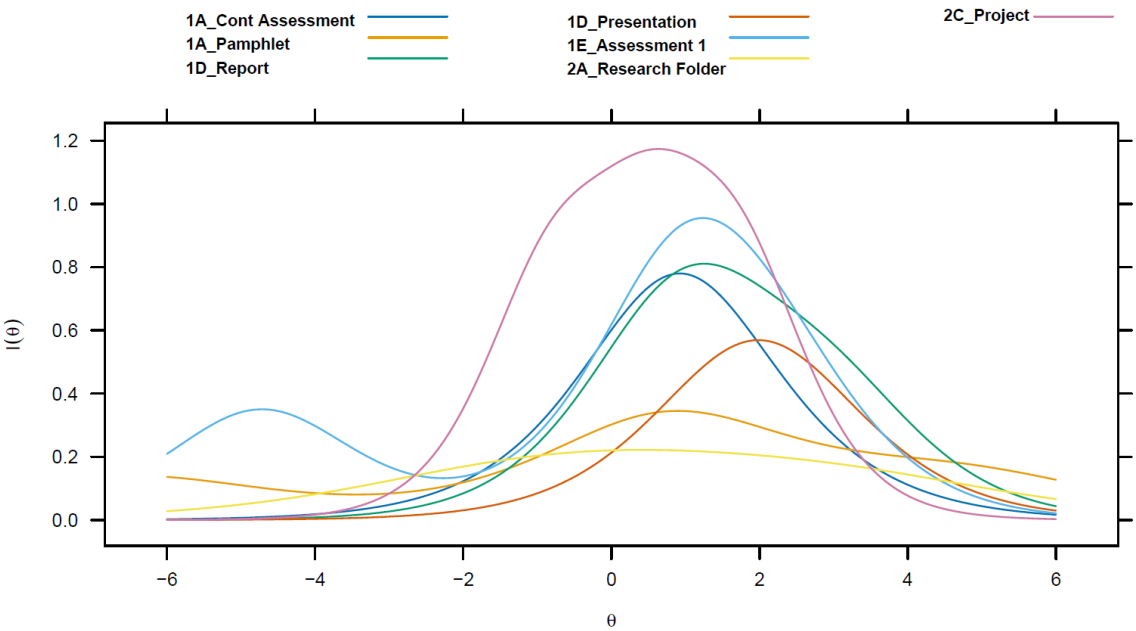

Figure 4. Item information curve for assessments in Standard 2

For Standard 3, one assessment (2B_Assessment 1) had a *p* value less than 0.05 and RMSEA = 0.08 indicating a misfit (PowerPoint presentation of identifying and evaluating classroom resources). Another assessment (4A_Critical Analysis Workbook) has a small item discrimination value, indicating that the assessment cannot discriminate between high-achieving individuals and low-achieving ones. Figure 5 shows that 2B_Assessment 1 has relatively low item information, while 3B_Case Study has the most information.

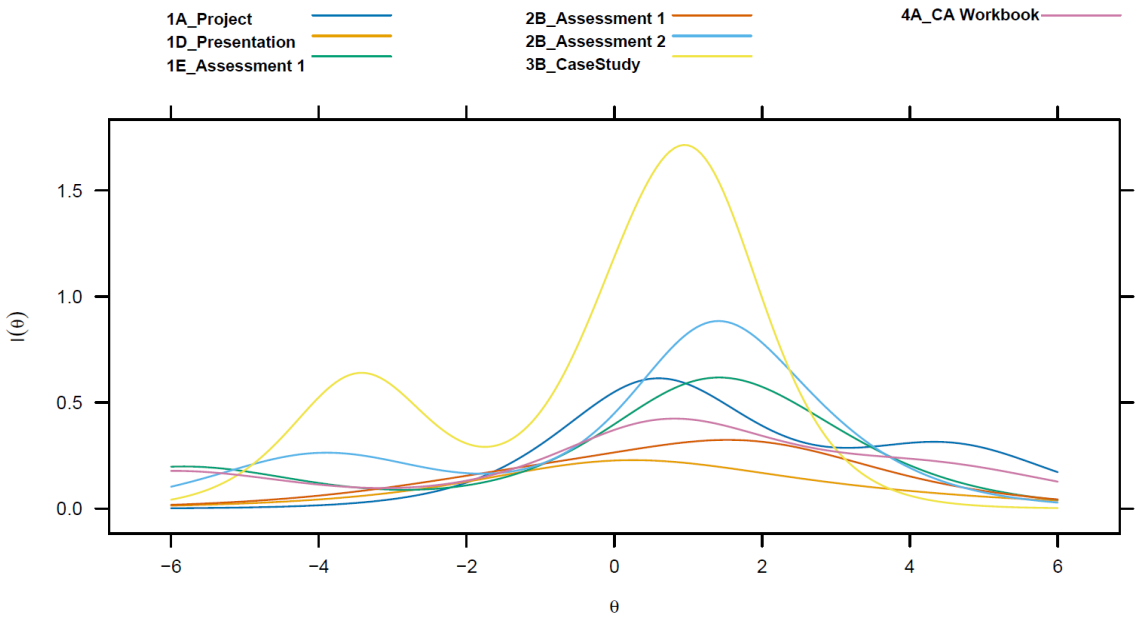

Figure 5. Item information curve for assessments in Standard 3

For Standard 4, a reflective report (2D_Assessment 1) had a *p* value less than 0.05 and RMSEA = 0.07 indicating a misfit. Two other assessments (2D_Continuous Assessment and 1B_Presentation) had low discrimination values and hence were excluded from the analysis. The item information curve (Figure 6) further illustrates that these two assessments have much less item information and are represented by straight horizontal lines.

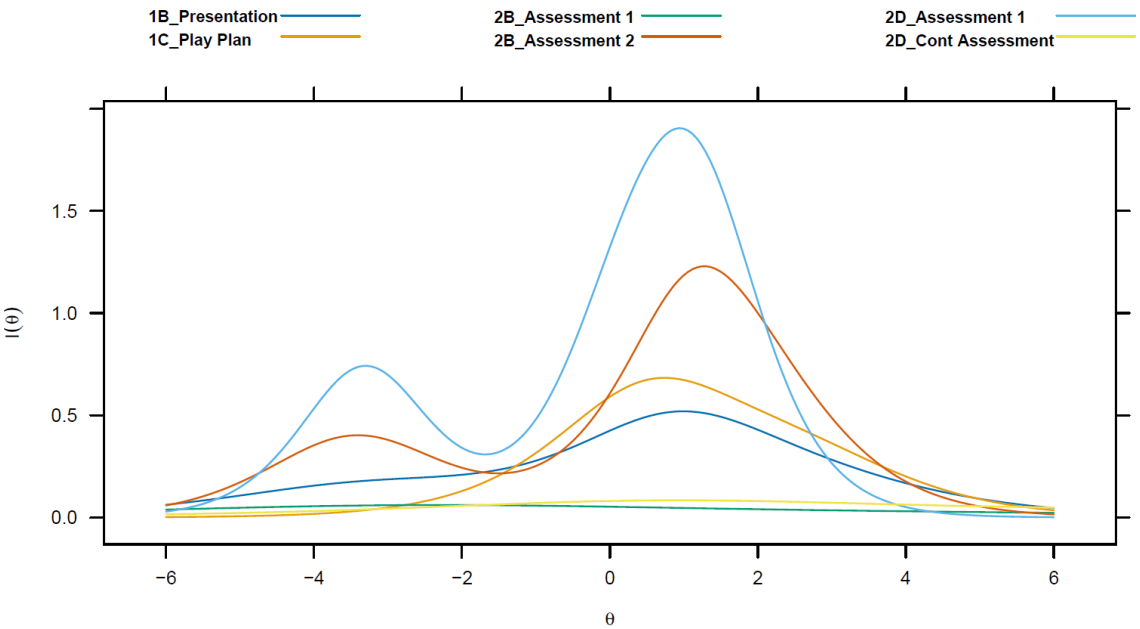

Figure 6. Item information curve for assessments in Standard 4

Discussion

Results interpretation

To address our RQ, we investigated an existing curriculum mapping and validated the alignment of several teaching standards to the course-level assessments of an ITE programme prepared for re-accreditation.

Specifically, we demonstrated the implementation of four-item response theory models to validate the mapping between assessments and the four standards. In that sense, the analysis presented here provides an empirical approach to validate if the assessments used in the programme measure the intended learning outcomes or teaching standards (Divjak et al., 2021; Divjak et al., 2023).

The results suggest that, based on the statistical measures used, Standard 1 demonstrated the highest level of alignment and did not contain any misfitting assessments. This suggests that performance across these assessments accurately approximates learners' acquisition of Standard 1 (Know students and how they learn). Furthermore, this standard is well covered with assessments from all 4 years of the degree programme (Table 2) and continuously assesses learners' development of the standard. The remaining three standards are mainly assessed during the first and the second year of the programme and fail to measure learners' development during the later years. Although the assessments in the final years were mainly dedicated to developing the later teaching standards, which were not included in this analysis, programme coordinators and learning designers should consider to continuously assess all the standards throughout the programme.

Our analysis also identified a few instances of misalignment between the second, third and fourth standard and their respective assessments. Interestingly, the misfitting items were mainly comprised of continuous, low-stakes assessments. For instance, the 4A_Critical Analysis Workbook assessment requires learners to submit responses (three 350-word responses and one 900-word response) on four coursework-related topics at regular intervals. Other misfitting examples include presentation-type assessments (1B_Presentation, 1E_Assessment 1 and 2B_Assessment 1) and continuous assessments (2D_Continuous Assessment). This suggests that either these assessments were poorly designed and unable to distinguish high-achieving learners from their low-achieving counterparts or they were measuring a different construct. Typically, the role of formative assessments in any curriculum is primarily to gain insights into a student's learning progress and to inform feedback processes (Dawson et al., 2023; Gibbs, 2006). These assessments are often less structured than the standardised summative assessments that evaluate learners' knowledge against specific standards. Our findings align well with this notion, as the formative assessments exhibited either lower discriminatory characteristics or statistical misalignment with the teaching standards. It should also be noted that while an assessment (2B_Assessment 1) can be misfitted to a particular standard (Standard 3), but it could still be a good fit for measuring a different standard (Standard 4).

General discussion

In higher education, degree programmes are comprised of multiple courses with assumed sequential and scaffolded assessment and learning experiences. This poses a challenge for monitoring and assessing a learner's progress across a full programme of study. Curriculum designers and other stakeholders tend to map only the assessments and outcomes at the level of the declared curriculum, thereby ignoring the received curriculum that learners engage in and are assessed on. As noted by Divjak et al. (2023), it is imperative to compare the declared curriculum and the received curriculum to gain deeper insights about the appropriateness of our assessments. Such an analysis would enable us to identify the extent to which our assessments align with the declared curriculum as documented in the LD and the degree to which students' learning experiences are consistent with the intended outcomes.

Manually investigating these discrepancies is often time-consuming and can include biases. As such, there has been a lot of focus on using analytics to improve curriculum design. Despite several applications of CA to enhance and support curriculum design, CA has typically only been employed at the level of a single course (Barthakur et al., 2022; Divjak et al., 2023). These studies have adopted analytical approaches to investigate curriculum mapping at the level of a single course and focused on course level learning outcomes. Although such studies have contributed to our understanding of the role of analytics in curriculum (re-)design, there is a significant gap in how this can be implemented at the level of degree programmes. Our study attempted to tackle these limitations. In so doing, it aims to raise awareness of the potential for LA-based approaches to inform programme and course quality assurance practices.

This study provides a novel analytics-based approach to evaluate curriculum mapping in a higher education degree programme. This paper proposes the intersection of LA and psychometrics as a scalable approach to validate the mapping between certain teaching standards and course-level assessments. Although the approach has been implemented in an accredited professional programme in a higher education context, this can be easily replicated across other degree programmes, that are more typical in higher education, that require a demonstration of the alignment between programme-level outcomes, assessment and a learner's attainment of knowledge, skills and capabilities. For instance, it will be interesting to replicate the study by Holmes et al. (2018), in which they provide a quantitative curriculum mapping for certain engineering standards required by Engineers Australia based on the declared curriculum. Our approach using the actual learners' assessment scores, reflecting the received curriculum, can be a valuable extension to mapping learning activities and assessments to the engineering standards, as noted by Holmes et al.

Practical implications

The analysis and results of the revised mapping between the teaching standards and the assessments have several practical implications for curriculum development and quality assurance in higher education. The validated mapping serves as a valuable tool for future curriculum design and development. By explicitly linking the professional standards to specific assessments, educators and programme quality assurance committees can ensure that intended learning outcomes are effectively addressed throughout the programme. This alignment enhances the coherence and consistency of the curriculum, providing a clear roadmap for both teachers and learners. The revised mapping also informs future revisions and iterations of the curriculum, enabling the identification of areas where adjustments or improvements may be needed to enhance alignment between noted outcomes, assessment and professional standards.

Professional accrediting bodies – for example, the Quality Assurance Agency (Quinlan, 2016) or the Tertiary Education Quality and Standards Agency (Brawley et al., 2013) – require explicit mapping of the programme curriculum and where professional standards are offered and assessed. The evidence-based approach presented in our study provides a robust foundation for demonstrating compliance with accreditation standards. The inclusion of learners' assessment data strengthens the credibility of the mapping, showcasing the university's commitment to quality assurance and meeting the educational standards set by external accrediting bodies. The validated mapping can be submitted as part of the accreditation documentation, facilitating a smoother and more efficient accreditation review process.

The capacity to demonstrate coherence and achievement of the professional standards at an individual course and assessment level brings new insights for educators, programme coordinators and other stakeholders. The analytical outcomes presented as probabilities in the paper allow for a comprehensive understanding of learners' progress and proficiency across each standard. Educators can use this information to identify areas of strength and areas that require additional support or intervention. The findings can inform pedagogical strategies, instructional approaches and the provision of targeted feedback to learners.

A key outcome of this study relates to the scalability and objectivity of the analytical approach. A more data-driven model for quality assurance presents opportunities for wider application across other programmes and institutions. Adopting such evidence-based, data-driven methodologies for curriculum evaluation and quality assurance can facilitate benchmarking and comparisons within and across institutions. In turn, this can bring a culture of continuous improvement whereby educational programmes are more frequently and accurately refined and enhanced to better meet the needs of learners, align with industry expectations and prepare graduates for successful careers.

Limitations and future work

Akin to most exploratory studies, several limitations need to be acknowledged. First, although we acknowledge that curriculum is connected to certain historical, political and societal situations and includes much larger constructs of student learning experiences, our study takes a pragmatic approach to

investigating curriculum mapping for enhancing quality assurance processes in higher education. Second, our research cannot accommodate non-graded assessments, so the assessments linked to the latter three teaching standards could not be validated. Although this limits our approach from being fully analytical-based, as many of the curriculum mapping decisions are dependent on instructors and learning designers, we provide a novel methodology that can be further honed to manage these intricacies effectively. Future research should address some of these complexities by including some form of assessment linking all the standards. Moreover, our proposed methodology can be categorised as post hoc compared to other research studies, such as those by Holmes et al. (2018) and Divjak et al. (2023). Although this may be considered a limitation, we prioritise utilising factual data to present a comprehensive evaluation of the standards, and an ad hoc approach would not yield the same level of depth and precision. The findings of this study can be instrumental in improving the programme's future offerings. Another limitation of the methodology adopted in this work is that it cannot model the multiple attempts for an assessment-learner pair. In the study, we considered the final assessment attempt and the last recorded grade as they represent learners' acquired knowledge when completing the degree. Finally, we relied on a relatively small cohort size for this study. To establish the generalisability of our approach and findings presented here, another study with a larger sample must be conducted.

Conclusions

Universities recognise their responsibility for fostering and determining capabilities and dispositions that prepare students for the modern workplace. Aligning curricula to these capabilities, especially in terms of assessment, is essential to meeting these responsibilities. Assessments lie at the heart of any educational institution and make a vital contribution to determining if learners are meeting the required standards. The reality of enacted curricula is, however, often at odds with achieving this alignment. Fragmentation and compartmentalisation at the course level create obstacles to ascertaining connections between course-level assessment and programme-level standards. This is especially concerning for professional degree programmes, where these standards may be external to the university and overseen by other governing bodies. This, in turn, inhibits the essential process of evaluating and assuring the quality of the degree programme.

It is important to clarify that this work does not constrain the academic freedom afforded to classroom instructors in their pedagogical approach and subject matter. Rather, our work creates an opportunity to thoroughly investigate the higher education curriculum needed for quality assurance purposes and for improving overall teaching and learning. Using a case study of an ITE programme, we implemented a novel, analytics-based study to validate the alignment between professional standards and course-level assessment grades. Through the case study, we show that there is a possibility of presenting a scalable and analytical solution to more authentic curriculum mapping. Our study demonstrates that the proposed methodology provides diagnostic information that maps large-scale intentions (i.e., professional capabilities) to learner results through their assessments. We identified three out of the four standards investigated in this study, which were assessed during the programme's initial years and comprised poorly structured assessments. Such practices can not only contribute towards enhancing students' learning experience but can be used for quality assurance and programme evaluations at scale.

This study advances the field of curriculum mapping, providing practical insights for curriculum development, quality assurance, and instructional practices in higher education. Equally important, it demonstrates the viability of a curriculum analytics approach to overcoming recognised obstacles to standards-informed programme evaluation and quality assurance. We intend to capitalise on these results to further apply this approach in different disciplinary contexts and at a greater scale.

Author contributions

Abhinava Barthakur: Conceptualisation, Methodology, Software, Validation, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Resources, Visualisation, Project administration; **Vitomir Kovanović**: Supervision, Conceptualisation, Methodology, Validation, Writing – review & editing; **Shane Dawson:** Supervision, Conceptualisation, Writing – review & editing, Supervision; **Christopher C. Deneen:** Conceptualisation, Writing – review & editing, Validation.

References

Archambault, S. G., & Masunaga, J. (2015). Curriculum mapping as a strategic planning tool. *Journal of Library Administration*, *55*(6), 503–519. https://doi.org/10.1080/01930826.2015.1054770

Armatas, C., Kwong, T., Chun, C., Spratt, C., Chan, D., & Kwan, J. (2022). Learning analytics for programme review: Evidence, analysis, and action to improve student learning outcomes. *Technology, Knowledge and Learning*, *27*(2), 461–478. https://doi.org/10.1007/s10758-021-09559-6

Australian Institute for Teaching and School Leadership. (2022). *Australian Professional Standards for Teachers*. https://www.aitsl.edu.au/docs/default-source/national-policy-framework/australian-professional-standards-for-teachers.pdf

Baker, F. B. (2001). *The basics of item response theory* (2nd ed.). Office of Educational Research and Improvement.

Barthakur, A., Joksimovic, S., Kovanovic, V., Corbett, F. C., Richey, M., & Pardo, A. (2022). Assessing the sequencing of learning objectives in a study program using evidence-based practice. *Assessment & Evaluation in Higher Education*, *47*(8), 1429–1443. https://doi.org/10.1080/02602938.2022.2064971

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher Education*, *32*(3), 347–364. https://doi.org/10.1007/BF00138871

Brawley, S., Clark, J., Dixon, C., Ford, L., Ross, S., Upton, S., & Nielsen, E. 2013. Learning outcomes assessment and history: TEQSA, the After Standards Project and the QA/QI challenge in Australia. *Arts and Humanities in Higher Education*,*12*(1), 20–35. https://doi.org/10.1177/1474022212460745

Chalmers, R. (2012). mirt: A multidimensional item response theory package for the R environment. *Journal of Statistical Software*, *48*(6), 1–29. https://doi.org/10.18637/jss.v048.i06

Dawson, S., & Hubball, H. (2014). Curriculum analytics: Application of social network analysis for improving strategic curriculum decision-making in a research-intensive university. *Teaching and Learning Inquiry*, *2*(2), Article 2. https://doi.org/10.20343/teachlearninqu.2.2.59

Dawson, S., Joksimovic, S., Poquet, O., & Siemens, G. (2019). Increasing the impact of learning analytics. In S. Hsiao, J. Cunningham, K. McCarthy, & G. Lynch (Chairs), *Proceedings of the 9th International Conference on Learning Analytics & Knowledge* (pp. 446–455). Association for Computing Machinery. https://doi.org/10.1145/3303772.3303784

Dawson, S., Pardo, A., Salehian Kia, F., & Panadero, E. (2023). An integrated model of feedback and assessment: From fine grained to holistic programmatic review. In I. Hilliger, H. Khosravi, B. Rienties, & S. Dawson (Chairs), *Proceedings of the 13th International Learning Analytics and Knowledge* (pp. 579–584). Association for Computing Machinery. https://doi.org/10.1145/3576050.3576074

Divjak, B., Kadoić, N., & Žugec, B. (2021). The use of decision-making methods to ensure assessment validity. In T. Daim (Chair), *Proceedings of the 2021 IEEE Technology & Engineering Management Conference - Europe* (pp. 1–6). IEEE. https://doi.org/10.1109/TEMSCON-EUR52034.2021.9488580

Divjak, B., Svetec, B., Horvat, D., & Kadoić, N. (2023). Assessment validity and learning analytics as prerequisites for ensuring student-centred learning design. *British Journal of Educational Technology*, *54*(1), 313–334. https://doi.org/10.1111/bjet.13290

Gibbs, G. (2006). Why assessment is changing. In C. Bryan and K. Clegg (Eds.), *Innovative assessment in higher education* (pp. 11–22). Routledge.

Gottipati, S., & Shankararaman, V. (2014). Learning analytics applied to curriculum analysis. In *Proceedings of the 2014 AIS SIGED: IAIM International Conference on Information Systems Education and Research, 2*, (pp. 1–11). https://aisel.aisnet.org/siged2014/2

Gottipati, S., & Shankararaman, V. (2018). Competency analytics tool: Analyzing curriculum using course competencies. *Education and Information Technologies*, *23*(1), 41–60. https://doi.org/10.1007/s10639-017-9584-3

Greer, J., Molinaro, M., Ochoa, X., & McKay, T. (2016). Learning analytics for curriculum and program quality improvement (PCLA 2016). In S. Dawson, H. Drachsler & C. P. Rosé (Chairs), *Proceedings of the Sixth International Conference on Learning Analytics & Knowledge* (pp. 494–495). Association for Computing Machinery. https://doi.org/10.1145/2883851.2883899

Holmes, D. W., Sheehan, M., Birks, M., & Smithson, J. (2018). Development of a competency mapping tool for undergraduate professional degree programmes, using mechanical engineering as a case study. *European Journal of Engineering Education*, *43*(1), 126–143. https://doi.org/10.1080/03043797.2017.1324404

Jessop, T., McNab, N., & Gubby, L. (2012). Mind the gap: An analysis of how quality assurance processes influence programme assessment patterns. *Active Learning in Higher Education*, *13*(2), 143–154. https://doi.org/10.1177/1469787412441285

Kang, T., & Chen, T. T. (2008). Performance of the generalized S-X^2 item fit index for polytomous IRT models. *Journal of Educational Measurement*, *45*(4), 391–406. https://doi.org/10.1111/j.1745-3984.2008.00071.x

Kelly, A. V. (2004). *The curriculum: Theory and practice* (5th ed). Sage Publications.

Komenda, M., Víta, M., Vaitsis, C., Schwarz, D., Pokorná, A., Zary, N., & Dušek, L. (2015). Curriculum mapping with academic analytics in medical and healthcare education. *PLOS ONE*, *10*(12), Article 0143748. https://doi.org/10.1371/journal.pone.0143748

Lam, B. H., & Tsui, K. T. (2016). Curriculum mapping as deliberation – examining the alignment of subject learning outcomes and course curricula. *Studies in Higher Education*, *41*(8), 1371–1388. https://doi.org/10.1080/03075079.2014.968539

Lockyer, L., & Dawson, S. (2011). Learning designs and learning analytics. In P. Long & G. Siemens (Chairs), *Proceedings of the 1st International Conference on Learning Analytics & Knowledge* (pp. 153–156). Association for Computing Machinery. https://doi.org/10.1145/2090116.2090140

Matcha, W., Gašević, D., Ahmad Uzir, N., Jovanović, J., Pardo, A., Lim, L., Maldonado-Mahauad, J., Gentili, S., Pérez-Sanagustín, M., & Tsai, Y.-S. (2020). Analytics of learning strategies: Role of course design and delivery modality. *Journal of Learning Analytics*, *7*(2), 45–71. https://doi.org/10.18608/jla.2020.72.3

Maydeu-Olivares, A. (2013). Goodness-of-fit assessment of item response theory models. *Measurement: Interdisciplinary Research & Perspective*, *11*(3), 71–101. https://doi.org/10.1080/15366367.2013.831680

Méndez, G., Ochoa, X., & Chiluiza, K. (2014). Techniques for data-driven curriculum analysis. In M. Pistilli, J. Willis, D. Koch, & K. Arnold (Chairs), *Proceedings of the Fourth International Conference on Learning Analytics & Knowledge* (pp. 148–157). Association for Computing Machinery. https://doi.org/10.1145/2567574.2567591

Méndez, G., Ochoa, X., Chiluiza, K., & Wever, B. de. (2014). Curricular design analysis: A data-driven perspective. *Journal of Learning Analytics*, *1*(3), Article 3. https://doi.org/10.18608/jla.2014.13.6

Motz, B., Busey, T., Rickert, M., & Landy, D. (2018). Finding topics in enrollment data. In K. E. Boyer & M. Yudelson (Eds.), *Proceedings of 11th International Conference on Educational Data Mining* (pp. 424–430). International Educational Data Mining Society. https://educationaldatamining.org/files/conferences/EDM2018/papers/EDM2018_paper_159.pdf

Nusche, D. (2008). *Assessment of learning outcomes in higher education: A comparative review of selected practices*. Organisation for Economic Cooperation and Development. https://doi.org/10.1787/244257272573

Ochoa, X. (2016). Simple metrics for curricular analytics. In J. Greer, M. Molinaro, X. Ochoa, & T. McKay (Eds.), *Proceedings of the 1st Learning Analytics for Curriculum and Program Quality Improvement Workshop* (pp. 20–26). Association for Computing Machinery. http://ceur-ws.org/Vol-1590/paper-04.pdf

Quinlan, K. M. 2016. Developing student character through disciplinary curricula: An analysis of UK QAA subject benchmark statements. *Studies in Higher Education*, *41*(6), 1041–1054. https://doi.org/10.1080/03075079.2014.966069

Siemens, G., & Long, P. (2011, September 12). Penetrating the fog: Analytics in learning and education. *EDUCAUSE Review, 46*(5), 30-40. https://er.educause.edu/articles/2011/9/penetrating-the-fog-analytics-in-learning-and-education

Sumsion, J., & Goodfellow, J. (2004). Identifying generic skills through curriculum mapping: A critical evaluation. *Higher Education Research & Development*, *23*(3), 329–346. https://doi.org/10.1080/0729436042000235436

Tyler, R. W. (1949). *Basic principles of curriculum and instruction*. University of Chicago Press.

Uchiyama, K. P., & Radin, J. L. (2009). Curriculum mapping in higher education: A vehicle for collaboration. *Innovative Higher Education*, *33*(4), 271–280. https://doi.org/10.1007/s10755-008-9078-8

Wang, C.-L. (2015). Mapping or tracing? Rethinking curriculum mapping in higher education. *Studies in Higher Education*, *40*(9), 1550–1559. https://doi.org/10.1080/03075079.2014.899343

Wijngaards-de Meij, L., & Merx, S. (2018). Improving curriculum alignment and achieving learning goals by making the curriculum visible. *International Journal for Academic Development*, *23*(3), 219–231. https://doi.org/10.1080/1360144X.2018.1462187

Wiles, J. (2008). *Leading curriculum development*. Corwin Press.

Wu, M., Tam, H. P., & Jen, T.-H. (2016). *Educational measurement for applied researchers: Theory into practice*. Springer. https://doi.org/10.1007/978-981-10-3302-5

Corresponding author: Abhinava Barthakur, abhinava.barthakur@unisa.edu.au

Copyright: Articles published in the *Australasian Journal of Educational Technology* (AJET) are available under Creative Commons Attribution Non-Commercial No Derivatives Licence (CC BY-NC-ND 4.0). Authors retain copyright in their work and grant AJET right of first publication under CC BY-NC-ND 4.0.

Please cite as: Barthakur, A., Kovanović, V., Dawson, S., & Deneen, C. C. (2024). The application of curriculum analytics for improving assessments and quality assurance in higher education. *Australasian Journal of Educational Technology*, *40*(4), 20–37. https://doi.org/10.14742/ajet.9383