Chapter 12

Postgraduate Supervision: A Case for Specialist Pedagogical Training in the Sciences

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Introduction

This work is based on reflections from our experiences in the PGDipE (HE) (hereafter, the PGDip) course offered by the Humanities Faculty at the University of the Witwatersrand (Wits). We argue for a science discipline-based programme because the current supervision course provides generic principles and practices of teaching and supervision but does not focus sufficiently on disciplinary specificities. For example, the Wits PGDip in the health sciences contains similar topics to those offered in the general PGDip programme but addresses theories of learning in the context of the health sciences. The expectation is that health education specialists will be able to identify and translate their theoretical and conceptual understanding better into their pedagogies. Similarly, as practicing supervisors in a science context, a course should cater to a diverse population of students ranging from clinical and basic science postgraduate (PG) students undergoing purely research or research and coursework PG degrees from different socio-economic backgrounds. In this chapter, we reflect on the higher education landscape, current practices in PG supervision with respect to teaching and learning, curriculum and assessment in the Science, Technology, Engineering and Mathematics (STEM) fields as it applies to the student and supervisor. We then reflect on our understanding and experiences and appraise existing literature to tease out aspects that make it necessary to contextualise these topics in supervisor training to improve supervisors' pedagogical competence. We work within a conceptual framework that incorporates the challenges of PG supervision in STEM such as issues of academic literacy and empirical training and emphasise the importance of institutional and national priorities in successful supervision. We also consider the theoretical grounding that supports our pedagogical approaches to PG supervision; namely, the functional model, social constructivism and the experiential learning model, all of which are critical to successful STEM supervision. Our purpose is to ensure that the enacted curriculum addresses the needs of supervisors and students while balancing expertise and interdisciplinarity in an emerging economy.

Contextualising postgraduate research supervision

In higher education, there are various contextual issues and challenges that influence research supervision. This is particularly true in the STEM area where training has a significant empirical focus. Some of the issues include the inability of the supervisor and/or the supervisee to crack the code of academic literacy and the lack of appreciation of students' social context in academic disciplines (McKenna, 2010; Boughey & McKenna, 2016). Moreover, there is a lack of curriculum understanding or assessment literacy, scant or no awareness of models of supervision, limited understanding of supervision as a teaching and learning model and inadequate knowledge of the role of institutional policies, amongst others. These challenges become more critical in STEM where the cost of postgraduate supervision in experimental projects is exorbitant. Competitive funding processes, international, national, and university procurement processes also need to be factored into project planning. These are only some of the challenges experienced in STEM projects, which when coupled with strict timelines for completion of a postgraduate degree, can negatively impact successful outcomes.

The need for postgraduate knowledge and skills

To sustain the change in the mandate of higher education institutions, postgraduate supervision is important in building human capacity and improving institutional research capacities, reputation and attracting financial support (Okeke-Uzodike, 2021). Since the early 2000s, South Africa has been promoting the need for more graduates with higher educational qualifications to service a knowledge economy and as key to the National Development Plan (NDP) with human development objectives to be achieved by the year 2030 (PMG, 2008; NPC, 2014). Key indicators for the success of the NDP include an increase in the proportion of academic staff with a PhD; a PG student enrolment rate of 25% of total university enrolment and the graduation of 100 Doctoral graduates per million of total population per annum (PMG, 2008, NDP, 2014). The 2019 White Paper on Science, Technology and Innovation (STI) (DST, 2019) highlights the significance of investing in postgraduate STEM education to reverse the ills of apartheid and produce graduates capable of addressing the country's socio-economic challenges. The University of the Witwatersrand's Strategic Plan for Postgraduate Research (2023-2027) echoes this stance.

Achieving the goals of these strategic plans is dependent on key indicators which include external funding, research publications, research staff capacity and postgraduate student numbers. In the period 2000 to 2018, the number of white academics declined significantly from 64% to 40% (from 24,484 to 22,877) while the proportion of black African staff doubled to

44 % (25,252) coloured and Indian academic staff numbers grew 6% (3,510) and 8 % (4,808) respectively (Maphalala et al., 2022; DHET, 2015). Despite these changes in the demography of academic staff, the retention, completion and progression of graduate students from honours degrees to Master's and from Master's to PhD in South African universities from 2001 appears to be shrinking across disciplines (Mouton et al., 2015). Mouton et al. (2015) demonstrate that, on average, 16% of Master's students progress to Doctoral studies, while the rate of progression in the natural sciences is 26.2%. Despite some progress, the annual production of Doctoral graduates will need to increase from 1,420 per annum (in 2010) to 5,000 per annum in 2030 (HESA Office, 2012) to approach the target of 100 Doctoral graduates per million of the South African population. The lack of sufficient academic supervision was cited as the most important constraint to achieving the set targets (Mouton et al., 2015).

Pedagogy in postgraduate supervision

Supervision is a challenging process, particularly for novice supervisors who lack the appropriate experience and ability to adapt to the pedagogic rigour required for successful postgraduate supervision (Turner, 2015). Internationally, the significance of support in the research supervision process has been highlighted (Anderson et al., 2008; Harwood & Petrić, 2017; Maxwell & Smyth, 2011; Wichmann-Hansen et al., 2015). Some of the factors identified as important include responsiveness to students' needs and the importance of maintaining a good student-supervisor relationship (Lee, 2008; Mainhard et al., 2009). Novice study leaders tend to be worried about student appreciation of the supervision process, their unpreparedness, and the limited or lack of adequate support for them as teachers, disciplinary experts and postgraduate supervisors (Amundsen & McAlpine, 2009). Additionally, "production" of high-quality graduates and research outputs within shorter durations are major pressures considered in the teaching and supervision process (Lee, 2008). Moreover, supervision of postgraduate students at Master's and PhD levels is increasingly being linked to research productivity (Sadiq et al., 2019), which in turn impacts institutional status and career progression of academics as defined by criteria for tenure and promotion. Developing strategies to cope with institutional pressures, supervisory loads, teaching, curriculum development, assessment and administration duties is thus essential to ensure successful outcomes for the student and the supervisor.

The generic Supporting Postgraduate Supervision course offered as an elective option for the PGDip at Wits is based on sound theories on the Scholarship of Teaching and Learning (SoTL). We argue, though, that contextualising these in the culture of the relevant disciplines would be ideal (Healey, 2000). This is in agreement with Silva-Fletcher and May (2018), who compared two groups of academics - those who completed specialised PGCert in veterinary education felt that the course aligned to their needs better than those who participated in the generic course.

Considering disciplinary differences, expectations and the potential advantage of a discipline-aligned PGDip, this chapter seeks to elucidate and propose recommendations on the need for a tailor-made specialist PGDip focused on STEM with an emphasis on foundational concepts provided by a humanities-centred approach. However, such courses would be best served by first identifying the challenges which are experienced by supervisors.

Examining challenges of postgraduate supervision in STEM

In STEM fields, acquisition of funding plays a major role in the design and completion of projects. Whereas South African research output saw a great boost since the 2000s, this has not been matched by continuously available and increasing funding from institutions such as the South African NRF, the main funding agency. In the last decade, the NRF has made changes to its funding support for research and development to universities and research entities motivated by government budgetary cuts (Engel, 2018). Consequently, they have been unable to ensure sustainable funding in light of the increasing number of researchers. Other agencies mandated to facilitate research and development in the STEM fields are the Medical Research Council, the Agricultural Research Council, and government departments including the

Departments of Higher Education and Training, Science and Technology and Trade and Industry but are also not immune to budgetary constraints (Luruli, 2014). Given the current funding limitations, researchers are encouraged to seek third-stream income, for example, through research commercialisation (Leitch et al., 2022) to fill budget gaps. It should be noted that third-party funding might constrain freedom of creativity through industry-style production. There is also the potential for reduced quality despite the potential benefits (Benner & Sandström, 2000; Luruli, 2014).

In a recent national assessment of PhD programmes, the Council on Higher Education (CHE) identified additional challenges affecting postgraduate supervision such as high academic workloads, particularly where academics teach undergraduate and postgraduate (coursework) programmes (Leitch et al., 2022). They noted the need for greater guidance and support for STEM postgraduate degrees and training in the use of specialised research equipment, laboratory techniques, data analysis and interpretation. With a lack of dedicated laboratory technicians and statisticians, the training is relegated to supervisors, effectively increasing their workload.

The CHE also identified bureaucratic pitfalls, such as unclear processes for applying for ethical clearance and inefficient university procurement procedures that impact the day to day running of projects (Leitch et al., 2022). There is inadequate training of emergent supervisors in navigating the bureaucratic minefield of academia and in the structuring of projects to facilitate postgraduate throughput and fostering graduate attributes. The numerous challenges and concerns can be considered as part of the pedagogic process of training postgraduates. An enabling supervisory pedagogy in STEM facilitates democratic engagements between the supervisor and student supporting the development of high levels of cognitive abilities and skills (Biggs & Tang, 2011). The pedagogical principles outlined below were introduced in the generic PGDip Supervision course but need to be adapted for the sciences.

Teaching and learning during PG supervision

Generally, the postgraduate supervision process has three important nodes, the supervisor, the student, and the institution. In STEM, the institutional node includes laboratory and administrative support. A supervisor's decision to take on a student is usually motivated by research interest, funding availability and institutional guidelines and policies on postgraduate supervision. Universities typically have statements of principles for postgraduate supervision which highlight academic freedom and individual autonomy in the pursuit of knowledge, the need for a reciprocal relationship and mutual accountability between the supervisor and the student. Once a research project is identified, an agreement between the supervisor and the student defines the respective roles and project milestones that the student is expected to meet. At this point, the supervisor's expertise and role become significant in the timely and successful completion of the postgraduate degree.

PG student-supervisor relationship

Postgraduate training involves providing a learning environment that is conducive to the development of the PhD candidate, balancing mentoring, support and the process of gaining independence (James & Baldwin, 1999). However, defining initial boundaries is necessary for the supervisor, while developing real relationships with their PG students. Mayeza and Mpofu (2018) highlight the complexity of this relationship where not all supervisors will follow the mentoring approach but may focus on instruction, as has typically been the case. The shift to a mentoring approach is suggested as better shaping and developing the postgraduate student (McAlpine, 2021). Mentoring requires an active approach to engagement between the supervisor and the PG student. In addition to increasing the supervisor and the students' accomplishments in producing new knowledge, open and honest relationships impact the development of the students' academic identity (Barnett, 2009; Winch, 2014).

An unequal relationship where the supervisor is the expert and the student the novice, particularly in the sciences, is more evident, since experimental skills and the capacity to apply knowledge have to be inculcated. Progress in this regard tends to be easier where the student shares the linguistic and the academic culture of the supervisor (Picard et al., 2011). However, it is incumbent on the supervisor to lead the student into the academic discourse. While some negative learning experiences could form part of a PhD undertaking, the role of the supervisor is to assist students to navigate the state of liminality (McKenna, 2017), described as the "oh hell I'm confused" period just before "everything makes sense." Where experiments and processes have to be constantly negotiated, students may lack the necessary social capital to meaningfully contribute to solving the attendant challenges (Picard et al., 2011). In this case, there is always a need for collective responsibility between students and supervisor but also at the higher level of research administration. Anderson et al. (2018) propose a framework to support students and supervisors with a focus on stakeholder needs, but simultaneously recognising the need to develop both parties professionally.

Timely completion is an important aspect of successful supervision and is facilitated by the pedagogic assistance given to a student, the availability of funding to enable degree completion and student agency. Many authors have been advocating for the recognition of pedagogy in the supervision process, especially in the sciences, because it gives structure to the system, leading to supervision effectiveness (De Valero, 2001; Emilsson & Johnsson, 2007; Gill & Bernard, 2008; Golde, 2010; Ives & Rowley, 2005).

Supervisors often have to continue training postgraduate students to read and write complex academic texts and to think critically (Hubbard, 2021) in STEM fields where theory is often abstract, concepts dense and a high level of technical terminology is used (Fang, 2005). The research student is trained in how to review literature, develop their writing and data analysis skills and prepare grant applications (McCallin & Nayar, 2012). Cognitive apprenticeship strategies where the supervisor role models research tasks for the student have been shown to improve postgraduate research (Pearson & Brew, 2002). Here, the strategy can be hands-off or hands-on with the former having the student as the master of their own destiny while in the latter, a more structured approach to supervision is maintained (Sinclair, 2004).

In STEM, where the postgraduate research project usually involves laboratory or field experiments field experiments with demands for a high level of cognition ability from the student, an all-inclusive approach is necessary when considering supervision as a pedagogy (McCallin & Nayar, 2012). Kolb's (1984) experiential learning cycle is a useful model to apply to field or laboratory learning. The learning cycle consists of a concrete experience phase (teaching practice), reflective observation (observe), abstract conceptualisation (theory) and active experimentation. Given that most scientific research consists of reinforcement of knowledge incrementally like solving a puzzle, this cycle enables the gradual building of knowledge and competence based on a constructivist approach. In a study by Abdulwahed and Nagy (2009), the application of Kolb's (1984) learning cycle to a laboratory education model showed significant enhancement of the learning outcomes.

Models of supervision

The PG research process is such that while one model of supervision may dominate at a given time, flexibility and adaptability are essential in dealing with the different stages of study. For example, strategies aimed at the proposal and design phases of a postgraduate project may be markedly different from those employed at the experimental or data collection stages. Over the years, there has been a push for changes in the postgraduate training approach to be guided by skills needed, intellectual engagement (Barnett, 2009; Blackmore, 2009), or by considering more purposeful projects that are solution-oriented (McAlpine, 2021). While a PhD can be contextualised with a focus on disciplinary expertise, a skills approach that transcends disciplines is necessary (Bernstein, 2000; Maton, 2020). Using strategies that are more associated with the humanities, like approaches to encouraging and facilitating reading and communication skills, can cut across disciplines. Moving from general skills to specific contextualised skills in reading and interpreting STEM-specific content may thus assist the PG student in navigating the postgraduate degree. More recently, interdisciplinarity is being encouraged where students require tools and theories of multiple disciplines to solve societal problems (Millar, 2016). Here, competencies and skills gained can permit crossing of disciplinary boundaries with the capacity to apply multiple tools acquired across multiple disciplinary research contexts. This warrants a move away from the traditional apprenticeship approach to supervision which requires individualised attention and where resources are limited, to more flexible approaches (Wisker et al., 2007; Manathunga et al., 2006).

In STEM, many supervisors ascribe to the functional model where research is mechanistic and reflects the process of dealing with research questions in a logical and operational manner. Currently, the success of scientific research is dependent on networks (Wolff & Moser, 2009). Such relationships can be achieved when models associated with human connections such as the emancipation, enculturation and the feminist models of supervision as captured by Lee (2008), are considered. As a core aspect of a PhD research process, the critical thinking model emphasises the capacity to reflect on existing concepts to analytically uncover associations and relationships when framing and answering research questions (Lee, 2007). Generally, especially in STEM fields, the application of a combination of models is becoming increasingly important in light of the need for postgraduate students to be adequately trained to tackle the increasing interdisciplinary nature of research questions (McAlpine, 2021; McKenna, 2017) and to be responsive in a changing world. The constructivist approach (Biggs & Tang, 2011; Hatano, 1996) to pedagogical processes is intrinsic to STEM fields and certain attributes of the functional model could be conflated with traditional pedagogical approaches that are deemed as "one-size fits all" approaches to supervision (Lee, 2008; Mayeza & Mpofu, 2018).

Where research includes a large component of skills-based acquisition, the social constructivist approach is applicable. It recognises the student as an active participant in the process shaped by the supervisor (Barnett, 2009; Moll, 2004). Through this dialogue, a student is not only engaged in knowledge acquisition and building but also preparing for the next steps of their career and acceptance into their academic, research or professional community. This places some of the onus for successful outcomes on the student as well, which emphasises the importance of student agency on successful outcomes. This process also dovetails with the enculturation model (Lee, 2008) that strives to assist students in developing an academic identity. Supervisors need to be adaptable to student needs, while not losing their own purpose and sense of self. Ultimately, there comes a point where supervisors may ascribe to the emancipatory model, in which they aim to provide an avenue for students to participate meaningfully in the academic project, gain social and analytical skills and become professionals in their academic space.

The supervisory process is centred on the student to not only encourage development and empowerment but to actively facilitate membership of an academic discipline. It requires dialogue, with emphasis on face-to-face engagement, discussion of research articles and laboratory findings. In this way, supervisors are guides, supporting PG students through the research process, and encouraging student ownership and accountability of the research process (Case, 2015; Mayeza & Mpofu, 2018; McKenna, 2017).

The science curriculum context

The celebration of STEM as an effective way to cultivate key competencies of 21st-century talent has not been matched by sustained curriculum improvement to achieve this. Though this argument is common for undergraduate courses, the same can be said of the PG degree where there is an expectation for graduates to use theories, knowledge and skills to contextualise solutions without support to everyday life problems. This has been attributed to the absence of clear and structured systematic development and implementation of STEM curricula for PG supervision (Hu & Guo, 2021). In constructing a curriculum for PG supervision, Nomme and Birol (2014) suggest that an evidence-based approach be used to inform content and design a framework that adequately addresses the needs of PG supervisors, at different stages of their careers.

In classroom teaching, the curriculum is a guide to enable students to carefully examine their own conceptions during instruction (Hand & Treagust, 1991). But this is largely absent in postgraduate supervision where many actors within and outside academia can be involved. A programme of planned activities and intended learning outcomes is the standard practice in curriculum development (Schubert, 1986). Evolution from the traditional conception of curriculum development should include a focus on administrative *and* academic processes (Morris, 2007). This is particularly the case at the postgraduate level where the student's enthusiasm for a research project is matched with supervisor satisfaction with the progress of the project (Ameyaw et al., 2019). Thus, developing a curriculum in STEM for PG supervision requires a curriculum that is adaptable, based on sound foundational principles to assist the PG supervisor to conceptualise and construct their own approach to the supervisory process and simultaneously generate knowledge.

Interdisciplinary curricula

As interdisciplinary approaches to solve complex problems are being promoted, the intellectual challenge of designing a coherent curriculum is acknowledged (Gantogtokh & Quinlan, 2017; Gurukkal, 2018). This stems from the need to integrate multiple bodies and forms of knowledge and to encourage students to apply higher-order thinking and problem-solving skills necessitating organisational, structural and pedagogical support from institutions. Within STEM, cognisance must be given to the fundamentals of discipline or domain-specific knowledge and skills that need to be acquired prior to effectively transitioning to interdisciplinary approaches. Additionally, the social aspect of an interdisciplinary curriculum design process can be intense and requires dialogue with diverse individuals and ideas, learning environments and bodies of knowledge (Gantogtokh & Quinlan, 2017). Supervisors need to be prepared for facilitating domain-specific and interdisciplinary approaches to research. This necessitates institutions to provide adequate training and support to enable the application of these approaches and how best to design the pedagogy of research for postgraduate success.

Training and development

Generally, PG degree programmes are designed to be attained within specific timeframes. To progress in the STEM area, the structure of research projects includes training in the core aspects of the degree (proposal and final reporting) within courses on research methodology, scientific writing and statistics. For the novice supervisor, research project design is critical and requires disciplinary expertise, and planning and defining experiments according to strict timelines. Continuous assessment and feedback on progress culminate in the final research report.

The PGDip curriculum design thus needs to firstly consider the general structure of research projects at varying levels (proposal development, monitoring and feedback and final reporting) to guide supervisors in the planning of postgraduate degrees. Additionally, supervisors should encourage postgraduate students to join research communities through attending frequent informative talks, research days and postgraduate workshops.

Given the pedagogical demands outlined above, it is evident that the requirements of a science educator are deeply rooted in the context of their teaching practice (Silva-Fletcher & May, 2018). This complexity is tied to the cognitive conflict often experienced by students in the understanding of scientific concepts - a phenomenon that contributes to pedagogical discontent amongst science teachers (Southerland et al., 2001). Such conflict arises from the distinct methodologies employed in science, which emphasise empirical investigation and explanatory frameworks that differ markedly from those used in the humanities (Kandlbinder & Peseta, 2009). As educators navigate these methodological tensions, their pedagogical approaches must adapt to reconcile conceptual challenges with effective teaching strategies.

Assessment in PG supervision

Assessment outcomes provide an opportunity to judge and validate student performance and offer suggestions for improvement. Curriculum, pedagogy and assessment are intricately linked and have to be designed in ways congruent with disciplinary knowledge structures; this is particularly important in STEM fields. At the postgraduate level, student assessment is more complex.

Given the diverse competencies and attributes expected of the PG student, the supervisor should be able to assess the candidate's readiness for the degree and identify gaps that can be addressed. This requires a diagnostic assessment, which is performed at the beginning of the degree. It could involve processes such as quizzes on their understanding of the scientific method for the science degree, software applications skills, ability to work independently in a laboratory space, or successful completion of a literature review. Upon student enrolment, the formative assessment process begins, which involves peer review and feedback.

Consistent written and oral feedback is required not only in terms of written work, but also in cases of laboratory protocol designs, data analysis and data interpretation prior to compiling the thesis. The subsequent correcting, marking and assessment of the thesis is different from that of an essay or an assignment because of the peer review process (Powell & Green, 2007). Lovitts (2007) describes it as an "authentic" assessment since the aim is to develop a researcher who can produce new knowledge and is able to present the work at a level that can be judged by peers (Lovitts, 2007). This will include an understanding of the appropriate use of formative assessment tools such as regular meetings, emails, presentations, debriefing after a task is assigned. Furthermore, in the science space, the importance of assessment tools such as hands-on exercises in the laboratory or students engaging in simulation videos e.g., the Predict-Observe-Explain sequence of Zacharia (2005), has led to richer explanations from teachers.

The socio-cultural aspect of formative assessment can be complex during the postgraduate degree. Feedback can be offered in any format which could be a one-on-one meeting between supervisor(s) and students, group meetings, presentations to peers, peer assessment etc. (Chugh et al., 2022). Howson et al. (2022) highlight that in a cross-cultural PhD supervision process, learning can be enhanced where there is a sense of belonging, a democratic process where there is mutual learning, and an appreciation of different cultures of supervisors and students. The absence of appropriate feedback is the main contributing factor to a negative supervisory process (Cekiso et al., 2019). Therefore, ensuring that adequate, timely, constructive and critical feedback is provided, becomes important in addition to other factors that contribute to student success. In STEM postgraduate degrees, the formative assessment process has multiple areas that need supervisor training. Generally, deciding on assessment tools, and the specific knowledge, skills, attitudes and beliefs that must be assessed is highly contextual and as a result, makes the process even more complicated (Capraro et al., 2011). Challenges with formative assessment can also be pedagogical or practice-related, contextual and/or individual-specific (Black & Wiliam, 2018; Henderson et al., 2019).

Given our experiences of challenges at the summative assessment phase of PG supervision and limited availability of empirical data in this regard, it is important that supervisors appraise some of the pedagogical issues of the formative assessment process that are hindering uptake of feedback as it pertains to PG supervision in the sciences. These challenges are not only applicable to the PG supervisor, but the student as well, since an individual's perspective and the availability of a supportive learning environment need to be considered (Dijksterhuis et al., 2013). A supportive environment is one where assessment is recognised as integral to the learning process (Moeed, 2015). A study by Underwood indicates that participant teaching practices improved as well as the frequency of formative assessment in a classroom consisting of science teachers after formal training on formative assessment (Underwood, 2012). This is not unexpected given that formative assessment feedback in science disciplines reportedly require attention to the data, its analysis and presentation while in the education disciplines, emphasis was focused on improving the argument (Holbrook et al., 2012). A pedagogical approach to formative assessment could potentially train supervisors and students to avoid such pitfalls.

Conclusion

The complexities and technological advances in today's society, call for the training and development of more postgraduate researchers with cognisance given to the socio-cultural nature in which postgraduate researchers operate in South Africa. Moreover, these postgraduate researchers would need to show fluency and fluidity in critical thinking, application, and the recontexulisation of concepts beyond the academic setting. A comprehensive curriculum on postgraduate supervision training and development of supervisory capacity has been identified as necessary to achieving the goal of 100 PhDs per million population in 2030 (Sehoole, 2011, NRF, 2014)**.** This is especially important for STEM disciplines where particular cognitive and experiential learning experiences are necessary for the success of the postgraduate process. The focus of curricula for postgraduate degrees should not only be on outcomes related to disciplinary knowledge and practices but also on the processes related to ethics, research integrity, innovations towards the scholarship of teaching and learning (SoTL), and technology transfer. In so doing, a culture of continuous learning and reflective practice that advances SoTL is likely to be fostered.

Postgraduate supervision across different STEM disciplines has similar contexts of practice, particularly in laboratory-driven research projects that require considerable input and funding as well as training. Nevertheless, it is expected that within these settings, supervisors may be subject to different pressures and assume different pedagogical approaches. Being able to consider postgraduate supervision from a more strategic viewpoint is necessary to provide an overarching framework that supervisors can function within (Bernstein, 2000; Maton, 2020), while simultaneously being able to define individual areas of concern. Developing a PGDip that includes core principles from a humanities perspective with a focus on PG supervision within the sciences, would require participants to reflect on epistemological processes as described by Hatano (1996), Ashwin (2015) and Maton (2020). However, this needs to be undertaken contextually, by considering how supervisors assume their supervisory roles, which are shaped by the supervisor's identity and discourses (academic or otherwise), and in turn how this undertaking is perceived, reflected and acted upon by the postgraduate students. It must therefore be recognised that supervisors themselves require training and institutional support to perform their role adequately.

We argue that specialist PGDip courses will be beneficial if they are contextualised for various disciplines and in this case, PG supervision in STEM. While such a discipline-specific STEM-focused PGDip has advantages in aligning with the needs of the student and educator, Silva-Fletcher and May (2018) warn that such an approach could isolate the discipline from the wider teaching communities in higher education and hence may not be good for fostering interdisciplinarity. However, there are also concerns that moving into interdisciplinary research without a strong foundation in the fundamentals of a discipline, may contribute to poor project design and ultimately result in poor outcomes. Therefore, the need for a programme with humanities-based fundamentals dovetailing with a contextualised discipline-specific programme, and the benefits that come with it such as improved teaching practices and potential reduction in student dropout rate, remain.

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