

# A new perspective to aid in MMed research report completion: The effort-time trajectory model

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**Background.** Since 2011, the Health Professions Council of South Africa has required all specialist trainees to complete a Master of Medicine (MMed) research report, a requirement intended to strengthen the production of relevant local research. However, evidence shows that this expectation substantially increases trainee workload, contributes to delays in specialist registration and may impede clinical skills development. SA studies report that registrars frequently lack the time and support needed to complete research tasks, with many exceeding the nominal training period. These challenges mirror international experiences where integrating research into busy clinical programmes remains difficult.

**Objective.** To introduce and describe the effort-time trajectory model as an innovative conceptual framework to support MMed trainees in planning and completing their research reports.

**Methods.** We describe the effort-time trajectory model, originally developed by Nel, which complements existing scheduling-based research support models by explicitly incorporating anticipated cognitive effort. Drawing on educational theory, particularly cognitive load theory, the model conceptualises research progression as a dynamic trajectory of both practical and cognitive effort over time.

**Results.** The model highlights predictable peaks – such as protocol development, data analysis and final writing – and lulls, such as routine data collection. Mapping these fluctuations enables early identification of periods where trainees are most vulnerable to overload and where targeted supervisory or institutional support may have the greatest impact.

**Conclusion.** The effort-time trajectory model provides a more holistic lens for supporting MMed research training by accounting for both temporal and cognitive demands. Its application may reduce last-minute workload surges, improve research completion timelines and support more sustainable integration of research within specialist training programmes.

**Keywords:** MMed, specialist training, cognitive load theory

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Since 2011, the Health Professions Council of South Africa (SA) has required specialist trainees to complete a research report as part of a Master of Medicine (MMed) degree,<sup>[1]</sup> with the intended goal to increase the production of relevant medical research.<sup>[2]</sup> While academically valuable, this requirement adds substantial workload to already busy clinical schedules, and often delays specialist registration.<sup>[3]</sup> Patel *et al.*<sup>[4]</sup> reported that nearly 90% of SA general surgery registrars felt that they lacked sufficient time to conduct research. Similarly, Parry and Coovadia<sup>[5]</sup> found that paediatric registrars at the University of the Witwatersrand, SA, took a median (interquartile range) of 30 (21 - 42) months to complete the MMed research report, with 17.7% of registrars exceeding the nominal 48-month training period. These challenges are echoed internationally, where integrating research with clinical duties remains difficult.<sup>[6]</sup>

In addressing these challenges, solutions such as workshops, mentorship and templates remain institution-specific and fragmented. In 2016, Aldous *et al.*<sup>[7]</sup> proposed a modular approach that provided a structured roadmap with defined milestones and task-specific templates over a 4-year period. The model primarily considered the research project as a sequence of scheduled tasks with requisite milestones and, while it demonstrated success among the single cohort, the model did not explicitly account for the dynamic

fluctuations in cognitive workload that often occur at different stages of research. Consequently, registrars using similar approaches may experience last-minute workload surges, cognitive overload, or delays despite attempted adherence to the planned schedule.

This article aims to describe the development of a conceptual effort-time trajectory model that incorporates anticipated cognitive effort into research report planning, offering a complementary lens to gaps in prior models.

## Methods

### Study design

The development of a conceptual model was undertaken to propose a novel practical tool and framework for describing anticipated fluctuations in cognitive and practical effort during completion of the MMed research report by specialist trainees.

### Theoretical framework

The effort-time trajectory model aligns with principles of self-regulated learning and cognitive load theory.<sup>[8]</sup> Self-regulated learning emphasises planning, monitoring and reflecting on one's learning process. By providing a visual representation of cognitive workload with associated practical effort peaks, the model supports

anticipatory planning and scaffolding, enabling trainees to organise tasks, allocate cognitive resources effectively and seek targeted support at critical points.

From a cognitive load perspective, the model highlights periods of high intrinsic load, including complex tasks such as protocol development and statistical analysis – and allows for interventions to reduce extraneous load, for example, through use of templates, stepwise guidance, or staged feedback. By explicitly mapping these effort variations, supervisors can help trainees navigate periods of high demand without becoming overwhelmed, promoting sustainable progress towards completion.

### Model development procedure

In developing this model, we first defined the typical stages and effort of the MMed research report journey using experiential insights: supervisor/topic identification; research question refinement; protocol drafting; ethics submission; data collection; data management; analysis; report writing; submission for marking. For each stage we assigned relative levels of (i) practical effort and (ii) cognitive effort. We then created the model's physical design, with the y-axis representing practical effort (task workload) plotted as a trajectory over time, while cognitive effort (anticipated cognitive load) was represented using a colour gradient. Green indicates lower cognitive effort, while

red indicates higher effort. The timeline of the model (x-axis) was defined using the GN's knowledge of specialist trainees' required years of training. Finally, stages were listed as milestones along the model's curve.

The relative assignments of effort (both physical and cognitive) were informed by the synthesis of theory identified using a targeted narrative review: we identified three key literature sources on (i) barriers to completing the specialist training research report component in SA and abroad; (ii) timelines and bottlenecks occurring during the different phases of research report completion, i.e. protocol development, data management and analysis, and write-up; and (iii) current proposed approaches to supporting MMed completion. The review was purposive rather than systematic, and aimed to identify common phases where effort is likely to be highest, and to inform model constructs. Because the initial draft of the model was conceptual, the targeted review was then used to anchor and refine it; we sought to minimise bias by searching for literature that could either challenge or support the model's assumptions. We searched a small set of recurring terms in PubMed (registrar/specialist trainee, MMed/research report/dissertation and barriers/facilitators/timelines/supervision/cognitive load/self-regulated learning), together with following references in key articles to find additional sources. We included sources that

helped to define a stage of the model or to explain why certain phases involve high or low effort. The curve shape and gradient distribution were then iteratively refined based on information sources used.

### Implementation

To explore the usability of the model in the MMed programme, a conceptual design was included in an SA academic hospital's specialist trainee welcome pack at the start of training. Informal, anecdotal impressions regarding its perceived usefulness and clarity were sought from 10 - 15 trainees during January 2022 - December 2023. This feedback was not collected using a formal evaluation tool, and was not intended as empirical validation.

## Results

### The effort-time trajectory model

The effort-time trajectory model is presented in Fig. 1. The model is a practical tool that charts expected trainee practical effort on the y-axis against time on the x-axis, highlighting anticipated peaks (e.g. protocol development, dissertation writing) and lulls (e.g. routine data collection).

The model uses a colour gradient to demonstrate time periods requiring higher cognitive effort (bright red) through to periods of lower levels of effort (bright green). In the model, both cognitive and practical effort rises steeply in the first year

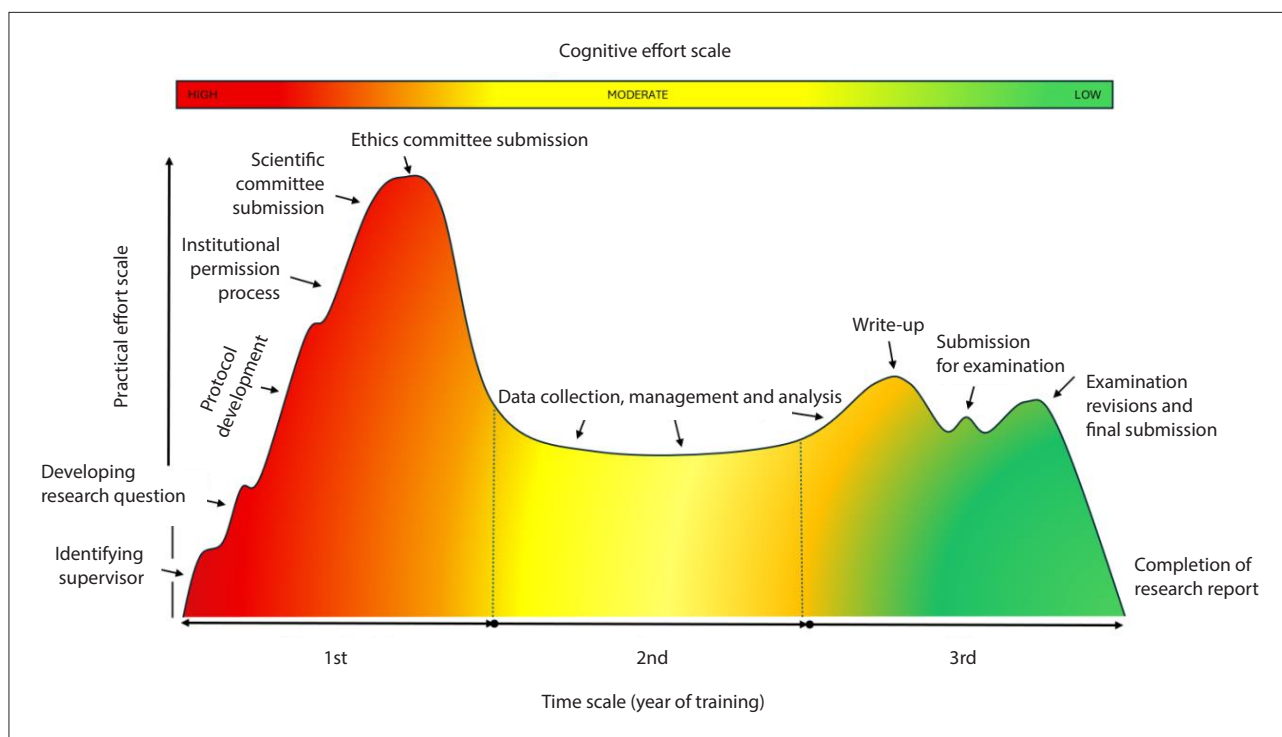


Fig. 1. The effort-time trajectory model.

**Table 1. Practical implications for trainees, supervisors and institutions**

Trainees	<ul style="list-style-type: none"> <li>• The effort-time trajectory model maps the intensity of cognitive and/or practical effort required at each stage of the research process.</li> <li>• It enables trainees to anticipate when research tasks will require disproportionate cognitive and practical investment.</li> <li>• By visualising workload peaks and lulls, it supports strategic time and effort allocation to achieve the time-based deadlines.</li> </ul>
Supervisors	<ul style="list-style-type: none"> <li>• It enables supervisors to anticipate critical phases requiring heightened support of trainees.</li> <li>• It supports proactive interventions, such as workshops, academic writing support, or targeted feedback.</li> </ul>
Institutions and curriculum design	<ul style="list-style-type: none"> <li>• It informs allocation of protected research time.</li> <li>• It supports scheduling of regular ethics, methodology and biostatistics workshops.</li> <li>• Embedding effort-aware planning into the MMed (Master of Medicine) curriculum aligns resources with trainee needs, supporting both trainee success and institutional throughput.</li> </ul>

(identifying a supervisor, developing a research question, drafting the protocol), plateauing during data collection, before practical effort rises again in the late 2nd and early 3rd years as the student undertakes data management and preliminary analysis, and then writes and submits the report. At this stage in the model (submission for examination), the cognitive effort dissipates to an appropriate lower level. Patel *et al.*<sup>[4]</sup> identified draft protocol preparation and data analysis as the most time-consuming steps in the MMed journey, corresponding to the red-yellow gradient of this model.<sup>[4]</sup>

### Implications for use

The effort-time trajectory model additionally presents a set of implications for use in the training environment. Table 1 summarises how the model can be applied for trainees, supervisors and institutions, including anticipatory planning for high-effort phases and targeted support aligned with predicted peaks.

### Discussion

The effort-time trajectory model conceptualises research progression as a dynamic curve of both practical and cognitive effort over time, highlighting predictable peaks (e.g. protocol drafting, data analysis, final report writing) and lulls (e.g. routine data collection). By mapping the anticipated cognitive and practical effort, informed by educational theories such as cognitive load, the model demonstrates where trainees may struggle, and identifies phases where targeted support is most impactful. This approach aligns with broader scholarship recognising that postgraduate research progression is shaped not only by task completion, but by the timing and intensity of cognitive demands on trainees.<sup>[9]</sup>

Existing SA literature consistently describes the MMed research component as difficult to integrate into specialist training, with registrars reporting inadequate time and programmes documenting prolonged completion times.<sup>[3,5,7]</sup> Complementing the modular approach of Aldous *et al.*,<sup>[7]</sup> which focuses on milestone achievements, the effort-time trajectory model further emphasises intensity and distribution of practical effort while introducing a complementary lens describing anticipated cognitive effort. This enables strategic planning so that trainees and supervisors can anticipate high-effort periods and allocate time and resources accordingly, with targeted supervision where support can be focused (Table 1). The model, when considered against the trainee's allocated clinical duties, highlights potential conflicts between research and clinical workload, facilitating proactive adjustments, including protected time or revised milestones.

Beyond the SA context, studies of specialist training programmes internationally similarly highlight structural barriers to completing

compulsory research, including limited supervisory access, competing clinical priorities and inconsistent research standards.<sup>[6,10,11]</sup> These studies suggest that uniform or time-based support models may be poorly aligned with the lived experience of trainees. The effort-time trajectory model addresses this misalignment.

Although the model has not been formally evaluated, anecdotal evidence provided preliminary insights into acceptability and usefulness. Feedback from a small group of trainees suggested that the model was well received, and helped in planning for anticipated peaks in effort and workload. These impressions should be interpreted as evidence of usefulness rather than evidence of effectiveness.

### Study strengths and limitations

This novel model was derived from existing literature, practical experience and the realities of postgraduate clinical environments, providing a unique framework that resonates with current supervision challenges in SA medical specialist training. It also contributes to discourse on strengthening postgraduate supervision within the health sciences, by presenting a new pedagogical tool that can improve postgraduate student completion rates. Despite the unique dual clinical and academic demand on specialist trainees completing the MMed research report, this model can be utilised in other Master's-level research programmes to recognise periods of heightened effort, task prioritisation and timing.

A key limitation is that the effort intensity levels and curve shape were assigned conceptually through theory-informed narrative synthesis and experiential insights, rather than derived from longitudinal measurement of registrar effort. The model's effectiveness, feasibility and impact on research quality and completion rates must be formally assessed. Further research should involve pilot testing within MMed programmes to assess these outcomes.

### Conclusion

The effort-time trajectory model describes how effort is distributed across the research report timeline. Trainees, supervisors and institutions can use it to anticipate common bottlenecks in report completion, to plan timelines and resource allocations more realistically and to target support where delays are most likely. The model should undergo empirical validation within Master's-level research programmes to confirm its applicability and usefulness.

**Data availability.** N/a.

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