Research article

Scientific writing development: Improve DNP student skill and writing efficiency

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ABSTRACT

Background: Doctor of Nursing Practice (DNP) students lack sufficient opportunities to practice writing. Students and faculty require clear expectations and consistent feedback to improve skills.
Objective: This study evaluated a rubric-driven scientific writing development program.
Design: A mixed methods design was used.
Setting: The study was conducted in a post-Master's DNP Program.
Participants: The sample included DNP students and faculty.
Methods: The intervention was delivered to 10 students and writing proficiency was assessed over five semesters. Overall doctoral project quality and rigor were assessed at the end of the program and compared to a similar group of students ($n = 20$). Seven faculty and eight students participated in qualitative interviews.
Results: Performance improved from Semesters 1 to 5; and though quality and rigor did not differ, the intervention group's final papers were more efficiently written with approximately 17 fewer pages and an average review time of eight fewer minutes than the comparison group. Participants identified the rubric, feedback, and scaffolding as helpful program components.
Conclusions: Scientific writing development is essential to DNP education. The intervention improved skill performance and writing efficiency.

1. Background

With >25,000 Doctor of Nursing Practice (DNP) students in the United States (US; American Association of Colleges of Nursing [AACN], 2017), thousands of nursing faculty engage in DNP project development and dissemination. In comparison to research-focused (i.e., PhD) doctorates, that prepare nurses to engage in scholarship that generates knowledge to guide nursing practice, the DNP practice-focused doctorate prepares nurses to translate and apply research evidence within the practice setting for the purposes of improving health outcomes (AACN, 2022). DNP projects, the culminating activity for DNP programs, are intended to improve health care quality and safety by promoting timely research uptake and implementation of evidence-based practice (Brown and Crabtree, 2013; AACN, 2006). Scientific writing development plays an important role in the doctoral student's professional socialization as a nurse, understanding of a common language within the research literature, and development of one's identity as a nursing scholar (Tyndall et al., 2019). It is also an integral component for guiding students through the rigorous process of designing, implementing, evaluating, and disseminating the doctoral project.

This process is challenging because faculty and students often lack knowledge for rigorous DNP project implementation (Dols et al., 2017; Volkert and Johnston, 2018). DNP project rigor is defined as "a systematic, logical, and thorough approach to…design and implementation…that addresses a significant problem and includes an evaluation process based on appropriate metrics…that provide a valid and reliable determination of project outcomes" (Roush and Tesoro, 2018). Unclear

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expectations, limited faculty time and compensation, and student writing proficiency contribute to inconsistent DNP project quality and rigor (Dols et al., 2017).

Graduate nursing students are at risk for progression delays or program withdrawal if scientific writing deficits are not addressed. Further, the shorter time frame for post-Master's DNP (1.75 years; Udlis and Mancuso, 2012) compared to PhD programs (5.1 years; Nehls et al., 2016) requires rapid skill acquisition. DNP students' writing skill development needs included: grammar, style, content, construction, format, citation use, plagiarism, and synthesis (Cone and Van Dover, 2012; Dols et al., 2017; Hampton, 2018; Pintz and Posey, 2013). While skills can be developed within DNP programs, faculty miss development opportunities. Students reported limited writing practice options and indicated that feedback (if provided) was minimal, inconsistent, or overemphasized mechanics (i.e., grammar and sentence structure), a practice that can hinder student engagement and learning (Gazza et al., 2013; Giddens and Lobo, 2013; Mitchell et al., 2020).

Though many students require mechanics development, they also need development in content, organization, and synthesis (Hampton, 2018). Multiple interventions for graduate nursing students are described in the literature, but there is no consensus on duration or delivery method (Cone and Van Dover, 2012; Falk et al., 2014; Krishnamurthy and Wood, 2018; Pintz and Posey, 2013; Roberts and Goss, 2009; Salani et al., 2016; Tornwall and McDaniel, 2022; Tyndall et al., 2021; Vogt et al., 2021; Walker and Tschanz, 2013; Weaver and Jackson, 2011). Additionally, few studies measured skills outcomes. Oermann et al.'s (2015) review ($N = 80$ studies) found that only 35% of writing intervention studies reported outcomes. Without these data, effectiveness is unknown.

Evidence indicates that stand-alone writing courses are ineffective for achieving the knowledge and skill acquisition required for graduate nursing students (Tornwall and McDaniel, 2022; Tyndall et al., 2021; Vogt et al., 2021). Instead, experts recommend writing instruction that is interwoven throughout the curriculum (Mitchell and McMillan, 2018). Of studies that reported writing skill improvements, interventions included rubric use, frequent feedback, and sequenced assignments (Mitchell and McMillan, 2018; Roberts and Goss, 2009; Tai et al., 2016), components of scaffolding.

Per Wood et al.'s (1976) seminal work, scaffolding involves an expert who guides learners through multiple stages of a larger task through six phases: gaining learner interest, breaking the task into manageable subcomponents, providing motivation and forward direction, giving feedback that identifies discrepancies in student's actual versus expected performance, creating an environment of support, and providing demonstration. Gazza and Hunker (2012) proposed the scaffolding framework to develop writing skills in nursing education applying its three elements: *foundation* (detailed instructions, rubrics, goal setting, connection to prior learning, examples, writing resources), *frame* (sequenced assignments throughout a course or curriculum), and *cross braces* (skill mastery reinforcement and continuous feedback).

DNP students lack sufficient opportunity to practice writing and receive feedback, key components for scientific writing development. Further, valid and reliable tools to evaluate students' writing skill and DNP project quality and rigor exist, but are infrequently used to coach writers. The specific aims of this study were to evaluate a rubric-driven scientific writing development program's effect on: 1) student skill progression over time, 2) DNP project quality and rigor, and 3) faculty and student perceptions of the intervention.

2. Methods

2.1. Design

A mixed-methods design was used. Writing proficiency was assessed from Semesters 1 through 5 using a repeated measures design (Aim 1). A quasi-experimental, post-test only design was used to compare DNP project quality and rigor to a similar group of students (Aim 2). Qualitative methods were used to assess faculty and student perceptions (Aim 3).

2.2. Setting

The study was conducted at a public California university's post-Master's DNP program. The students entered the 5-semester program in Fall 2019. It was previously offered as a joint program for six years with another institution. The programs were separated, but retained the same curriculum with one minor course sequence change and many of the same faculty. Online courses were primarily asynchronous with a 1-day synchronous orientation at the beginning of each semester.

2.3. Sample

The sample included enrolled students between Fall 2019 and Spring 2021 (Aim 1). Eligible applicants were registered nurses with active California licenses, Master's degrees in nursing or health-related fields, and grade point averages above 3.0. The comparison sample included randomly selected, deidentified DNP project papers from joint program graduates within the previous two years retrieved from the university's public repository (to ensure the sample was as similar as possible regarding DNP project requirements) (Aim 2). Enrolled students and full-time, part-time, or adjunct faculty who taught a DNP theory course or served as a DNP project chair were eligible to participate in qualitative interviews. The majority of faculty supported students in both the intervention and comparison groups. The university's institutional review board approved this study.

2.4. Data

The Scientific Writing Assessment (SWA) evaluates writing proficiency using 13 skills in three domains (Hampton and Chafetz, 2021). The domains include fundamental skills, information literacy and integrity, and organization, conceptualization, and critical analysis (referred to as conceptualization hereafter) (see SWA user guide for skills and performance criteria; Hampton, 2021). Skill scores range from 1 to 5 (65 total) with higher scores indicating greater proficiency. Concurrent validity was established comparing SWA ratings with a standardized essay rubric ($r = 0.56$); and interrater consistency for the SWA was 82.3% (Hampton and Chafetz, 2021).

The DNP Project Critical Appraisal Tool (DNP-PCAT) evaluates 16 components of DNP project quality and rigor. Scores range from 0 (absent) to 3 (satisfactory) with varying weights (141 total) (Roush and Tesoro, 2018). Fourteen components address content and two address writing skill. Content validity was assessed at 0.95.

Faculty participated in focus group interviews (~90 min) and students participated in individual, semi-structured interviews (~30–60 min) to determine perceptions of the intervention. Questions addressed writing challenges, helpful aspects, and suggestions for improvement. Number of pages and minutes to review final DNP project papers were included as proxy measures of writing efficiency and faculty workload.

2.5. Procedures

The intervention was designed to facilitate collaboration between faculty, students, and advisors. Course faculty and DNP project chairs were trained in SWA use and giving feedback. At Semester 1 orientation (mandatory for students and faculty), an outline detailing deliverables due each semester was provided. Each following semester featured one writing-intensive course with a scaffolded assignment and a writing-focused didactic session that aligned with the deliverables for the upcoming semester (see Table 1). At the end of the semester, advisors downloaded writing samples directly from the learning management system and evaluated them using the SWA. Advisors recorded scores,

Table 1
DNP project deliverables and scientific writing activities by semester (S).

	Synchronous group session didactic content	Faculty/advisors	Students
S1	○ SWA rubric ○ Skill demonstrations ○ APA format	○ SWA training session ○ Week 4 SWA assessment (3 introductory paragraphs) ○ Multiple sub-component assignments leading to final theory course paper ○ SWA evaluation of Week 4 writing samples ○ Week 4 narrative feedback by email ○ *S1 SWA evaluation of final theory course paper* ○ S1 narrative feedback by email ○ Consultation as needed	○ *SWA self-assessment* ○ DNP project development in course work
S2	○ IRB process and approvals ○ Overview of background and methods of DNP project	○ Feedback training session ○ Multiple sub-component assignments leading to final research course paper ○ *S2 SWA evaluation of final research course paper* ○ S2 narrative feedback by email ○ Consultation as needed	○ DNP project development in course work
S3	○ Review IRB process and approvals ○ S2 proposal refinement ○ Planning data collection and implementation	○ Focus group interview ○ *S3 SWA evaluation of IRB proposals* ○ S3 narrative feedback by email ○ Consultation as needed	○ 1:1 interviews ○ DNP project development in course work ○ Collaboration with DNP project chair for project approvals
S4	○ Analyzing data and reporting results ○ Overview of discussion and conclusions	○ Individual work with DNP project chairs ○ Consultation as needed	○ DNP project development embedded in course work
S5	○ Identifying appropriate journals ○ Author guidelines: Writing for publication	○ *S5 SWA evaluation of final DNP project papers* ○ DNP-PCAT evaluation of S5 DNP project papers by independent reviewers ○ Consultation as needed	○ DNP project completion in course work ○ Collaboration with DNP project chair to finalize manuscript

Data collection points (in bold and italics).
APA = American Psychological Association.
DNP = Doctor of Nursing Practice.
SWA = Scientific Writing Assessment.

but only provided narrative feedback to students via email (to promote a growth mindset and to assuage anxieties about potential effects on grades). Feedback included acknowledgement of strengths, improvement needed, and referred students to suggested activities and resources to build skills. Advisors maintained a site within the learning management system to archive content and provide resource links for individualized support (see Table 2 for activities used to operationalize the scaffolding framework within DNP courses). Archives included an American Psychological Association (APA) template, examples of DNP project manuscripts, video tutorials, and resource links (i.e., online writing lab, university writing center, detailed instructions, and deadlines). Advisors used the site for communications to promote student and faculty engagement throughout the program.

Two blinded reviewers conducted DNP-PCAT ratings and recorded

time for review in minutes by documenting start and end times. Qualitative interviews were conducted in Semester 3 to provide the investigators with a preliminary evaluation of program acceptability by faculty and students. Due to the COVID-19 pandemic, interviews were conducted via Zoom rather than face-to-face. Session transcripts were downloaded and deidentified before analysis.

2.6. Analysis

IBM SPSS Statistics, version 28.0 was used for data analysis. SWA and DNP-PCAT scores reflect the average of two independent raters. Means and standard deviations were obtained for student self-assessment at baseline and advisor scores for Semesters 1, 2, 3, and 5. SWA performance comparisons were conducted via repeated measures ANOVA (Aim 1). DNP-PCAT scores for intervention and comparison groups were compared using an independent samples t-test (Aim 2). Narrative analysis was used to understand how students and faculty constructed stories from their experiences. Three investigators repeatedly read student and faculty focus group transcripts (three times) to: confirm transcript accuracy with audio recordings, highlight meaningful sections, sentences, or phrases, code transcripts, and identify themes and subthemes (Aim 3).

3. Results

3.1. Quantitative findings

Thirteen students enrolled in the program with three withdrawing for personal reasons. Analyses for data collected after Semester 1 included 10 students. The comparison sample included 20 DNP project papers. See Table 3 for baseline student self-assessment and Semester 1 advisor-assessed SWA scores. Students rated themselves highest on organization/use of headings (4.46 ± 0.52) and use of scholarly sources (4.38 ± 0.65), and lowest on avoids repetition (3.58 ± 0.64) and critical appraisal (3.62 ± 0.77). Differences between student self-assessment and Semester 1 advisor ratings were not statistically significant, but faculty rated students highest on adheres to rubric (4.81 ± 0.38), organization/use of headings (4.46 ± 0.55), and organization/logical flow (4.46 ± 0.45), and lowest on use of primary sources (3.77 ± 1.16), paraphrasing/avoids plagiarism (3.77 ± 0.95), and critical appraisal (2.54 ± 0.94).

Mean SWA scores were compared for Semesters 1, 2, 3, and 5 (Table 5). In Semester 5, ratings for 11/13 skills were 4.55 or above with critical appraisal (4.30 ± 1.02) and use of primary sources (3.78 ± 0.69) among the weakest skills. Use of primary sources peaked in Semester 2 (4.48 ± 1.04), but regressed thereafter. Huynh-Feldt p-values are reported for the repeated measures ANOVA (Table 3) to correct for the assumption of sphericity (Aim 1). There were significant differences in SWA overall scores ($F = 12.45, p < .001$) with steady improvement over time and significant pairwise differences between Semesters 1 and 5 ($p = .007$). The domains: fundamental skills ($F = 6.46, p = .002$), information literacy ($F = 5.56, p = .02$), and conceptualization ($F = 12.88, p < .001$) also had statistically significant differences with significant pairwise comparisons for fundamental skills (Semester 1 to 5; $p = .02$) and conceptualization (Semesters 1 to 5, $p = .003$; 2 to 5, $p = .01$; and 3 to 5, $p = .03$). Individual skill scores (8/13) also significantly increased.

Table 4 compares independent samples t-test results for DNP-PCAT overall and component scores with means and standard deviations for total number of pages and minutes to score (Aim2). There were no significant differences in overall DNP-PCAT scores for the intervention (99.45 ± 12.50) and comparison groups (103.38 ± 16.02). However, the intervention/project design component (10.00 ± 2.36 vs. $13.00 \pm 2.24, p = .002$) was significantly lower for the intervention group. Number of pages (20.70 ± 3.97 vs. $37.40 \pm 10.81, p < .001$) and minutes to score ($28.05 \pm 4.40$ vs. $36.40 \pm 7.76, p < .001$) were also significantly lower for the intervention group.

Table 2
SWA-focused skill acquisition recommendations per scaffolding framework (Wood et al., 1976).

Scaffolding function/SWA skill	Gaining learner interest	Breaking up task	Motivation/forward direction	Feedback on discrepancies	Environment of support	Demonstration
Grammar				○ Turnitin ○ Grammarly ○ Microsoft Word ○ Criterion	○ S/US summative assessments on sub-component assignments	○ Online writing lab tutorials ○ University writing center tutors
Format	○ Orientation APA overview			○ Explain errors in comments ○ Provide links to Purdue OWL		○ Purdue OWL ○ APA manual ○ University library
Adheres to rubric	○ Recorded video review of paper rubric in Week 1 of course		○ Post final paper rubric in sub-component assignments descriptions			○ Provide example of previous student papers highlighting rubric requirements
Avoids repetition	○ IMRaD review of each scientific paper section's purpose		○ Students share best practices for proofreading	○ Peer review using SWA and content rubric		
Substantive content	○ IMRaD - identify sections of paper with majority of citations	○ Assign literature table submission mid-course	○ Require a minimum number of citations	○ Feedback on substance of cited information in table (detail, number of sources, primary vs. secondary, etc.)	○ Literature table revision and resubmission for insufficient substance	○ Share example of literature table
Primary sources				○ Randomly inspect a reference to detect secondary source citation		○ Instruct to cite from results ○ Demonstrate interlibrary loan service use
Avoids plagiarism	○ Practice paraphrasing ○ Retrieve a source from a published paper to inspect ○ Review Turnitin originality report				○ Schedule appointment with student when plagiarism detected ○ Review Turnitin originality report together ○ Opportunity to correct for errors in first submission	○ Plagiarism and paraphrasing tutorials
Scholarly sources	○ Workshop with librarian at orientation		○ Schedule 1:1 coaching and assistance with librarian or faculty			○ Demonstrate literature search, return demonstration ○ Reinforcement as needed ○ Save searches ○ Sign up for alerts
Narrow focus	○ Reverse outline a published paper	○ Initial PICO ○ Revised PICO ○ Draft outline	○ Schedule 1:1 meeting to ensure appropriate PICO	○ Provide outline feedback that distinguishes relevant vs. tangential information		
Organization – headings	○ Identify headings and phenomenon-specific subheadings in published paper	○ Require specific subheadings in student outlines		○ Assist to identify appropriate subheadings in literature table submissions		○ Demonstrate reverse outlining for a published paper identifying subheadings
Organization – logical flow		○ Sub-component assignments	○ Peer review	○ Faculty feedback on sub-component assignments	○ Prioritize feedback by issues related to 1) invention, 2) organization, and 3) mechanics (Madson, 2018) ○ Acknowledge strengths and improvements ○ Lighten load in final weeks of course (time for critical thinking, proofreading, and taking a break)	○ Revisit outline as needed
Critical appraisal				○ Identify and distinguish summary statements ○ Demonstrate critical appraisal, where indicated		○ Demonstrate summary and critique of sample studies ○ Repeat as needed throughout program
Synthesis				○ Identify opportunities for synthesis in student's paper ○ Demonstrate skill		○ Identify synthesis in a published study

S/US = satisfactory/unsatisfactory.
SWA = Scientific Writing Assessment.
IMRaD = introduction, methods, results, and discussion.

Table 3
SWA: baseline student self-assessment vs. Semester 1 faculty assessment, paired samples *t*-test, $N = 13$.

	Student self-assessment	Faculty rating			
	Mean (SD)	Mean (SD)	t	d	p
Domain 1: fundamental skills	*15.77 (2.20)*	*17.13 (1.85)*	*−1.69*	*−0.47*	*0.93*
Grammar	4.00 (0.82)	4.10 (0.62)	−0.30	−0.08	0.27
Format	3.85 (0.90)	4.10 (0.77)	−0.93	−0.26	0.28
Adheres to rubric	4.35 (0.69)	4.81 (0.38)	−1.76	−0.49	0.07
Avoids repetition	3.58 (0.64)	4.13 (0.67)	−2.32	−0.64	0.70
Domain 2: information literacy	*16.85 (2.40)*	*15.85 (3.38)*	*0.80*	*0.22*	*0.54*
Substantive content	4.11 (0.58)	4.08 (0.90)	0.11	0.03	0.10
Primary sources	4.11 (0.82)	3.77 (1.16)	0.90	0.25	0.89
Paraphrasing/ avoids plagiarism	4.23 (1.07)	3.77 (0.95)	1.04	0.29	0.41
Scholarly sources	4.38 (0.65)	4.23 (0.66)	0.68	0.19	0.48
Domain 3: critical analysis	*19.50 (2.36)*	*20.12 (2.23)*	*−0.60*	*−0.17*	*0.32*
Narrow focus	3.77 (0.70)	4.31 (0.54)	−1.92	−0.53	0.29
Organization – headings	4.46 (0.52)	4.46 (0.55)	0.00	0.00	0.99
Organization – logical flow	3.85 (0.69)	4.46 (0.45)	−2.45	−0.68	0.47
Critical appraisal	3.62 (0.77)	2.54 (0.94)	3.33	0.92	0.80
Synthesis	3.81 (0.69)	4.35 (0.56)	−1.84	−0.51	0.17
SWA total	*52.12 (6.08)*	*53.09 (6.81)*	*−0.37*	*−0.10*	*0.75*

SWA = Scientific Writing Assessment; SD = standard deviation.
The italicized rows represent the three domains of the instrument (fundamental skills, information literacy, and critical analysis). The non-italicized rows are the individual skills assessed within the domains.

3.2. Qualitative findings

A subset of seven students participated in semi-structured interviews and eight faculty opted-in to participate in a focus group. Four themes emerged from the thematic analysis: recognizing skill development needs, identifying strategies that work, writing within time constraints, and clarifying writing's purpose (Aim 3). (To distinguish faculty from student remarks, each quote is followed by an (F) or (S) indicating a faculty or student statement, respectively.)

3.3. Recognizing skill development needs

Student and faculty participants identified challenging skills including: data management and organization, paraphrasing and plagiarism, APA format, critical appraisal, and synthesis.

…trying to read it…understand it, and…learn how to pull out citations…without plagiarizing was a challenge…(S)

I was struggling…initially…my research was just – Google the topic – and I was not getting scholarly articles…so that was a learning curve. (S)

…the critical appraisal piece…I think I'm still very much a novice at…(S)

Table 4
DP final papers: DNP-PCAT scores, independent samples *t*-test, $N = 30$.

	Intervention group ($n = 10$)	Control group ($n = 20$)	95% confidence interval		
	Mean (SD)	Mean (SD)	Lower	Upper	p
Introduction	5.00 (1.33)	4.85 (1.18)	−1.13	0.83	0.76
Problem statement	6.75 (1.77)	7.43 (1.72)	−0.70	2.05	0.32
Specific aims	6.00 (2.35)	7.13 (1.94)	−0.52	2.77	0.17
Theory	2.30 (0.92)	2.43 (0.83)	−0.55	0.81	0.71
Strategic planning	0.60 (1.97)	0.45 (1.00)	−0.96	0.66	0.71
Literature review	4.35 (3.27)	6.60 (1.57)	−0.15	4.65	0.06
Intervention/ project design	10.00 (2.36)	13.00 (2.24)	1.19	4.81	0.002
Ethical concerns	3.10 (1.97)	2.60 (2.21)	−2.19	1.19	0.55
Data collection	13.50 (2.11)	12.50 (2.43)	−2.85	0.85	0.28
Evaluation/data analysis	12.50 (2.36)	11.63 (2.60)	−2.88	1.13	0.38
Results	11.25 (2.70)	11.50 (2.74)	−1.91	2.41	0.82
Discussion	6.90 (2.26)	5.48 (2.02)	−3.09	0.24	0.09
Limitations	4.20 (1.75)	4.75 (1.62)	−0.77	1.87	0.40
Conclusions	4.70 (1.16)	5.00 (1.26)	−0.67	1.27	0.53
Writing/formatting	3.10 (1.10)	3.45 (1.15)	−0.55	1.25	0.43
Citations	5.20 (1.03)	4.60 (1.03)	−1.53	0.33	0.20
DNP-PCAT total	*99.45 (12.50)*	*103.38 (16.02)*	*−7.96*	*15.81*	*0.50*
Number of pages	*20.70 (3.97)*	*37.40 (10.81)*	*11.11*	*22.29*	*<0.001*
Mean reviewer time to score (minutes)	*28.05 (4.40)*	*36.40 (7.76)*	*3.79*	*12.91*	*<0.001*

DNP-PCAT = Doctor of Nursing Practice Project Critical Appraisal Tool.
DNP-PCAT total indicates only the distinction between individual items/skills on the instrument.

When elaborating on challenges, information literacy was most prominent and featured database searching, organizing large amounts of information from articles, reference management software use, and navigating use of multiple resources. Critical appraisal was the skill considered most difficult to comprehend.

3.4. Identifying strategies that worked

Students and faculty identified effective skill development strategies. The SWA rubric, detailed feedback, templates, examples, and scaffolded assignments helped to clarify expectations for students and faculty.

…The feedback from my instructors has been hugely beneficial…I always read the feedback…and…apply it to my next semester classes…[T]here wasn't duplication [of feedback]. So, I think…there's improvement…these writing proficiency assessments…[are] really helpful.(S)

Students also appreciated support from DNP project chairs and librarians, and though they appreciated written feedback given by email, one student suggested that live feedback might be preferred. Participants reported that prior to entering the DNP program, they either received no or minimal substantive feedback. Feedback given each semester reinforced learning through repetition, revision, and progressive

Table 5
SWA scores: semesters 1, 2, 3, & 5, repeated measures ANOVA, $N = 10$.

	Semester 1	Semester 2	Semester 3	Semester 5	df	Mean square	F	p
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)				
Domain 1: fundamental skills	*17.13 (1.85)*	*17.57 (1.83)*	*17.65 (1.66)*	*18.98 (1.10)*	*2.57*	*4.57*	*6.46*	*0.002*
Grammar	4.10 (0.62)	4.30 (0.69)	4.19 (0.61)	4.88 (0.24)	2.81	0.71	5.61	0.006
Format	4.10 (0.77)	4.30 (0.61)	4.33 (0.58)	4.55 (0.54)	2.45	0.18	0.89	0.45
Adheres to rubric	4.81 (0.38)	4.73 (0.47)	4.81 (0.43)	4.75 (0.35)	3.00	0.07	0.78	0.52
Avoids repetition	4.13 (0.67)	4.25 (0.75)	4.33 (0.72)	4.80 (0.35)	1.30	2.46	3.12	0.10
Domain 2: information literacy	*15.85 (3.38)*	*17.45 (3.02)*	*17.52 (2.81)*	*18.68 (0.62)*	*1.98*	*23.48*	*5.56*	*0.02*
Substantive content	4.08 (0.90)	4.23 (0.76)	4.29 (0.76)	4.98 (0.08)	2.66	1.39	6.94	0.003
Primary sources	3.77 (1.16)	4.48 (1.04)	4.35 (1.06)	3.78 (0.69)	1.40	7.02	6.57	0.02
Paraphrasing/avoids plagiarism	3.77 (0.95)	4.09 (1.28)	4.19 (1.20)	4.98 (0.08)	1.96	3.91	5.37	0.02
Scholarly sources	4.23 (0.66)	4.66 (0.39)	4.69 (0.37)	4.95 (0.16)	1.50	2.38	8.56	0.007
Domain 3: critical analysis	*20.12 (2.23)*	*20.80 (1.87)*	*20.71 (2.00)*	*24.15 (1.16)*	*2.47*	*32.17*	*12.88*	*<0.001*
Narrow focus	4.31 (0.54)	4.73 (0.34)	4.77 (0.33)	5.00 (0.00)	1.92	1.14	5.00	0.02
Organization – headings	4.46 (0.55)	4.34 (0.58)	4.29 (0.65)	5.00 (0.00)	1.70	1.48	4.71	0.03
Organization – logical flow	4.46 (0.45)	4.20 (0.66)	4.38 (0.66)	4.90 (0.21)	2.56	0.64	2.97	0.06
Critical appraisal	2.54 (0.94)	3.05 (1.26)	2.92 (1.20)	4.30 (1.02)	2.11	9.35	9.76	0.001
Synthesis	4.35 (0.56)	4.48 (0.53)	4.35 (0.70)	4.95 (0.11)	2.38	0.60	4.02	0.03
SWA total	*53.09 (6.81)*	*55.82 (6.36)*	*55.85 (5.93)*	*61.80 (2.14)*	*2.45*	*132.76*	*12.35*	*<0.001*

SWA = Scientific Writing Assessment.

DNP project building throughout the program.

> Having the students build the paper through the course is something I find really helpful…everything is related to their project…you catch…those errors and hopefully by the end, the final paper is a lot better…I plan to do that for all of my classes from now on…(F)

> [The] new way of doing it [the writing intervention]…as a chair…it's just so helpful to have…clear expectations…we're all on the same page and trying to give consistent feedback, and to know what feedback that student has already gotten.(F)

With the exception of one course in which the advisor was also the course faculty, advisors alone provided SWA feedback, and therefore separate from course faculty and grades. This facilitated a low pressure learning environment and limited influence on grades.

3.5. Writing within time constraints

Student writers were initially uncertain about writing expectations, and as they learned, reported feeling overwhelmed and pressured to perform. Many felt frustrated by the lack of time to synthesize information. Students experienced multiple competing priorities in their personal and professional lives.

> I genuinely wish I had more time to…sit with information and get lost in researching…and I just…don't have that opportunity…I think I'm frustrated by that…(S)

> The biggest thing we can do is set boundaries…with people that want to socialize…They want you cooking…playing games…and unfortunately, that's when my assignments are due.(S)

Faculty struggled with providing support to students within the confines of the five-semester DNP Program, a rigid timeline for students with lower levels of scientific writing proficiency.

> …our challenge as faculty and…as project chairs is to…sync everyone who's coming in at…different [proficiency] levels when we have to also keep them on the same timeline…(F)

The intervention provided a means to centralize needs assessment as a core component of the program, educate students regarding writing performance expectations, and provide tools for skill development. As a result, individual course faculty and DNP project chairs were able to focus their efforts more efficiently on supporting content development

with the time available.

3.6. Clarifying writing's purpose

DNP faculty held two opposing points of view regarding writing's purpose in the program. The first was writing as a gatekeeping structure or "elitist activity."

> I always taught in the first semester and…wanted to have…a systematic way…that people could be weeded out between semesters… I think not everybody is actually DNP material.(F)

> …When I get them in their first semester and the writing is not up to par…you're making corrections about their sentence structure…I'm not an English teacher. I shouldn't be doing this.(F)

The alternate point of view involved writing as a learning process. These faculty believed in the ability of students to develop as writers versus an inherent ability or lack thereof.

> I'm just not an advocate for that because if…[writing] was their determination whether I got into the program or not…I would never have gotten in.(F)

> There is a myth of being a good writer or not a good writer…writing isn't a one-time thing. It's a process.(F)

Though the gatekeeping perspective persisted in the program culture to a degree, the leadership team's efforts to promote writing's purpose as a learning process with the integration of the intervention into the semester orientation sessions, and courses across the curriculum, all of the students and the majority of the faculty interviewed valued the impact of the intervention. DNP project chairs felt their students were well-prepared for DNP project development and implementation.

4. Discussion

The first aim of this study was to evaluate scientific writing skill development in a post-Masters DNP program. Overall SWA scores increased significantly with the largest mean increases in the information literacy and conceptualization domains. Meaningful improvements were noted as early as Semester 2, when all mean scores exceeded 4.0 for individual skills. SWA scores for this study exceeded those from a national sample. Semester 5 DNP project paper scores were higher overall (61.80 vs. 54.60), and for fundamental skills (18.98 vs. 17.10), information literacy and integrity (18.68 vs. 17.00), and conceptualization

(24.15 vs. 20.00) (Hampton and Chafetz, 2021). The regression in scores for use of primary sources reinforces the need for ongoing assessment and repetition as needed to achieve skill mastery.

The second aim involved comparing the intervention and comparison groups on DNP project quality and rigor. Although the scores for both groups exceeded those of DNP project papers sampled from a national repository (78.27 ± 27.36, Roush and Tesoro, 2018), there were no significant overall differences. This is likely related to consistent DNP project expectations across programs. Many of the faculty who taught within or served as a DNP project chair for the intervention group cohort, also taught in the joint program from which the comparison group students graduated. The one component that differed, intervention and project design, was a content area with broad criteria, so it is difficult to discern what contributed to lower scores. Minor differences in content-related requirements (versus writing skills) could contribute to score variations between groups.

These findings support the use of distinct content (DNP-PCAT) and scientific writing skill (SWA) rubrics to improve student performance (Hampton and Chafetz, 2021; Minnich et al., 2018). Though content expectations can vary across programs, courses, or disciplines, the SWA's focus on scientific writing skill makes it a useful rubric that can be applied in any course or context in which undergraduate, graduate, or professional nursing and health science writers seek fundamental, information literacy, or conceptualization skill development. In previous studies, rubric use effectively increased interrater consistency (Bickes and Schim, 2010; Cyr et al., 2014; Hampton and Chafetz, 2021; Minnich et al., 2018) and decreased grade inflation (Bickes and Schim, 2010), with sufficiently narrow criteria (Turbow et al., 2016). Additionally, using a scientific writing rubric can be instrumental in coaching nursing and health science students to master skills that are not addressed in general essay rubrics (Hampton and Chafetz, 2021).

The third aim addressed faculty and student perceptions. Despite the lack of consensus on writing's purpose, there was sufficient buy-in among the majority of faculty and students to reap the intervention's benefits. The structure provided by the scaffolding framework (foundation, cross braces, and frame) staggered learning opportunities throughout the curriculum and these were reinforced by program leadership and faculty. Though the program's fast pace and time constraints were identified as stressors, they found use of the SWA, scaffolding, and frequent feedback were helpful to clarify performance expectations. In Agius and Wilkinson's (2014) review, students valued a balance of positive comments with constructive and timely feedback. Substantive feedback is recommended not only for improving performance, but also for developing community and facilitating role transition from practitioner to scholar (Tyndall et al., 2021).

Faculty require training to give substantive feedback. Those who lack experience might focus solely on mechanics or provide no feedback at all. Content-related feedback is important to consider, but also its sequence and pace to avoid overwhelming the student (Mitchell et al., 2020). Invention (ideas) should be addressed first, followed by arrangement (organization), and expression (word choice, mechanics) with feedback provided in multiple formats (verbal/visual/written) that address both strengths and needed improvements (Madson, 2018).

With regard to writing efficiency, students in the intervention group achieved comparable quality and rigor (DNP-PCAT) in fewer pages. Student writing that addresses content requirements concisely with less redundancy and fewer mistakes in grammar, punctuation, format, plagiarism, or organization reduces the complexity and time required for faculty to review papers. The total number of pages and minutes to score DNP project papers was significantly lower for the intervention group. In a cohort of 25 students, the time savings would equate to ~3.5 h for a single assessment, a potential reduction in faculty workload. Though scaffolding requires time to score building block assignments, these sub-component assignments are often one page or less and contribute to cumulative improvements in subsequent submissions, potentially resulting in a net improvement in either time or quality of faculty workload.

As noted, all skills (except critical appraisal) were above 4.0 by Semester 2 and performance resulted in reduced need for remedial writing support after the first semester. Advisors spent approximately 30–60 min of time each semester for SWA review and feedback for each student. Most often, students were able to use feedback to follow-up on development recommendations independently, without additional support required. This model could require a modest amount of advising units for faculty assignments. Alternatively, DNP project development and feedback could also be integrated into the designated writing course for each semester.

This study's strengths included the quantification of writing skills, measurement over time, and comparison of two similar student groups, one of which received an intensive writing development intervention. There were limitations that should be considered in interpreting the results. First, there were four rather than five assessments. The initial study plan included five iterations of the DNP project manuscript in each semester. Though students continued writing development in other courses, because students were in the process of data analysis, there was no DNP project submission for Semester 4. Additionally, two investigators served as program advisors and taught one of the courses used for SWA assessment. With the exception of this course, SWA assessment was conducted by faculty advisors outside of courses, but as a small program, there were not sufficient resources to contract with SWA raters who were not affiliated with the program across the two years of the study. Findings regarding skill performance were nonetheless aligned with a previous study of DNP project papers from a national repository (Hampton and Chafetz, 2021) and the qualitative and quantitative findings were congruent. Further, to provide an unbiased assessment for quality and rigor, two independent raters who were blinded to the intervention and DNP program students and faculty, evaluated deidentified and randomly ordered writing samples. Both SWA and DNP-PCAT ratings were the combined average of two independent raters, a practice recommended for writing evaluation (City University of New York, 2010). Finally, the sample was small, which could make detecting a significant difference in performance difficult, but the use of a comparison group of 20 sample papers increased power and the effects of the intervention were robust producing statistically significant findings.

5. Conclusions

The majority of doctoral nursing students require scientific writing skill development with wide performance variations in any given cohort. Screening applicants for writing ability at entry could result in the unnecessary exclusion of qualified applicants whose writing performance, though in need of development, is consistent with students nationally. Using the SWA, scaffolding assignments, and consistent feedback throughout the program were effective methods for skill acquisition in DNP students in a post-Master's program. The results of this study also demonstrate the need for a scientific writing rubric to supplement content-focused rubrics to improve skill mastery and writing efficiency.

Declaration of competing interest

The authors declare no conflicts of interest.

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