Developing pre-service teachers' skills in assessment *for* learning (A*f*L): A plan using design-based research

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This methodology paper presents how design-based research (DBR) can be used to prepare pre-service teachers (PSTs) to build their assessment for learning (A*f*L) literacy. A total of 335 PSTs involving 30 PSTs in the intervention group and 305 PSTs in the cohort group from one of the teacher training institutes in Myanmar participated in this study. The four phases of DBR, (1) problem analysis; (2) design and development; (3) testing and refinement; and (4) reflection to enhance the solution, were adopted. This paper highlights how each phase of DBR was used as a pedagogical approach to professional development in PSTs. The findings demonstrate the important contribution to teacher education of explicit teaching of A*f*L literacy using a specific professional development model.

Introduction

Assessment knowledge and skills have been integral to initial teacher education. Teacher preparation has shifted its focus from developing pre-service teachers (PSTs) ability to use summative assessments to building PSTs' knowledge and skill on using a range of classroom-based assessment information to improve student learning (Brevik et al., 2017; Izci & Caliskan, 2017). This shift reflects changes in assessment policy in many educational systems from a focus on summative assessment (assessment *of* learning) to formative assessment (assessment *for* learning) (Alonzo et al., 2021; Levy-Vered & Alhija, 2018). However, the integration of assessment *for* learning (A*f*L) into teacher education programs is still limited (DeLuca & Volante, 2016), and concerns about the A*f*L literacy of PSTs are well-documented in the literature (Grainger & Adie, 2014; Oo et al., 2022; Siegel & Wissehr, 2011). In addition, enhancing "a spirit of A*f*L" in teachers seems far more challenging (DeLuca et al., 2019, p. 1).

Charteris and Dargusch (2018) found that PSTs' A*f*L literacy is relatively low; hence, they felt that they need more theoretical and practical assessment knowledge for the teaching profession. This study used a design-based approach to address these issues to improve PSTs' A*f*L literacy. Using this approach, the professional development (PD) program started with identifying the PSTs' A*f*L needs and then used the results to develop the PD program. Then, the changes in PSTs' A*f*L literacy before and after the PD program were measured. The research question below guided this paper:

How can the four phases of the DBR approach improve PSTs' A*f*L literacy?

Assessment *for* learning literacy programs in teacher education

As teachers' AfL literacy is critically important for effective learning and teaching, PSTs should possess a certain level of AfL literacy before they enter the profession. PSTs should be given more opportunities to experience all AfL strategies during initial teacher education (Macken et al., 2020). However, most teacher preparation has historically focused on teachers' competency in test design and analysis, use of standardised tests, and administration of tests (Lomax, 1996; Piro et al., 2014). Following the work of Black and Wiliam in the 1990s, the literature in teacher education now emphasises improving classroom assessment practices that are supportive of effective learning and teaching (Black & Wiliam, 1998; Siegel & Wissehr, 2011; Yan & Brown, 2021) within an overall framework of AfL. This is "the process of seeking and interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go and how best to get there" (Assessment Reform Group, 2002, p. 2).

A closer look at assessment programs in initial teacher education shows that different approaches, including offering a stand-alone course in assessment (Craven et al., 2014; Izci & Caliskan, 2017; Levy-Vered & Alhija, 2018), and integrating assessment concepts into the curriculum or general education courses (Brevik et al., 2017; Greenberg & Walsh, 2012). Whilst these approaches are reported to raise PSTs' AfL literacy, research evidence demands a more strategic approach with a greater focus on extended practice to provide opportunities for PSTs to acquire practical AfL knowledge and skills (DeLuca & Volante, 2016; Heck et al., 2020; Oo, 2020; Oo et al., 2022). For example, Oo et al. (2022) reviewed articles on assessment programs in initial teacher education from 1998 to 2020. According to their findings, only 14% of the included articles described that assessment practices in actual classrooms were embedded in assessment programs while 83% mentioned assessment tasks and assignments as classroom practice-driven assessment programs. Practical experiences in applying assessment knowledge in teaching should be an integral part of teacher preparation (Charteris & Dargusch, 2018; Hill et al., 2014).

Context of the study

This study was conducted in Myanmar, with three Education Universities and 25 Education Colleges providing pre-service and in-service teacher training programs. All curricula in universities in Myanmar are designed by the Boards of Studies established by the Council of University Academic Bodies (Banks et al., 2013; Gibson & Htay, 1992). In the current initial teacher education programs of Education Universities, the main assessment content is a compulsory educational testing and measurement course. As the name suggests, the contents are mostly related to test design and analysis, which are heavily underpinned by psychometric principles. Even though other forms of assessment – including formative assessment, assessment for learning, performance assessment, and portfolios – are covered, the practical understanding and use of these assessments are still problematic. According to recent teacher education reviews in Myanmar, current support for teachers is inadequate for their development (JICA, 2013; Maber et al., 2018). Hardman et al. (2016) also found that assessment is still not integrated into classroom

teaching in Myanmar, that teachers did not use peer tutoring and did not seem to know how to build pupils' responses into subsequent questions. Researchers have argued the need for teacher professional development in schools, colleges and universities (Hayden & Martin, 2013) and assessment training is needed for teachers to choose appropriate assessment strategies (Aung et al., 2013; Maber et al., 2018; Oo et al., 2021).

Relationship between theory and practice of PSTs' A*f*L literacy

Integrating theory and practice in PSTs' A*f*L literacy has to go beyond the traditional ways of integrating knowledge and practice as PSTs encounter varied socio-cultural contexts (Willis & Klenowski, 2018). The traditional dichotomy between theory and practice, described in Figure 1, presumes that there is no two-way interaction between each aspect, which is an area requiring investigation (Kemmis & Smith., 2008; Poehner & Inbar-Lourie, 2019) as it limits the role of practical knowledge in informing theoretical knowledge. The application of this unidirectional model can be seen in most stand-alone assessment courses as they focus more on the theoretical dimension of assessment, and consequently, they cannot meet students' needs in practice (Craven et al., 2014).
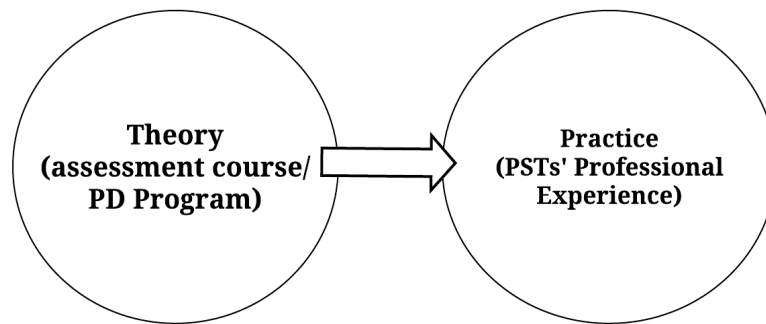

Figure 1: Unidirectional model between theory and practice

The interrelationship of theory and practice, known as praxis, is grounded in a socio-cultural perspective (Lantolf & Poehner, 2014; Poehner & Inbar-Lourie, 2019). Praxis is defined as the "knowledge [that] results from the activity of theoretically-driven practice that informs theory" (Chan & Davison, 2019, p. 119), a bidirectional relationship between theory and practice (Figure 2). This has implications for how theory is conceptualised and how it is practised in the actual classroom. If theoretical knowledge is brought into the actual classroom and PSTs have the opportunity to see how such knowledge operates in several classroom settings, this can help the development of their practical knowledge. By reflecting on their classroom experience, PSTs can generate information that informs their theoretical knowledge.

Although a large number of articles has been published on PSTs' assessment practices (Charteris & Dargusch, 2018; Grainger & Adie, 2014; Hill et al., 2014), empirical evidence of PSTs' A*f*L literacy development is needed to describe the relationship between theoretical knowledge and practice. Therefore, the current paper is an additional

contribution to this area, highlighting the use of a methodological framework grounded in praxis to implement an AfL literacy program using design-based research (DBR), as explained below.
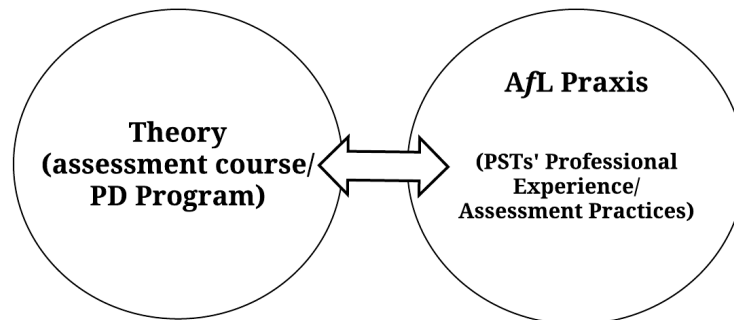

Figure 2: Praxis model between theory and practice

Design-based research as a methodological framework

Design-based research (DBR) is a series of approaches to produce new theories and artefacts in a naturalistic setting (Barab & Squire, 2004). DBR can help understand how, when, and why educational reform is appropriate in practice (Design-Based Research Collective, 2003). It is a methodological approach in the field of education which was first introduced in the studies by Brown (1992) and Collins (1992). They brought into research the concept of design in learning and teaching practices using innovative design experiments in classroom settings.

According to the literature, the significant characteristics of DBR and its benefits for research into educational reform can be seen in the following:

1. DBR is context-embedded, that is, the design of a particular study is related to its specific context (van den Akker et al., 2006).
2. DBR focuses on design and intervention that can best be applied to an actual classroom, not an experimental context (Design-Based Research Collective, 2003).
3. DBR is a collaboration between the researcher and the practitioner based on the local context (Brown, 1992).
4. DBR comprises mixed methods in which different methods can be chosen based on the research problem.
5. DBR involves continually adjusting the design to refine it (McKenney & Reeves, 2013).
6. Design principles or patterns are developed for their practicality through the reflections on the design (Anderson & Shattuck, 2012).

With the above characteristics in mind, this study adopted DBR in this context in which Myanmar has a unique socio-cultural context with teaching and learning needs differing from Western contexts and other Asian countries. The types of assessments in Myanmar

schools are still heavily weighted toward examinations such as end-of-term, end-of-year exams, and national level assessments (examinations). As a result, there is a strong emphasis on rote learning (Aung et al., 2013; Maber et al., 2018; Metro, 2015; Ross et al., 2020). Classroom-level assessment is included as a small portion of the whole academic year. The Myanmar community focuses a lot of attention on the matriculation examination results to gain entrance to universities, which can guarantee a job after graduation. As a result, teacher preparation has focused on teachers' competency in the development of tests, and the assessment content in initial teacher education is limited. Therefore, an innovation for the design is needed based on the demands of the actual situation, especially in this specific context (Design-Based Research Collective, 2003).

Specifically, we used the DBR model developed by Amiel and Reeves (2008). In their empirical study of the DBR model, there are four stages: (1) problem analysis: (2) design and development; (3) testing and refinement; and (4) reflection to enhance the solution (Figure 3).
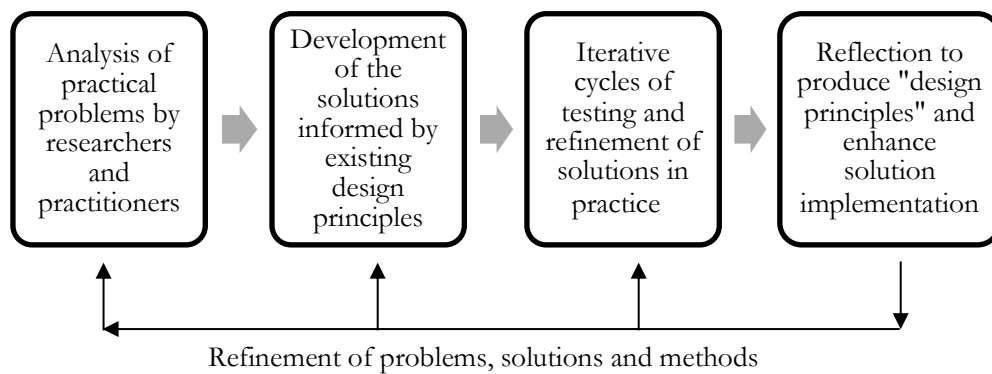
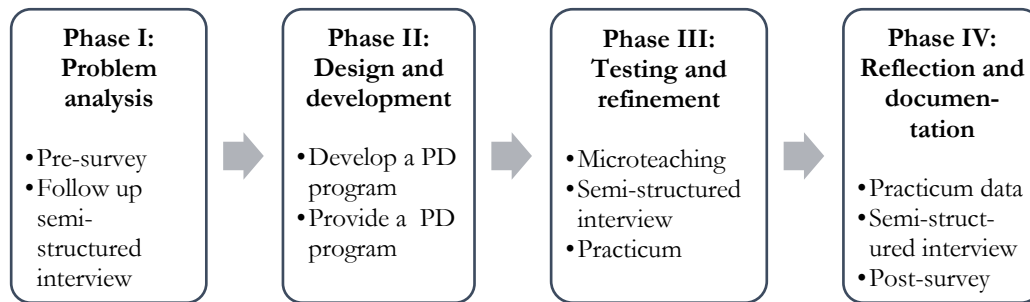Figure 3: Four phases of design-based research (DBR) (Amiel & Reeves, 2008)

Figure 4: Phases of DBR used in this study

Methods

This paper presents the methodology used in our study (Oo, 2020) that investigated the ways PST education can be adapted to help develop AfL literacy among PSTs. Based on the phases of DBR presented in Figure 3, the phases used in this study with their accompanying data collection methods are presented in Figure 4.

Participants

The participants in this study are PSTs from one of the universities of Education in Myanmar. Fourth-year student teachers who had already had one extended practice teaching experience in their third year were chosen. Their second teaching practice was chosen for the study as this was less likely to be influenced by negative classroom teaching experiences, and there might be fewer obstacles in applying more innovative assessment practices. A non-probability sampling method was used due to the voluntary nature of participation.

Recruitment

To get a large number in the sample, all fourth-year PSTs in the teacher training institute were invited to participate. A total of 335 participants (79% of all fourth-year PSTs) were involved in the surveys, 305 participants in the cohort or comparison group and 30 participants in the intervention group. Of the 30 PSTs involved in the intervention group, 10 PSTs (33%) were male, and 20 PSTs (67%) were female. Turning now to the cohort group, of the 305 PSTs involved, 54 PSTs (18%) were male, and 251 PSTs (82%) were female. Before the data collection process, ethics approval was sought from the Institutional Review Board (IRB) of the Ethics Committee. Also, written permission was obtained from the Head of the participating university in Myanmar.

DBR approach to intervention

Phase I: Problem analysis
As a first step, a problem analysis was conducted to design a needs-based PD program to improve PSTs' AfL literacy. First, we used a survey instrument that was designed for DBR as context-specific. The questionnaire was adapted specifically for Myanmar and focused mainly on PST AfL literacy. The questionnaire developed by Nguyen (2016) was chosen for its reliability with Cronbach's alpha high ($\alpha = .85$) using a five-point Likert scale. Five main sub-constructs of teacher AfL literacy were included: (i) beliefs and understanding of assessment; (ii) confidence in planning assessment; (iii) confidence in conducting assessment; (iv) confidence in using assessment; and (v) adherence to ethical issues in assessment.

Follow-up semi-structured individual interviews were conducted after the pre-survey. Regarding the follow-up, semi-structured individual interviews based on the pre-survey analysis, 10 PSTs (three male PSTs and the rest female) responded to the recruitment flyer, indicating their willingness to talk about their understanding of assessment and AfL.

The interview comprised open-ended and close-ended questions concerning the PSTs' experiences, practices, and perceptions. Examples of interview questions were: 'Do you think there is an interrelationship between assessment and teaching? Why do you think so?'; 'How can you use assessment in class?'; 'How can you choose the appropriate assessment methods to check your students' levels of learning?'. The data from the interviews helped reveal different aspects of the PSTs' understanding of A/L.

Phase II: Design and development
Based on the results of the needs analysis presented in Phase I, the content of the program was tailored to suit the needs of the PSTs. For example, PSTs need to clearly understand the concept of A/L and the types of A/L. Therefore, a PD program pertaining to A/L was constructed with an understanding of the interrelationship between assessment, teaching and learning, and the characteristics of A/L. The level of the program and the content was adjusted based on the results of the needs analysis presented in the previous section. The program was grounded in the view of A/L literacy by Alonzo (2016) that reflects A/L principles: teacher A/L literacy comprises "the knowledge and skills to make highly contextualised, fair, consistent and trustworthy assessment decisions, to inform learning and teaching, and to effectively support both students and teachers' professional learning" (p. 58).

Each workshop session was designed based on material from A/L projects in Australia and Hong Kong (e.g., SBA Consultancy Team, 2007; The TEAL project, 2015). These materials were more suitable for this study than other sources. First, the sources from Australia were chosen because there is a wide range of resources available to support formative teacher assessment (e.g., Centre for Education Statistics and Evaluation, 2015; Curriculum Corporation, 2010; The TEAL project, 2015), as opposed to other educational bureaucracies, where most material for teachers support only summative assessment due to the influence of high-stake standardised tests (Demir & Keleş, 2021; Flaitz, 2011), with resources related to summative tests rather than formative assessment. Second, this program was also developed based on sources from Hong Kong school-based assessment teacher support material which complemented the Australian resources. The education system in Hong Kong is still very exam-oriented but with many AfL features (Hamp-Lyons, 2007). The experience of Hong Kong is well-suited to apply to Myanmar, particularly on how to embed A/L in an examination-driven system.

Phase III: Testing and refinement
For testing and refinement purposes in DBR, two assessment practices were conducted. First, microteaching or peer-group practice teaching was included so PSTs could test their assessment practices before working with students in school classrooms. Peer assessment and feedback on their microteaching helped them improve their A/L literacy and clarify their understanding of the application of A/L strategies. Semi-structured individual interviews following their microteaching were conducted. The interview questions explored their understanding of A/L strategies for learning and teaching. For example, 'Of all the assessment strategies presented during the PD program, which one(s) did you use most frequently? Least frequently? Why?', 'What do you think which strategies cannot be used during your teaching? Why?'. Through the interviews, PSTs were able to refine the

understanding of their implementation of AfL strategies and prepare for their authentic assessment practices.

Second, PSTs practicums were used as authentic assessment practices where PSTs were able to work with students in real classrooms. Without these practices, PSTs could not have a chance to translate their theoretical knowledge into concrete action. Previous studies highlight that a practicum is essential for PSTs to integrate theory and practice not only in the context of assessment (for example, Charteris & Dargusch, 2018; DeLuca & Klinger, 2010; Luttenegger, 2009) but also in the context of teaching (Allen & Wright, 2014). Ellis and Loughland (2017) also highlighted that strong support in PSTs enhancing knowledge in their practicum/ professional experience is still needed in initial teacher education.

Phase IV: Reflection and documentation
This phase was conducted for PSTs to reflect on their practices to enhance their implementation. Other forms of data were collected both during and after their practicum for reflection and documentation. We collected lesson plans, observation checklists and audio recordings of their teaching for at least seven teaching periods. These were used to engage PSTs in reflective practice about their assessment practices.

Lesson plans were collected to investigate how PSTs planned to include assessment strategies in their teaching. In the template of the lesson plan, there is a section for PSTs called "Learning and Teaching Strategy" to prepare, including AfL in their teaching to improve students' learning. For example, 'How will you use the assessment strategies in your teaching?'; 'How will students learn using assessment strategies?'

An observation checklist was also provided to PSTs to record their own use of AfL strategies in their practice teaching. This checklist helped PSTs to reflect on how they used assessment strategies related to their lesson plan. The observation checklist included which assessment strategies the PSTs used, the responses of the students and the outcome for the students. The PSTs could prepare for their following assessment by reflecting on their experience.

An audio recording of their teaching was obtained to triangulate their use of AfL strategies. The recording of their teaching complemented their reflection discussing what happened during their classes. The audio recording provided accurate evidence of their teaching, and the recordings were used as another source of data to reflect on how PSTs used AfL strategies during their teaching.

The post-survey and semi-structured individual interviews were conducted at the end of the practicum. The post-survey, the same questionnaire used in the pre-survey, was conducted with the same participants who completed the pre-survey. The semi-structured individual interviews with 30 PSTs from the intervention group were conducted to explore how they applied their knowledge to their practice. For example, 'What AfL strategies have you tried out in class?' 'Why did you use [*assessment strategy*] most frequently/least frequently? How did you use? Can you give me an example?'. They could

also reflect how well their implementation of A/L strategies worked through the post-survey.

Findings and discussion

This study resulted in the design of an A/L literacy program using DBR. In line with the phases of DBR, the design of an effective PD program, based on the empirical data, is presented in the following. Each phase is essential in designing the PD program, considering the context of initial teacher education. The detailed descriptions of each phase of DBR for an effective PD program and key findings are presented.

Key finding from Phase I

Descriptive statistics, including frequency, were calculated for each item of the pre-survey. Semi-structured interviews were used to triangulate the analysis results of pre-survey data. The descriptive analysis of the pre-survey found that PSTs demonstrated stronger beliefs and understanding of A/L ($M = 3.99$, $SD = 3.72$) compared with other sub-constructs of PSTs' A/L literacy. Among the items, PSTs agreed that the purpose of A/L is the improvement of student learning (97% of PSTs) rather than improving their teaching (90% of PSTs). However, according to the individual follow-up interviews, a divergent and often conflicting reason emerged, with eight out of ten PSTs mentioning that one of the main reasons for using assessment in the classroom is to improve their teaching. They did not mention that improving students' learning was one of the reasons for using assessment.

Regarding types of assessment, 30% of PSTs did not agree with using different assessment methods in their teaching. The findings of the follow-up interviews highlighted that they did not know most A/L strategies used in improving students' learning. The types of assessment they commented on were written tests, oral tests, questioning, observation, performance assessment, placement tests, diagnostic tests, formative tests, and summative tests. They could not give a detailed clarification of the characteristics of formative assessment.

> I think types of assessment are written test, oral test, and questions. Honestly, I can't differentiate between criterion-referenced tests and norm-referenced tests. Can you explain what it is? (PST A, L 10-12)

> I don't remember the detailed meaning of assessment *for* learning. Isn't it similar to the placement test? For example, is that assessment used to recall the prior knowledge of students? (PST B, L 8-11)

These findings highlight that PSTs need to clearly understand the concept and types of A/L. Therefore, a PD program specific to A/L needed to be constructed with an understanding of the interrelationship between assessment, teaching and learning, and the characteristics of A/L.

Key finding from Phase II

Grounded on the AfL sources presented in the previous section and the analysis results from Phase I, the PD program includes four main parts, (1) AfL strategies, (2) applying AfL to practice, (3) developing teacher AfL literacy, and (4) microteaching or peer-group practice teaching. Part 1 is designed to improve the beliefs and understanding of AfL, Part 2 includes how to apply AfL into practice, Part 3 focuses on developing teacher AfL literacy, and Part 4 includes peer-group practice teaching. This program was conducted over two months (a total of 36 hours), with each session taking two hours. The course content and structure of the 13 workshop sessions are presented in Table 1.

Table 1: Course content and structure of the PD program

Week	Content	Topic
1	Part 1: AfL strategies	Session 1: Understanding the interrelationship between assessment, teaching and learning
		Session 2: Understanding assessment *for* learning (AfL)
2		Session 3: Framing learning intentions and success criteria
		Session 4: Designing a rubric to improve student learning
3		Session 5: Involving learners in assessment (self- and peer-assessment)
		Session 6: Giving effective feedback and feed-forward
4		Session 7: Using strategic questioning
		Session 8: Using summative assessment in a formative way
5	Part 2: Application AfL to practice	Session 9: Designing appropriate assessment strategies
		Session 10: Planning learning and teaching experiences
6		Session 11: Enhancing the trustworthiness of an assessment
		Session 12: Gathering assessment information
7	Part 3: Developing teacher AfL literacy	Session 13: Evaluating and developing teacher assessment literacy
	Part 4: Micro-teaching or peer-group practice teaching	Session 14: Peer-group practice teaching
8		Session 15: Peer-group practice teaching
		Session 16: Peer-group practice teaching
9		Session 17: Peer-group practice teaching
		Session 18: Peer-group practice teaching

The PD program was an essential component of PST learning. Many assessment courses in initial teacher education are not underpinned by the principles of AfL (Timperley, 2014). Hence, the present study integrated the suggestions of Davison (2013) and Timperley (2014) that the assessment program should explicitly highlight AfL strategies. Hence, the program included initial 'sharing/reflection' to explore the students' background knowledge or to encourage them to recall their previous experiences and 'follow-up' to enable PSTs to reflect on what they had learned.

Key finding from Phase III

Microteaching or peer-group practice teaching, and the inclusion of an extended practicum provided the opportunity for PSTs to implement A/L strategies, similar to the work of Tsagari and Vogt (2017), who highlighted the need to support teachers with opportunities for concrete and practical implementation and contribute to the growing body of research that calls for theoretical and empirical support in improving PSTs' A/L literacy (for example, Alonzo, 2016; Black & Wiliam, 1998; Hattie, 2008).

In their microteaching, two PSTs worked together for this activity. They took constructive feedback from their peers, and prepared for their practicum. During their semi-structured individual interviews following their microteaching, PSTs commented that they learned how to implement assessment strategies from their microteaching. After the interview, PSTs had a chance to experience their assessment strategies in their professional experience.

Key finding from Phase IV

Over Phase IV of the program, the data analysis from pre-survey and post-survey was conducted using repeated MANOVA measures to explore the utilisation of the PD program to build PSTs' A/L literacy. The key analysis results highlighted significant positive changes in PSTs' A/L literacy (Oo et al., 2023). This finding is consistent with other studies (DeLuca & Klinger, 2010; McGee & Colby, 2014; Ogan-Bekiroglu & Suzuk, 2014) that also found positive effects of PD. The only study it contradicts is that by Izci and Caliskan (2017), who found that changes in PSTs' conceptions of assessment after PD program were insignificant. They argued that this was possible because of the challenges and complexities of integrating assessment into student learning. Overall, the findings in this study revealed that the PD program effectively improved PSTs' A/L literacy. This finding contributes to research in teacher assessment education in initial teacher education that has emphasised the need to develop teacher assessment literacy using a more strategic approach (e.g., Aung et al., 2013; Hayden & Martin, 2013; Malone, 2013; Macken et al., 2020). This paper shows that this PD program can be used as an effective way for PSTs to improve their A/L literacy.

The thematic analysis of semi-structured individual interviews and practicum data provides more insights into what leads to the ability of PSTs to implement A/L strategies. This study found that the influences enhancing the implementation of PSTs' A/L literacy included the PSTs' beliefs and understandings of A/L literacy, their efforts in applying A/L strategies in their practicum, the influence of supervising teachers, and the student responses to assessment, and the physical context of the classroom. These results are consistent with other research (Carless, 2011; Charteris & Dargusch, 2018; Heng et al., 2021; Willis & Klenowski, 2018; Xu & Brown, 2016) that identified the different socio-cultural influences.

In addition to these influences, this study found that there was an interaction of influences among the PSTs' beliefs, understandings and confidence in A/L literacy, their efforts to

apply A*f*L strategies in their practicum, their supervising teachers, students' responses to these, and physical context of the classroom. For example, PSTs who had highly controlling supervising teachers did not put effort into the implementation of A*f*L strategies. Consequently, they received negative responses from students. In addition, they could not implement A*f*L strategies successfully due to the influence of other factors in the classroom, although they had positive changes in PSTs' A*f*L literacy in their theoretical understanding. This finding suggests that no matter how well-prepared PSTs are with their theoretical A*f*L knowledge, there are still problems at the level of the local context. This is because there is the bidirectional relationship that, on one hand, greater knowledge of A*f*L literacy helps to develop better practice, and on the other, better opportunities for practice would develop higher levels of A*f*L literacy. These results confirm Poehner and Inbar-Lourie (2019) who highlighted the dialogic and interactive nature of theory and practice.

More broadly, given the four stages presented above, a conceptual model for developing PSTs' A*f*L literacy through praxis has been developed (Figure 5). These components, which need to be considered in designing PD programs, address the issue of the inadequacy of assessment practice in the unidirectional model underpinning most stand-alone assessment courses. This conceptual model resulted from reflection on assessment practices in initial teacher education informing the PD program. Therefore, there is a dialogic and interactive development between the program designed for teacher education and the actual classroom experience. As a result, using DBR in designing A*f*L literacy programs provides a better understanding of how to improve PSTs' A*f*L praxis through addressing the interactive and supportive nature of teacher education and school practices.
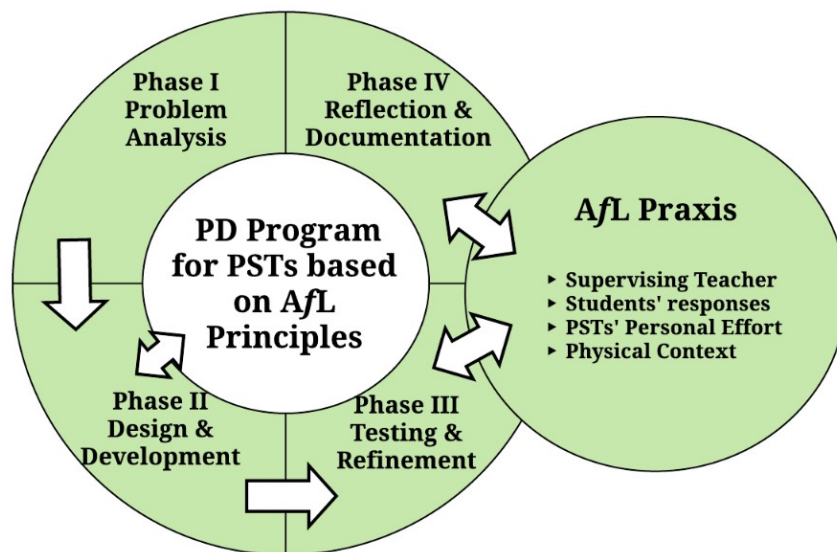

Figure 5: A conceptual model for developing PSTs' A*f*L literacy through praxis

Each component of the program is essential to improve their A*f*L literacy.

Phase I: Problem analysis in designing the PD program
The PD program, including problem analysis in designing a tailor-made PD program for PST A/L literacy, addresses the concerns of Tsagari and Vogt (2017) about teachers' difficulties in identifying their needs for professional development. Through problem analysis, the demands of dealing with the reality of A/L in school classrooms can be addressed.

Phase II: Design and development of the PD program
This study highlights that a sound theoretical framework is essential in designing a PD A/L literacy program. Designing the program supports previous studies (Grainger & Adie, 2014; Hill et al., 2014), which indicated that a scaffolded program is required to move from novice assessment literacy towards expert.

Phase III: Testing and refinement of the PD program
This study found that a testing and refinement phase is essential in designing a PD program using DBR. This finding is supported by Tsagari and Vogt (2017), who highlighted the need to support teachers with opportunities for explicit and practical implementation. This study adds to the growing body of research that indicates the need for theoretical and empirical support in improving PST A/L literacy (e.g., Black & Wiliam, 1998; Davison, 2019; Hattie, 2008).

Through authentic assessment practices in school classrooms, PSTs were prepared to improve their A/L praxis working with supervising teachers and students. Without these practices, PST could not have a chance to translate their theoretical knowledge into concrete action. This supports evidence from previous studies which highlights that a practicum is essential for PST to integrate theory and practice not only in the context of assessment (for example, Charteris & Dargusch, 2018; DeLuca & Klinger, 2010; Willis, 2007) but also in the context of teaching (Allen & Peach, 2007; Allen & Wright, 2014; H. T. M. Nguyen, 2017).

Phase IV: Reflection and documentation of the PD program
From the findings of this study, it is suggested that a phase of "reflection and documentation" is needed in designing a PD program to identify solutions to any unanticipated problems. The data indicated that PSTs were able to reflect upon their understanding of A/L literacy through this phase of DBR, with such reflection feeding back into the design of the next PD. These findings support the theoretical literature (Arnold & Mundy, 2020; Kemmis & Smith., 2008; Lantolf & Poehner, 2014) that highlights the nature of praxis which considers all the conditions in the practicum and how they inform theory (Chan & Davison, 2019). As a result, using DBR in designing A/L literacy programs provides a better understanding of improving PSTs' A/L praxis by addressing the interactive and supportive nature of teacher education and school practices.

Limitations

The limitation of this study is that there was only one iteration of the whole phase of the DBR approach. Although this DBR approach presents the design of a PD program that

affects improving PST AfL literacy, it would help to redo these phases of DBR to evaluate the effectiveness of the PD program. In addition, this study was conducted in one of the universities of teacher education in Myanmar. Further research into AfL should be undertaken in diverse contexts.

Conclusion

Using DBR as a pedagogical approach in designing a PD program is new to assessment research. Needs-based workshops where the practice of learnt knowledge is encouraged were included in the PD program rather than including all concepts of AfL. Specifically, this PD program highlights how the praxis model works in teacher education. We have demonstrated how to design a PD program using the phases of DBR to meet the needs of the target groups of PSTs. Generally, this study advocates tailoring a PD program through a scaffolded DBR approach.

Our experience and the empirical evidence support the potential use of DBR as a pedagogical approach to developing PSTs' AfL literacy elsewhere. It is a strategic approach to addressing PSTs' assessment knowledge and skills needed to gain a deeper theoretical knowledge and provide an opportunity for PSTs to apply this knowledge in actual classroom settings to develop practical skills. The reflective process allows PSTs to see the bidirectional relationship between theory and practice, where their practical experience also informs their theoretical knowledge.

Acknowledgement

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