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Teaching about curriculum and assessment through inquiry and problem-based learning methodologies: an initial teacher education cross-institutional study

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ABSTRACT

It is well documented that the integration of inquiry-based learning (IBL) and problem-based learning (PBL) methodologies in initial teacher education (ITE) provides opportunities to enhance pre-service teachers' research skills. However, few studies articulate the processes by which teacher educators implement and sustain these approaches in cross-institutional collaboration. This paper explores the journey of two teacher educators and their pre-service teachers, within a cross-institutional study on curriculum and assessment, problematising aspects of the longitudinal application of IBL and PBL methodologies. Dialogical reflections by the teacher educators and a critical friend, along with student questionnaires, were analysed in this three-year action research study. Findings demonstrate an increase in pre-service teachers' research skills but limited transferability of learning to teaching. The papers' central contribution proposes that as ITE reconfiguration evolves programmes can capitalise upon cross-institutional professional collaborations between teacher educators. Collaborative IBL and PBL learning spaces can be creatively explored to enhance transferability, developing pre-service teachers as researchers, a core element of initial teacher education programme accreditation.

Introduction

Teacher education is a complex and non-linear phenomenon influenced and shaped by multiple variables (OECD 2019; Strom 2015; Walsh and Dolan 2009). In Ireland, part of this complexity is related to recent curriculum reforms that have conditioned change in the structure of initial teacher education (ITE) programmes, encouraging them to be research-based (Gleeson, Sugrue, and O'Flaherty 2017; Sahlberg, Furlong, and Munn 2012).

The necessity of enhancing pre-service teachers' inquiry and research skills in ITE forms the backdrop to this study. It is well documented that the implementation of inquiry-based

learning (IBL) and problem-based learning (PBL) methodologies in ITE settings provides opportunities to advance research processes and skills in pre-service teachers (Barrett 2017; Levy, Aiyegbayo, and Little 2009; Strom 2015). However, few studies articulate the ongoing processes by which teacher educators enact and sustain these approaches in ITE (Tsybulsky et al. 2020). Capturing the collective meaning of the whole process, and problematising aspects of its practice, is also considered essential to understand the complexity of IBL, but is under investigated (Prinsen 2015). As such, prompted by Prinsen (2015) and Tsybulsky et al.'s (2020), the aim of this paper is to present a three-year cross-institutional study on the implementation of IBL and PBL methodologies with pre-service teachers in curriculum and assessment studies, to problematise aspects of its longitudinal application in ITE. In order to address this purpose, three research questions were formulated: (1) To what extent do IBL and PBL methodologies enhance pre-service teachers' knowledge and application of curriculum and assessment studies? (2) To what extent do IBL and PBL methodologies enhance the research skills of pre-service teachers? and (3) What factors hinder/enable a sustained implementation of IBL and PBL methodologies in ITE?

Theoretical framework

Inquiry and problem-based learning methodologies in ITE

Encompassing the related approaches of PBL, project-based learning, case-based learning and problem-solving, IBL is often is used to describe approaches that offer pre-service teachers considerable freedom in defining and directing their inquiries, since it is oriented towards open-ended questions and problems, and has a clear focus on teaching pre-service teachers the research approaches and techniques of their disciplines (Levy et al. 2010). The iterative cycle from an initial questioning and purposeful engagement with well-designed inquiry tasks takes place in a challenging but supportive setting. Levy, Aiyegbayo, and Little (2009) identified two main conceptual axes through which learners viewed experiences, namely an information frame (staff-led through to student-led) and a discovery frame (exploring and acquiring existing knowledge to participating in building knowledge in the discipline) – activities learners engage in maybe in one quadrant or may extend over more.

In the same vein, Pedaste et al. (2015) developed a synthesised inquiry cycle that combines strengths of existing inquiry-based learning frameworks. In their framework, inquiry-based learning begins with orientation and flows through conceptualisation to investigation, where several cycles are possible. PBL is one form of IBL where a problem is posed which becomes the centre and driving force of the learning. Normally a collaborative group activity, PBL is defined by Yew and Goh (2016, 75–76) as a 'pedagogical approach that enables students to learn while engaging actively with meaningful problems'. Barrett (2017, 2) explains that 'a key and defining characteristic of problem-based learning is that students experience the problem at the *start* of the learning process before other curriculum inputs' and adds that the problem motivates students to construct knowledge through independent study and through dialogue with others. Therefore, on the basis of these discussions of PBL, the teacher educator is charged with designing a problem effectively, establishing and moderating PBL tutorials (i.e. dialogue and reflection spaces for the

pre-service teachers), training the pre-service teachers in PBL roles and guiding them in the direction of high quality, original and ethical research outputs.

By adapting PBL in a research-based ITE programme it is hoped that pre-service teachers are able to utilise educational research as part of their work in school settings (Sahlberg, Furlong, and Munn 2012; van der Linden et al. 2012). Making the connection between research and learning explicit, ensures that such an approach can provide possibilities for strengthening links between research and teaching in ITE and ultimately in the school placement experiences (Spronken-Smith and Walker 2010). Indeed, inviting pre-service teachers to participate in knowledge-building communities and collaborations during their ITE programme may allow for productive teacher educator-pre-service teacher partnerships, similar to other staff-student relationships (Levy, Little, and Whelan 2011). Challenges presented by IBL and PBL are also in evidence in the literature. Gholan (2019) argued for the superiority of guided instruction, except where significant prior knowledge is in place, on the basis that IBL and PBL methodologies (among others) fail to align with established cognitive theory, not least that significant prior knowledge is a pre-requisite for independent successful knowledge construction. Barron and Darling-Hammond (2010) also stressed the importance of teacher educators having a deep understanding of the IBL approach but also of the extensive scaffolding and constant assessment required. Formulating meaningful questions or learning challenges and enacting sustained and longitudinal IBL approaches are also considered as essential for a successful learning journey (Gholan 2019).

As reported in Prinsen (2015), IBL draws on several theoretical frameworks to explain how learning happens. For the purpose of this study, we drew on experiential learning theory (Kolb and Kolb 2009), and collaborative inquiry (David 2008). The central tenets of experiential learning theory adopted for this study were: (1) learning is best conceived as a process; (2) learning requires the resolution of conflicts through dialogue; (3) learning is a holistic process of adaptation; and (4) learning is the process of creating knowledge. Experiential learning theory proposes a constructivist theory of learning whereby social knowledge is created and recreated in the personal knowledge of the teacher educators and pre-service teachers' involved in the sustained implementation of IBL and PBL methodologies (Kolb and Kolb 2009).

The conceptualisation of inquiry, based on a socio-constructivist model of self-regulated learning from Butler and Schnellert (2012), also informed this study. In particular, a model of self-regulation for professional learning that involves a goal-oriented iterative cycle that includes defining problems or expectations, setting goals, selecting, adapting, or inventing task appropriate strategies, self-monitoring outcomes, and revising goals or approaches to better achieve desired outcomes (Butler, Schnellert, and Cartier 2013). Particularly, we focused on teachers' practice-level inquiry. Practice-level inquiry can be conceptualised as teachers' recursive engagement in planning, enacting, monitoring, and revising practices to achieve valued goals for their students and their own learning (Butler and Schnellert 2012).

Curriculum and assessment in ITE

Curriculum studies is a core component of ITE programmes and may be considered as a place where theories run together to enhance the study of practice, and referring to pre-

service teachers Malone (2011, 74) stressed '(i)n a very real sense, you are the curriculum (or at least a very important part of it) for the students in your classes'.

According to Simmons and MacLean (2018), curriculum is a dynamic process which involves teachers navigating policy frameworks to provide success for individual pupils. Curriculum can be seen, not a product to be delivered uncritically by practitioners through a 'tick box' approach (Priestley and Biesta 2013), but rather a process of sense-making and the development of contextualised practices (Ketelaar et al. 2012). Implicated in curriculum is the understanding of sense-making which is enacted from policy to practice (Blignaut 2008; März and Kelchtermans 2013).

Curriculum is intimately intertwined and constructively aligned with both pedagogy and assessment (Biggs 1996). Dialogic and collaborative pedagogies as well as the continuous approach to assessment and the development of teacher agency through the teacher becoming a curriculum developer is central (Priestley 2016). In bridging a gap between intended and the received curriculum, the role of assessment – and particularly formative assessment – is integral in ITE (Walsh and Dolan 2009). Assessment is intended to establish whether, and to what extent the curriculum intention has been achieved (Malone 2011). In Ireland for example, a formal, typically written, high-stakes assessment takes place at the end of the post-primary curriculum. This form of assessment has the effect of influencing the teaching methodology adopted by teachers and indeed is a basis for certain preconceived perceptions of curriculum by pre-service teachers upon entering ITE (MacPhail and Halbert 2010).

Curriculum and assessment studies is a study, in its own right, involving a critically reflective application of theoretical perspectives of curriculum and assessment to the practice of teaching and is a core component of initial teacher education programmes. Though not an applied science, curriculum studies are a form of study 'which takes full account of the need for teachers and pre-service teachers to adopt what has been called an "extended" professionalism, that attitude to their work which make them professionals in the full sense rather than merely practitioners' (Kelly 2009, 27). ITE must be cognisant of these theoretical and conceptual analyses but also realise that curriculum and assessment studies may be seen as the mechanics of practical curriculum planning, development, innovation and evaluation. Integral to these processes lies the capacity to critically reflect and research, hence the potential value of the use of IBL and PBL methodologies with pre-service teachers.

Pre-service teachers as researchers

The research agenda in ITE and that of practising teachers in Ireland has undergone much transformation and reform in recent years (O'Donoghue, Harford, and O'Doherty 2017). In fact, there has been a proliferation of discussions on research-led learning in teacher education (Coolahan et al. 2017; Gleeson, Sugrue, and O'Flaherty 2017; HEA 2019), and McKenney and Schunn (2018) remind us that when we do research on education, we are also invariably doing research for education.

Currently all ITE programmes in Ireland are expected to incorporate multiple reflective and inquiry-led processes, including a substantive research project (MacPhail and O'Sullivan 2019). The role of research in Irish ITE was highlighted in the 2012 Sahlberg report which strongly encouraged the enhancement of pre-service teacher learning by an

increased focus on research (Sahlberg, Furlong, and Munn 2012). The report recommended strongly that graduate teachers become capable of applying research to their work in a constructive and reflective way and also lead by example – by encouraging learning, which is enquiring, engaged and critical (21). In achieving the latter, the report recommended the creation of synergies through degree programmes and courses to promote 'innovative pedagogical practices' (33).

In summary, we aimed to explore two teacher educators' journey to enact a three-year cross-institutional IBL and PBL approach to curriculum and assessment studies in ITE. Furthermore, prompted by Sahlberg, Furlong, and Munn (2012), the study explored the complexities of a longitudinal implementation of IBL and PBL methodologies in ITE programmes.

Method

Research design

A three-year collaborative action research mixed-methods design was adopted in this study, similar to the work of Murray (2015) and Yin and Buck (2019), following the model of a reflective teaching cycle (Smith 2001). Collaborative action research ensured that teacher educators developed and evolved their practice through reflective teaching cycles including planning, teaching and reflecting (Butler, Schnellert, and Cartier 2013). Of interest to this study is the more specific concept of dialogical action research, where the reflective process is situated in the context of dialogue or reflective conversations between the teacher educators and with a critical friend (Costello, Conboy, and Donnellan 2015). Figure 1 shows a visual summary of the research design, the three academic years enactment and the action research cycles.

Research participants

The research participants in this collaborative action research study include three cohorts: (1) two teacher educators who led the curriculum and assessment module delivery throughout the three academic years, (2) their pre-service teachers, and (3) an external teacher educator who acted as critical friend (Fletcher, Ní Chróinín, and O'Sullivan 2016). Both teacher educators had backgrounds in STEM education and prior experience with collaborative action research. The three teacher educators are authors of the paper.
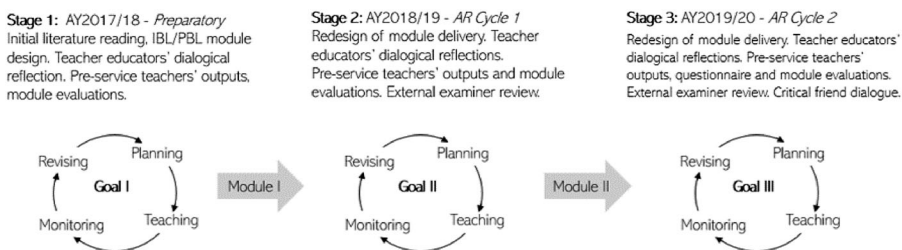

Figure 1. Collaborative action research cycles stages and cycles based on Butler, Schnellert, and Cartier (2013).

The pre-service teachers included university-based pre-service teachers from a Bachelor of Arts (Hons) in Mathematics and Education degree programme and pre-service teachers from an Institute of Technology on a Bachelor of Science in Education (Hons) Design, Graphics and Construction degree programme who met weekly in the University setting. The age profile of pre-service teachers on the module (AY2019/20) ranged between 18 and 25 years, with a minority of mature students aged 25 and over (<10%). There was a significantly larger number of male participants in both AR Cycles (Cycle 1 – Female 8: Male 25, and Cycle 2 – Female 8: Male 22). The gender imbalance is explained by the fact that participants on the Institute of Technology Teacher Education degree programme are traditionally heavily male based, mirroring documented gender stereotyping in subject selection at second level (DES 2019, 42).

IBL pedagogical approach

The year three 5 ECTS 'Curriculum and Assessment' module explores key academic concepts, principles and theories relating to curriculum and assessment. Delivered over a 12-week semester, the module builds upon students' prior knowledge and experience of curriculum and assessment in years one and two. The module is a component of the accredited undergraduate concurrent teacher education programme in each of the HEIs. Students investigate key terminology, explore models of curriculum and assessment, examining national and international developments and trends. Furthermore, they develop an understanding of the role of curriculum studies in teachers' professional development and, in this context, engage in a curriculum planning process which has a particular focus on contemporary issues in Irish curriculum policy and practice. With respect to the methodology of delivery, an adaptation of the Pedaste et al. (2015) IBL model was chosen (Figure 2).

The module has six learning outcomes and two main assessment components (Table 1). Assessment one relates to an individual IBL assignment task on the fundamentals of curriculum and assessment, and assessment two relates to a collaborative group PBL assignment, on higher level (meta) issues pertaining to curriculum and assessment.

Individual IBL assignment: In this task the pre-service teachers individually conducted academic research on a question relating to the curriculum and assessment, for example 'With reference to mathematics and the technical Junior Cycle subjects, clarify what is
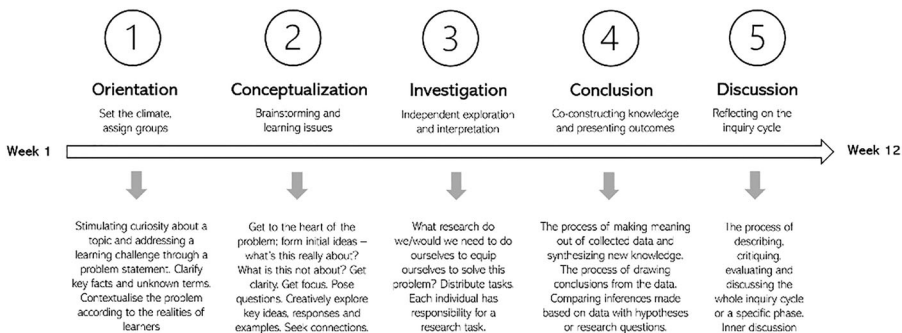

Figure 2. Timeline of the IBL approach (based on Pedaste et al. 2015).

Table 1. Mapping the curriculum and assessment module learning outcomes and continuous assessment tasks.

Learning outcome	Description	Assessment
LO1	Demonstrate an appreciation of the role of curriculum studies in teachers' professional development.	CA1
LO2	Use a range of strategies to support, monitor and assess pupil progress.	CA1, CA2
LO3	Plan coherent, progressive and integrated teaching events and modules,	CA2
LO4	Demonstrate an understanding of contemporary debates about curriculum developments and initiatives in second-level education.	CA1, CA2
LO5	Critically appraise schools as organisations and learning communities.	CA2
LO6	Contribute to curriculum and subject planning in their practice school.	CA2

meant by the terms "Curriculum" and "Assessment", and explore their inter-relationship in the context of effective subject delivery'. Students presented their independent findings in the formats of: (1) an 800–1000 word scholarly academic essay (short paper), and (2) a 3-minute public speech.

Collaborative group PBL assignment: This is a group task exploring curriculum change and the pre-service teachers were asked to demonstrate effective planning for cross-curriculum collaboration and delivery at Junior Cycle or Transition Year (Senior Cycle) levels. Following Pedaste et al. (2015), the pre-service teachers assume different roles within the group, including chairperson, scribe/recorder, reader, timekeeper, and observer.

Data collection and analysis

There were four forms of data collection: dialogical reflections by teacher educators, online critical friend dialogues, informal conversations with the pre-service teachers, and pre-service teacher questionnaires. Guided by Kitchen and Steven (2008), the teacher educators focused their dialogical reflections on the three research questions (outlined above). Furthermore, following the approach taken by Fletcher, Ní Chróinín, and O'Sullivan (2016), the teacher educators and critical friend engaged in regular reflective dialogues at the analysis and write-up phase of the research cycle, critically assessing and feeding back strengths and limitations of the analysis. The pre-service teachers' questionnaire was validated by colleagues from the teacher educators' institutions and one other institution and administered at the start and end of semester. Pre-service teachers were asked to define, explain in their own words, and indicate applications of key terms: curriculum, syllabus, specifications, assessment of learning, assessment for learning, formative assessment, and summative assessment. Further questions related to their knowledge of debates pertaining to current curricular reform in Ireland – specifically Junior Cycle reform – and to knowledge and application of IBL and PBL methodologies. Concluding questions focused on module evaluation.

Data analysis

Quantitative data was captured and analysed by means of a binary frequency analysis using an Excel spreadsheet in cases where appropriate knowledge content was either in evidence, or not. Percentage of appropriate knowledge and incorrect responses were

collected. Descriptive statistics (mean and SD) and the Mann–Whitney test was performed, given that the sample did not follow a normal distribution ($p < .005$) (Muijs 2010). Qualitative data extracted from the transcription of the teacher educators' reflections, and the dialogue with the critical friend, were coded in phases. The initial phase of coding was done line-by-line and represented phrases or words drawn from the teachers describing the data to reduce researcher interpretation (Charmaz 2014). In the focused phase of coding, categories and subcategories were constructed, and revisited through constant comparison (Boeije 2002). In the final phase of coding, theoretical connections and relationships were made between the research goal and underpinning theory and the constructed categories. The analysis moved from inductive and descriptive (stage one) to more deductive and theory informed (stage two and three). Qualitative statements were also captured from the open questions in the questionnaire relating to pre-service teachers' capacity to apply learnings from the module to classroom practice. Brief memos were also logged on the excel sheet to provide a rationale and further detail on each binary score (e.g. 'correct-good quality'; 'definitions are skimp and partial'; 'not sufficiently grasped-vague').

Findings

The research findings, and sub-themes emerging from the data analysis, are structured around the study's three research questions. Supportive data is provided from teacher educator reflections (TE1_ journal and TE2_journal), and dialogical reflections with the study's critical friend (TE_dialogic), the pre-service teachers' (PST) questionnaire responses (AY2019/20) and external examination reviews.

RQ1: To what extent do IBL and PBL methodologies enhance pre-service teachers' knowledge and application of curriculum and assessment theory?

The results of the students' responses to the questionnaire are presented in Table 2. With respect to their knowledge and application of assessment concepts PSTs showed a significant improvement in their knowledge of the key concepts from pre-test to post-test in both action research cycles in several variables. Results from the (1) formative assessment learning increased from 21 to 78, $p < .001$; (2) summative assessment increased from 26 to 75, $p < .001$; (3) inquiry-based learning increased from 37 to 81, $p < .001$; and (4) problem-based learning also increased from 63 to 91, $p < .001$, however the PST's ability to apply these concepts in practice was limited.

Two dominant sub-themes identified from the analysis included: (1) module output disjunction, and (2) application of theory to practice.

Module output disjunction

Consistent with previous years, in AY2019/20 there was evidence of high-quality module outputs relating to curriculum and assessment knowledge and application. This was demonstrated in both the individual IBL (academic essay) and the group collaborative PBL (research poster) tasks. Teacher educator reflections identified specific strengths, including: 'a strong grasp of curriculum reform and stakeholders in the Irish context, in particular junior cycle reform' (TE1_ journal_1a), 'very good demonstration of

Table 2. Pre-test and post-test comparison of means ($n = 33$).

Variable	Mean (SD) Pre	Mean (SD) Post	Δ	z	p
Definition of concepts					
Curriculum	58 (.50)	69 (.41)	11	−0.77	.437
Assessment	74 (.45)	88 (.33)	14	−1.23	.215
Syllabus	47 (.51)	84 (.36)	37	−2.77	.005**
Specifications	00 (.00)	22 (.42)	22	−2.17	.030*
Formative assessment	21 (.41)	78 (.42)	57	−3.94	.000**
Summative assessment	26 (.45)	75 (.44)	49	−3.36	.001**
Assessment for learning	21 (.41)	61 (.78)	40	−2.16	.030*
Assessment of learning	26 (.45)	70 (.91)	44	−2.19	.028*
Inquiry-based learning	37 (.49)	81 (.39)	44	−3.17	.001**
Problem-based learning	63 (.49)	91 (.29)	28	−3.24	.001**
Application of concepts to practice					
Formative assessment	26 (.45)	78 (.42)	52	−3.59	.000**
Summative assessment	32 (.47)	75 (.44)	43	−3.01	.003**
Assessment for learning	26 (.45)	55 (.93)	29	−1.20	.230
Assessment of learning	32 (.47)	58 (1.09)	26	−0.83	.407
Inquiry-based learning	10 (.22)	50 (.50)	40	−3.24	.001**
Problem-based learning	32 (.47)	47 (.50)	15	−1.063	.288
Analysis of national curriculum					
Advantages	84 (.37)	94 (.24)	10	−1.097	.273
Disadvantages	84 (.50)	88 (.33)	4	−0.353	.724

*$p \leq .01$.
**$p \leq .001$.

knowledge of the subject-specialist curriculum content as well as cross-disciplinary curricular overlaps' (TE1_ journal_1a) and professional and competent research poster presentations (TE1_ journal_1b). With respect to application, the skill capacity to develop innovative cross-curricular Transition Year (senior cycle) schemes of work and planning grids applicable to school placement was effectively demonstrated (TE_dialogic#1). Examination results and dialogue with external examiners from both institutes confirmed the teacher educators' viewpoint on the high standard of module outputs (external examination review).

Limitations were also identified, including: the absence of deeper philosophical debates relating to curricular reform and society (TE1_ journal_1b), some confusion around curricular reform debates, little consideration of senior cycle curriculum reform in the Irish context (TE1_ journal_1c), insufficient evidence of engagement with the module curriculum, assessment and IBL/PBL reading materials (TE1_ journal_1d), 'limited discussion of curriculum theoretical models – benefits and shortcomings' (TE2_ journal_1c), and the absence of discussions relating to the international dimension of curriculum (TE1_ journal_1e; external examination review).

A disjunction between high-quality module outputs evidenced in the pre-service teachers' collaborative PBL assignment and the subject-specific literacy deficiencies and limited knowledge content evidenced in the individual IBL task – and mirrored in the questionnaires – was also noted.

Application of theory to practice

The application of the theory of curriculum and assessment to the practice of teaching was somewhat evidenced in the effective development of cross curricular modules in the PBL collaborative task. One teacher educator reflection illustrates the teacher educators' expectations in this regard:

> … since the pre-service teachers have collaborated with students from a different institute and identified points of overlap in their respective syllabi and curriculum specifications, they have successfully synthesised mutually beneficial planning grids that incorporate effective teaching and assessment strategies. The students can, hopefully, now transfer curriculum and assessment knowledge – as well as these newly acquired IBL and PBL methodologies – to classroom practice. (TE1_ journal_ 1d)

This expectation was not fully met, however. Dialogue on this point between the teacher educators and the critical friend highlighted a lack of transferability of knowledge and skills to wider school contexts:

> … it is as if the module is perceived by some pre-service teachers as disconnected from school placement – some learners appear to have a blind-spot or a difficulty in applying both curriculum and assessment knowledge and the IBL and PBL methodologies that they have experienced in this module to the second-level classroom setting, which is something to consider for the next iteration. (TE_dialogic#1)

Some pre-service teachers suggested in informal conversations, the need for lecture inputs or direct instruction to supplement the IBL and PBL processes, to increase knowledge of curriculum and assessment. Illustrative comments include 'we did a lecture on ethics but nothing on curriculum and assessment – it makes no sense' (PST#9). In light of these responses, the teacher educators considered whether it might be necessary in the future to incorporate more instruction so that core areas are not missed, but there was a concern that a prescriptive approach might undermine the current philosophical model of an exclusive IBL and PBL delivery, which strongly values student autonomy and choice (TE_dialogic#1).

   With respect to knowledge and application of IBL and PBL methodologies, the pre-service teachers' questionnaires (AY2019/20) showed evidence of an increased understanding of IBL and PBL at the end of the module (Table 2). The ability to appropriately define IBL rose significantly from 37% at the commencement of the module (pre-test) to 81% at the end of the module (post-test) ($p = .001$). However, few examples were provided of the transfer of the module curriculum and assessment knowledge to the school placement classroom or the whole-school context. Specifically, the pre-service teachers were asked to provide one example of application to practice. Findings from the questionnaire's pre-test measures showed that only 10% of the PSTs provided an appropriate application of IBL to practice (Table 2). However, a significant increase of 40 points ($p = .001$) was found after the experience. A different pattern was noted with PBL, where an increase of 15 points ($p = .288$). From the teacher educators' perspective these findings indicated a lesser capacity than expected, on the part of pre-service teachers, to effectively transfer IBL and PBL methodologies to the school placement classroom.

RQ2: To what extent do IBL and PBL methodologies enhance the research skills of pre-service teachers?

The main theme constructed from the data in relation to the enhancement of pre-service teachers' research skills was how IBL and PBL enabled research skills.

   The IBL and PBL approach to the module, involved bringing pre-service teachers through a research cycle process of identifying a problem, designing a research approach,

analysing the problem, researching the problem, finding a solution, and disseminating the research. At the outset there was an awareness that ' … these students are in year three of the programme, so some still lack confidence and skills in advanced library research, academic writing and public oral presentation skills' (TE_dialogic#2). There was also a concern to broaden the learners' research skill set: ' … what we need to achieve is evidence of enhanced research skills, including competently and confidently presenting research findings publicly' (TE2_ journal_ 2a). In fact (as indicated above) the quality of the PBL group work research outputs was high:

> There is evidence of a relatively high-standard of student research demonstrated in the PBL research posters and accompanying documents and the research findings were appropriately disseminated using a scholarly research poster format. Students have attended to best practice poster design, narrative, content and layout, and oral presentations were well scripted and rehearsed. This was an impressive achievement for year 3. (TE1_ journal_ 2a)

In the student final questionnaire PSTs identified a number of strengths of the module specifically relating to IBL and PBL-related research skills, including: 'public speaking – daunting but beneficial' (PST#5), 'investigating topics and concepts' (PST#7), and 'improved researching skills' (PST#13).

Limitations were also identified and the teacher educators' reflections indicated that there were some areas that fell short: ' … international reforms were not generally referenced when contextualising the research outputs and in some cases fundamental definitions of terms and concepts were insufficiently grasped' (TE2_ journal_ 2b). Pre-service students' questionnaires (AY2019/20) confirmed this viewpoint. A number of pre-service teachers were not able to define concisely in their own words key terms relating to curriculum, and assessment, including the term 'specifications', a curriculum literacy term that was introduced in the context of Irish Junior Cycle curriculum reform in 2015. This provoked discussion and reflection on the part of the teacher educators:

> We need to re-examine our assumptions – we had presumed that year three pre-service teachers would been familiar with this new term 'specifications' given that they had prior Junior Cycle Reform training sessions and that they have had a prior placement in a secondary school settings – but it appears not. More explicit attention must be placed on this element in the next cycle iteration. (TE1_ journal_2b)

RQ3: What factors hinder/enable a sustained implementation of IBL and PBL methodologies in module delivery?

Two sub-themes were identified in relation to sustaining IBL and PBL methodologies in this module: (1) the significance of professional working relationships and learning spaces, (2) learner resistance to a non-didactic delivery.

Significance of professional working relationships and learning spaces

The cross-institutional working relationships between both institutes, at the levels of school, department and module delivery, were considered to be highly professional, cordial and effective. A culture of mutual respect and cross-institutional co-operation had been firmly established, with both institutes sharing a similar philosophy and

vision of education, and lecturers being flexible, open to cross-institutional synergies and to a co-exchange of knowledge and expertise. One teacher educator reflects on this positive working relationship:

> This is a most enjoyable and productive collaboration. There is an excellent and mutually respectful professional working relationship well established now, making for a creative, committed and ongoing co-delivery. There is great collegiality; it helps that, as personalities, we get on very well together. It is a module that I always look forward to. (TE2_ journal_3a)

Teacher educators identify the professional working relationship factor as a significant strength in the long-term implementation of IBL and PBL in the module delivery.

There were divergent viewpoints between teacher educators and pre-service teachers on the module learning space: a spacious classroom located in the host institute. One teacher educator describes the learning space as 'a bright and roomy flat classroom, centrally located in the host institute, with large movable tables – ideally suited to group work' (TE2, Journal 3b). However, some student questionnaire responses were at variance with this perspective. Students from the visiting institution indicated that a challenging aspect of the module was having to travel to a dedicated learning space in the host institute one day a week for the duration of the first semester of the academic year. Pre-service teacher questionnaire responses identified specific aspects deemed 'unhelpful' (Q. 9): it should be 'every second week' in different institutes (PST#4 and PST#5), 'parking and getting over there was very expensive' (PST#29), 'trying to have meetings is awkward' (PST#16) 'the time it takes to get there (PST#28), 'commuting between two colleges' (PST#21 and PST#22).

Learner resistance to non-didactic delivery

There was evidence of resistance on the part of learners to the non-directive and non-didactic approaches inherent in IBL and PBL methodologies as employed in module delivery. Pre-service teacher questionnaire responses included such comments as: 'some lecture time should focus on CBA [classroom-based assessment]' (PST#2), 'the lecture time wasn't allocated well – did not learn about the content enough … use the lectures to tell us what curriculum is' (PST#6), 'delivery was at time confusing, with no definitive answers to questions by students' (PST#18), 'sometimes instructions are not clear' (PST #23), '[include] a talk on what is curriculum and what is assessment' (PST#26).

Teacher educators' reflections on learners' resistance to IBL and PBL methodologies raised the question of educating the pre-service teachers on the underlying pedagogy and the benefits of IBL and PBL, at the outset on the module, to offset resistance:

> perhaps more time needs to be allocated at the start of the module delivery on helping learners understand more fully – and buy into – IBL and PBL methodologies, highlighting the pedagogical strengths of these methodologies and demonstrating clearly relevance for school placement teaching? (TE1_ journal_3a)

Discussion

Prompted by Prinsen (2015) and Tsybulsky et al. (2020), the purpose of this paper was to present a three-year cross-institutional study on the implementation of IBL and PBL methodologies in an ITE curriculum and assessment studies module, and to problematise

aspects of its longitudinal application. As evidenced in our study, and mirroring the literature, successful implementation of IBL and PBL instructional approaches is complex (Prinsen 2015). Our study found that some pre-service teachers appeared to have difficulties in applying curriculum and assessment knowledge as well as IBL and PBL methodologies to the classroom setting.

The transfer of learning, or theory-practice integration, has been defined as the process through which students apply to a real world situation, the knowledge, skills and attitudes they have acquired in training (Holton et al. 2007). While elsewhere PBL, together with other strategies, has been identified as an approach that facilitates this process (Culyer et al. 2018), this study evidences a different outcome. To favour successful transfer of learning to the school context an alignment between the micro (module), meso (programme) and macro (cross-institution) requires further investigation.

Within a health education setting, Botma et al. (2015) proposed a framework for educational design to promote transfer of learning, consisting of two principles: (1) establishing a community of learning and (2) the primacy of a learning outcome. Based on these principles, four steps were proposed: (1) activation of existing knowledge; (2) engaging with new information; (3) demonstrating competence; and (4) application in the real world (Botma et al. 2015). In our study, the IBL and PBL approach followed was guided by learning outcomes (see Table 1). In addition, the pre-service teachers were exposed to different sources of information in the orientation and conceptualisation phases (see Figure 2). They also demonstrated their knowledge in the posters' presentation (conclusion phase). Two of the aspects that were not extensively addressed as suggested by Botma et al. (2015), were the creation of a sustained learning community (which could have been inhibited by the pre-service teachers' resistance to working with peers from a different institution), and a better activation of existing or prior knowledge to guide the IBL and PBL approach from the start as essential to stimulating both transfer of learning and academic performance (Richardson, Abraham, and Bond 2012).

Hofer and Lembens (2019) propose that a central aspect in enabling learning in IBL and PBL environments is the support of pre-service teachers in areas such as planning, implementing, and reflecting upon IBL units. Furthermore, there is a need for pre-service teachers to become familiar with both the processes of inquiry and the implementation of IBL as an instructional approach (Hofer and Lembens 2019; Preston, Harvie, and Wallace 2015). This need was particularly evident in the last iteration of our study.

Kolb and Kolb (2009) proposed that learning is a holistic process of adaptation and a process of creating knowledge. This central tenet of experiential learning theory was evidenced in our study, where the holistic process of adaptation was significantly conditioned by ongoing Irish and international teacher education and curricular reform. Over the three-year cycle of the study, the teacher educators were increasingly informed in regard to national developments relating to teacher practitioner research, not least as promoted by regulatory bodies such as the Teaching Council (2018). This influenced their decision to focus intentionally on enhancing the research skills of academic investigation, writing and dissemination of findings in module delivery. IBL and PBL methodologies are seen to provide opportunities to advance research processes and skills – especially where the problems explored are meaningful for the learners (Barrett 2017; Yew and Goh 2016).

Also, pre-service teachers learn more deeply when they can apply classroom-gathered knowledge to real-world problems (Barron and Darling-Hammond 2010). The problems designed in the module, the development of cross-curricular curriculum and assessment planning grids, and the respectful and fruitful working relationship between the two ITE institutions, mirrors the literature, and the multiple curricular reforms taking place in the Irish educational system, helped the teacher educators to define more meaningful and relevant problems, immersing pre-service teachers 'in the inquiry sequence' (Preston, Harvie, and Wallace 2015, 81). Some pre-service teachers however, perceived the approach disconnected from school-placement and missed more lecture-based instruction relating to curriculum and assessment. While explicit instruction in regard to the concept of teacher-as-researcher was not included in the module, the delivery was entirely research and inquiry-based since underpinned by IBL and PBL methodologies.

Research-based teacher education programmes are important and policy advises that teachers ought to be competent in utilising educational research as part of their work in school settings and demonstrate the capacity to reflect upon and plan their own professional development (Sahlberg, Furlong, and Munn 2012). McKenney and Schunn (2018) refer to the importance of purpose and empirical relevance to practitioners in conceptualising and enacting educational change and innovation, and this is the value of this longitudinal cross-institutional study on pre-service teacher education. It is important to note however, that undergraduate teacher education should emphasise inquiry to qualify pre-service teachers to question practices, to seek knowledge, and to work in evidence-informed ways, but not necessarily to conduct research themselves, when research is understood in more rigorous terms, involving scientific and systematic methods and peer review (Munthe and Rogne 2015). Our IBL and PBL approach, based on the Munthe and Rogne (2015) framework, sought to explore the nature of undergraduate research and inquiry. We can confirm that enacting a module that emphasises pre-service students undertaking inquiry-based learning that emphasises teaching processes of knowledge construction in the subject, might be an appropriate step in order to achieve the Sahlberg, Furlong, and Munn (2012) recommendations, which strongly encouraged the enhancement of pre-service teacher learning by an increased focus on research and inquiry. The recently published Teaching Council 'Céim: Standards for Initial Teacher Education' also reiterate the importance of teachers as researchers where accredited programmes are 'underpinned by a research-informed approach that supports student teachers in engaging with and in research' (Teaching Council 2021, 12).

Finally as Connolly et al. (2020) recently suggested, in the context of the COVID-19 pandemic, which forced ITE globally to move online, the value of a research-informed and principled approach to education and teacher education is reinforced. Participant pre-service teachers in this study expressed concern and anxiety regarding collaborative learning spaces between the two HEI's. Nevertheless, the move to online learning presents positive opportunities for future ITE delivery and programmatic development; practical challenges relating to location, travel and meeting spaces will be alleviated. Future research (Academic year 2020/21) will include both an examination of the impact of IBL and PBL methodologies in the context of online and blended learning environments, and an exploration of potential mechanisms to embed IBL and PBL methodologies at programmatic level.

Conclusion

This study set out to problematise aspects of the longitudinal application of IBL and PBL methodologies within a cross-institutional ITE programme in Ireland. Findings included that IBL and PBL methodologies correspond with pre-service teachers' enhanced learning in relation to curriculum and assessment, and that strong cross-institutional collegial relationships among faculty members proved to be a significant factor in success. In the context of a community of practice, the study identified a disjunction between successful collaborative inquiry by pre-service teachers and transferable knowledge to the school context. Limitations of the study include its focus on a single module and its localised setting; future research would expand to the programmatic level and to wider national and international contexts.

In agreement with, and building upon, the contribution of Munthe and Rogne (2015), this study suggests that a purposeful integration of inquiry-based methodologies at programmatic level might promote more effectively the transferability of critical enquiry to the school context. In other words, an intentional programmatic focus on the application of IBL and PBL learning to the school environment will assist preservice teachers to have a greater awareness of the effectiveness of inquiry-based methodologies and will more effectively enable transfer of knowledge. This study exemplifies and aligns to the Céim standards where a core element of ITE 'Creativity and Reflective practice' includes 'teachers as reflective practitioners … teachers as researchers' (Teaching Council 2021, 16).

Finally, with respect to longitudinal application, the study suggests that challenges associated the classroom-based learning spaces associated with cross-institutional delivery can be creatively resolved by means of exploring cross-institutional virtual collaborations.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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