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The quicksand of stewardship: A qualitative study of antimicrobial learning during clinical placements in European nursing education

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ABSTRACT

Aim: Investigate how undergraduate nursing students experience antimicrobial stewardship learning during clinical placements in two European countries.
Background: Nurses are vital but underused actors within antimicrobial stewardship interventions. Prior research has identified major gaps in undergraduate, university classroom-based antimicrobial stewardship education, yet how nursing students translate this learning during clinical placements remains unexplored.
Design: Qualitative design.
Methods: Semi-structured interviews conducted with 17 undergraduate nursing students (ten from the United Kingdom and seven from Spain) between 2023–2025. Data were analysed using reflexive thematic analysis. Rigour was enhanced through bilingual coding, peer debriefing and ongoing interpretive reflection.
Results: Students, across multiple educational and clinical contexts, found themselves navigating what we describe as an 'educational quicksand', a shifting terrain shaped by hidden curricula and systemic opacity, a disorienting and fragmented learning space marked by unclear roles, minimally structured teaching, workload-driven deviations in practice and sparse opportunities for reflection or interprofessional learning. Overall, four interconnected themes emerged: (1) antimicrobial stewardship is marginalised in both practice and pedagogy; (2) learning is self-directed and fragmented; (3) embodied learning and the role of modelling: between hesitation and enactment; and (4) students aspire to stewardship roles despite systemic constraints.
Conclusion: Across the two study settings, nursing students hover at the threshold of stewardship, constrained by comparable structural gaps, implicit curricula and unclear role boundaries. Embedding antimicrobial stewardship within mentorship, interprofessional dialogue and assessment frameworks could help students move more confidently through this 'quicksand' and support the development of antimicrobial stewardship as a core nursing competency.

1. Introduction

Antimicrobial resistance (AMR) is a pressing global health challenge, with ~39 million deaths attributable to resistant infections estimated over the next 25 years (Naghavi et al., 2024). The overuse and misuse of antibiotics across human medicine, animal agriculture and environmental systems continue to accelerate the development and spread of resistant organisms, complicating health treatments and undermining decades of medical and public health progress (Aslam et al., 2024; Trinchera et al., 2025). In response, antimicrobial stewardship (AMS)

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has emerged as a key strategy, promoting the responsible use of antimicrobials through coordinated, evidence-informed interventions (Dyar et al., 2017).

However, successful AMS depends on the engagement of all healthcare professionals and not just prescribers (Karnwal et al., 2025). There is growing recognition that nurses have important roles in stewardship efforts (Castro-Sánchez, 2024), administering antibiotics, monitoring therapeutic responses and adverse effects and communicating with patients (Bos et al., 2023; Gotterson et al., 2021). The contribution of nurses to AMS remains however under-recognised in policy, research and education.

This omission is particularly consequential for nursing students, who represent the future workforce and whose education is equally shaped by academic, classroom-based learning and the application of such learning during clinical placements. In the European Union, undergraduate nursing education is mandated to 2300 hours of theorical education matched with 2300 hours of supervised clinical practice (*Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the Recognition of Professional Qualifications [2005] OJ L 255/22*, n.d.).

Although many nursing curricula include modules on pharmacology, translation of this knowledge into effective antimicrobial stewardship practice remains inconsistent (Courtenay et al., 2022; Lim et al., 2021), questioning current pedagogical and practical preparation for stewardship practice (Castro-Sánchez et al., 2016; Rout et al., 2021; Catanzaro, 2022; Manning et al., 2022; Courtenay et al., 2019). Importantly, research hitherto has predominantly focused on classroom-based learning, with comparatively limited attention to how AMS is encountered, interpreted and enacted in real-world clinical environments (Zulu et al., 2021).

Clinical placements are intended to consolidate theoretical learning into professional competence, yet they often lack structured opportunities to develop competences (Ravik et al., 2025). However, learning during placements is often fragmented, opportunistic and implicit, shaped by local practices and hierarchies rather than structured pedagogical approaches (Zulu et al., 2021). Without clear learning outcomes or consistent supervision, clinical placements may reinforce views that stewardship is peripheral to nursing (Filipe et al., 2025). In such contexts, AMS may remain conceptually invisible, embedded within routine tasks but rarely articulated or critically examined.

To our knowledge, no published qualitative study has examined AMS clinical learning across multiple national nursing education systems. This study addresses this gap by exploring how undergraduate nursing students in two European countries (United Kingdom and Spain) experience AMS learning during clinical placements. These countries offer a productive comparative pairing: both operate under the EU Directive (2005)/36/EC), yet differ substantially in competency frameworks and clinical placement governance. Examining these dynamics across two distinct but structurally comparable settings would reveal whether the conditions shaping AMS learning are context-specific or hold across systems, informing strategies for embedding AMS within nursing education.

2. Methods

2.1. Design

We adopted a qualitative approach informed by an interpretivist paradigm (Creswell and Poth, 2024) to explore patterns of AMS learning among undergraduate nursing students. Interpretivism holds that social realities are contextually situated and constructed through the participant's meanings attached to experience. This is an ontological position well suited to investigating an educational environment characterised by tacit norms and implicit curricula. Epistemologically, this stance treats knowledge as relational and co-constructed by those who experience it. Semi-structured interviews allow depth and flexibility to follow participants' own, rather than imposed, framings.

2.2. Ethics

The research was conducted in accordance with the Declaration of Helsinki and relevant national and institutional standards. Ethical approval was granted by Brunel University London (Uxbridge, United Kingdom (UK), 42400-MHR-Oct/2023–47631–1, 15th Nov 2023) and the University of the Balearic Islands (Palma, Spain, 055CER25, 19th Nov 2024). All participants provided written informed consent at least 24 h after notifying the researchers of their interest in the study.

2.3. Participants and recruitment

Participants were purposively recruited through academic contacts, institutional networks and voluntary responses to study invitations disseminated before and after lecturers, as well as through social media, where permitted by ethical approvals. Recruitment sought diversity in the year of study, geographical setting and clinical placement experience. Seventeen undergraduate nursing students participated, ten from UK and seven from Spain, all from public universities. As per inclusion criteria, all participants had completed at least one clinical placement in any clinical environment, i.e. hospital wards, primary care and community settings. In practice, most had undertaken multiple substantive placements, offering varied insights into antimicrobial stewardship learning across clinical contexts.

2.4. Data collection

Semi-structured interviews were conducted by the research team (one male, one female, both nursing faculty, with prior qualitative research experience) via secure institutional online platforms (MS Teams) between March 2023 and May 2025. A shared topic guide explored students' exposure to antibiotic use, perceptions of antimicrobial stewardship, role boundaries, interprofessional learning and barriers to applying stewardship principles (Appendix A). Interviews lasted 35–55 min, were audio- and video-recorded with consent and were automatically transcribed verbatim using the transcription tool integrated in the platform. All transcripts were reviewed by the principal investigator against the video recordings and necessary corrections made. Spanish interviews were conducted and coded in their original language (researchers are Spanish, bilingual Spanish/English and one of them a migrant from Spain to the UK for 25 years). All data were anonymised and managed in accordance with the EU General Data Protection Regulation (GDPR) and institutional data protection policies. Interviewers also took contemporary notes, with one of the researchers allocated as rapporteur for each interview to note salient emotions, silences, or language used.

2.5. Analysis

Data were analysed using reflexive thematic analysis following Braun and Clarke's approach (Braun and Clarke, 2021). This method is aligned with the interpretive paradigm, affording subjectivity as an analytical resource to be surfaced, rather than eliminated. Transcripts were coded inductively to identify patterns of meaning and codes were iteratively developed into higher-order themes through iterative discussions with the research team. Spanish data were analysed bilingually, ensuring fidelity to linguistic nuances. Data collection and analysis occurred iteratively, allowing for the development of rich conceptual insights and nuanced interpretation of participants' experiences. We paid attention to minority viewpoints and divergent cases to avoid premature closures. Researcher reflexivity and memo writing supported analytical transparency. The research team held several meetings online to discuss emerged themes as well as explore positionality and reflexivity. Data management and coding were supported by NVivo 14 (QSR

International), facilitating systematic organisation of the analytical process.

3. Results

The analysis revealed four interrelated themes that describe how nursing students perceived, enacted and internalised antimicrobial stewardship during their clinical placements (Fig. 1, Appendix B). Rather than explicitly taught or consistently supported, stewardship emerged as a set of tacit, embodied and often ambiguous activities, shaped by local ward routines and interpersonal dynamics. Across both countries, students described fragmented learning, limited role modelling and unclear professional boundaries regarding stewardship.

Despite these challenges, many participants expressed strong ethical commitments to optimal antimicrobial use. Together, these findings highlight a clinical learning environment where antimicrobial stewardship is present but conceptually obscured, a phenomenon we term the 'quicksand of stewardship'. The following sections outline the four themes, each illustrated with verbatim excerpts from participants (UK participants labelled as UK+number and Spanish participants as ES+number).

1. Antimicrobial stewardship is marginalised in both practice and pedagogy

   Antimicrobial stewardship appeared marginalised in both clinical practice and structured nursing education. During placements, students often engaged in activities central to antimicrobial stewardship, such as administering antibiotics or conducting urinalysis, but these were rarely framed as stewardship or even connected to broader concerns about AMR or prescribing practices. As one participant reflected, "*I've never heard that term on placement*", even though they recalled hearing staff's "*caution around prescribing antibiotics.*" (UK01).

   For many, these actions felt disconnected from any explicit conceptual or educational framework, revealing the implicit and often invisible nature of antimicrobial stewardship in everyday nursing work. This disconnection was not isolated and other participants also experienced a clear contrast between university teaching and clinical practice. One student noted that the term 'antimicrobial stewardship' was pushed "*quite hard by the university*," yet in "*practical placements, I'd say that [hearing about* antimicrobial stewardship*] was a hard 'no.'*" (UK04). A Spanish participant echoed this disjunction:

   "In the university we have seen the topic of antibiotics… but then in the hospital in practice, in the end, it seems to me that it is a bit blurred." (ES07).

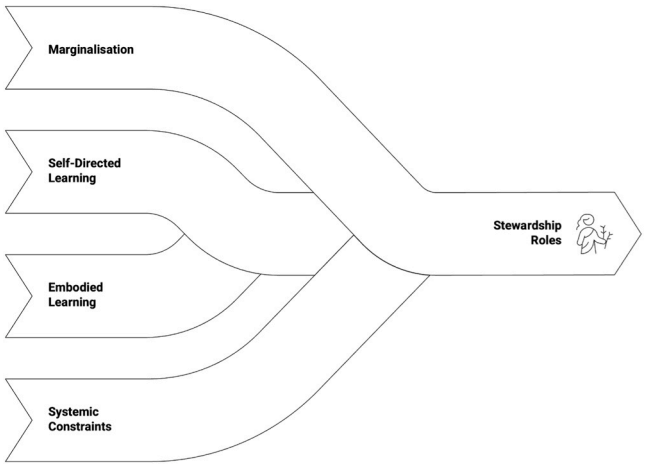


Fig. 1. Core themes characterising antimicrobial stewardship learning in undergraduate nursing students.

The learning experience in Spain reflected an additional angle; antimicrobial stewardship was indeed mentioned during university lectures, as noted, but as it was not included among the contents assessed, it was simply not prioritised by students and just faded away: *"It is not evaluated so you don't prioritise [its learning]."* (ES02). Such silences exemplify the hidden curriculum through which nursing students learn what aspects of care are valued, visible, or left unspoken. These reflections illustrate how assessment-driven learning and hidden curricula reinforce the marginalisation of antimicrobial stewardship in nursing education.

This marginalisation deprived students of stable anchors for understanding stewardship's relevance to their roles, further disconnecting theoretical and practical knowledge: *"At the faculty it is very theoretical yet seen very superficially, in the sense of pharmacology and that's it… [in practice] you learn it as you go."* (ES06). Another participant reinforced this contrast between academic ideals and bedside realities:

"Theory is the ideal world, perfection… but sometimes you can't apply pure theory as it is. You have to adapt to the situation." (ES04).

Their reflections extend the Spanish students' sense that theoretical preparation feels detached from the contingencies of practice, illustrating how adaptation becomes a normalised professional expectation rather than an exception. In these accounts, stewardship was not absent because students were not participating in it, but because it was never named, contextualised, or made visible: "*The nurse just said, 'Give it [the antibiotic] now,' and that was it*" said participant UK01. Similarly, student UK03 recalled: "*You draw it [the antibiotic] up, you give it… but you don't know the story behind it.*" And other participants focused on how administering intravenous antibiotics was treated as just another routine task *("a job"),* with oral antibiotics: "*put in the same sack as any other medication.*" (UK07).

This invisibility reflects not just an absence of stewardship, but its silent operationalisation, embedded in routine nursing tasks yet conceptually obscured. Antimicrobial stewardship becomes absorbed into the mechanics of care, carried out without reflection or recognition, focused solely on procedural correctness ("*just confirming the drug or [the patient's] identity*", UK04), but with no discussion of "*different classes of antibiotics. How do they work? What the side effects are."* (UK04). Implicit curricula and hierarchical norms sustain an environment where stewardship is enacted but seldom critically understood, constraining students' sense of ownership and professional agency.

2. **Learning is self-directed and fragmented**

   Across both settings, antimicrobial stewardship learning was not only self-directed but fragmented, developed largely through personal initiative rather than structured teaching. As one participant noted that understanding antibiotics was "*up to us*," built on "*self-directed knowledge*" developed alone using textbooks or the British National Formulary (UK01), reiterating a pattern of *learning by doing* rather than by guided instruction. In Spain, student ES07 described investigating a patient's iatrogenic event during vancomycin administration because, as they put it, competence development *"comes from clinical practice"*. Learning depended on motivation and chance rather than intentional pedagogy.

   This passive, unstructured, *ad hoc* and fragmented learning process generated frustration among students and an experience entirely reliant on the individuals (both mentors and students), with much potential for confusion from conflicting advice. One Spanish participant captured this "quicksand" effect vividly:

   "the nurse I was with… would tell me to do it one way and another [nurse] would tell me [to do it in] another [way]". (ES05).

   A UK student (UK05) likewise observed "*a lot of difference and beliefs*" among nurses, recalling contradictory advice about glove use and antibiotic administration. Such inconsistencies left students to

negotiate competing norms, sometimes internalising unsafe or outdated practices: *"It [practice] changed several times during that placement,"* with even [a nurse] *"wash[ed] her hands with the gloves on underneath the tap."* (UK10). In the absence of clear guidance and shared standards, antimicrobial stewardship learning becomes an improvised and routinised rather than evidence-based practice.

A particularly illustrative examples of these incohesive learning, teaching and practice is urinalysis, by now a clinical ritual, frequent and confidently executed, but rarely explained:

"The nurses will do the dipstick and if it shows blood or high white cells, then they send it for culture." (UK08)

"To start with you just do the dipstick and that kind of tells you the person's got an infection." (UK09).

However, students were not told "*what to do with the results*." (UK03). Sometimes, students did internally question this use of urinalysis. "*If the urine was cloudy or smelly, some nurses would just send it off*." (UK07), but "*a lot of the urinalysis we do is inappropriate, because most of the time the patient's just dehydrated*" (UK01). However, particularly in the Spanish context, student nurses opted for (although not preferred) avoiding questioning authority, under the weight of social and professional power dynamics: *"I can't say anything to them… I, as a student, am nobody to tell them anything." (ES02)*. This routine, unexamined and normalised, exemplifies how clinical rituals can obscure critical reasoning and reinforce passive learning within stewardship practices.

In terms of antibiotics and gloves, rather than receiving structured instructions on antibiotic handling, many students had to navigate safety practices alone or absorbing *ad hoc* messages from colleagues: *"We had to wear gloves to give antibiotics because they could be absorbed through our skin"* (ES05), without any formal explanation of the pharmacological basis for this claim, as (ES04) reported: *"I thought it was dangerous to touch it without gloves, in case something got through the skin, but no one explained anything.* This assumed transmission of risk was echoed in the UK: *"Someone said that we had to wear gloves when giving antibiotics because it could go through the skin"* (UK06).

The absence of consistent, evidence-informed explanations, if necessary, would also have implications for emerging themes in antimicrobial stewardship and clinical practice such as environmental sustainability. Overall, these accounts exemplify how learning around antimicrobial stewardship, especially safety, pharmacology and risk, is often built from inference and rumour rather than evidence-based teaching, highly contingent, uneven and dependent on improvisation rather than structured supervision from mentors.

3. **Embodied learning and the role of modelling: between hesitation and enactment**

As already suggested, students described antimicrobial stewardship learning as deeply embodied and formed through physical tasks, role modelling and relational dynamics. Where learning succeeded, students observed trusted mentors enacting broad principles in real-time: "*When you see a nurse flush the line and explain why, it sticks*." (UK08). Similarly, Spanish students highlighted role models who verbalised reasoning: "*Dilute that antibiotic in 50 [mL] because it dissolves better and it doesn't stay so condensed."* (ES02). These moments transformed routine tasks into teachable stewardship practices, anchoring students' knowledge in concrete examples of thoughtful clinical decision-making.

Conversely, the absence of such modelling disrupted students' ability or confidence to speak up when they felt something seemed wrong: "*I thought, maybe it's not my place to say anything.*" (UK09); *"[That approach] it's just so normalised that nobody questions themselves about it.*" (ES03). Together, these accounts reveal an embodied insecurity, a sense of responsibility for stewardship felt by students which were not socially permitted to express. This tension carried and emotional and ethical toll and struggle, needing to be *'proactive'* in seeking learning opportunities while also feeling pressurised not to *"question things because that's what was done.*" (UK01). Such reflections illustrate how, interpreted through a hidden curriculum lens, students appeared to internalise conflicting expectations — wanting to intervene while learning to remain silent — in ways that may have contributed to early professional identity formation. Whether this shapes professional identity in a durable sense is beyond the scope of a single-interview design.

Power dynamics further inhibited questioning. Reflecting on urine-analysis practices, a Spanish participant further explained why they did not question a mentor's practice, articulating well this pressure to conform and the reluctance to question authority, even under reservations about the mentor's practice: *"Maybe for fear that they would take it badly, that they think I am a bit arrogant… or so as not to bother them."* (ES07).

While the narratives often resembled a 'quicksand' in the learning environment, there were however positive role models and influences that serve as a counter-narrative. Student UK01 mentioned being *"really lucky with a few good senior nurses*." who acted as 'oases of stewardship,' providing students with the guidance and support often missing from the broader educational environment. Their positive role-modelling not only validates the students' learning in classroom but also demonstrates how to enact good antimicrobial stewardship teaching in a clinical setting and the profound and lasting impact that, despite systemic challenges, individual mentors can have on a student's development.

4. **Students aspire to stewardship roles despite systemic constraints**

Despite the marginalisation and ambiguity, students articulated strong ethical commitments to responsible practices, suggesting a deep, but often unrecognised, aspiration to enact stewardship: *"You want to feel you're not just a pair of hands*" (UK02), or *"We really want to do well the right thing, but nobody teaches us how to do that"* (ES06). These values motivated some students to ask questions, seek information and reflect on clinical practice decisions, always careful not to look too judgemental, even when doing so meant operating without clear support. The absence of visible role boundaries, formal guidance, or curricular scaffolding left many unsure of how to progress such aspirations: "*Sometimes I try to look things up after the shift, but there's no one to confirm if I've understood right*." (UK05).

Structural hierarchies and cultural norms constrained students' ability to act on their stewardship concerns*: "Telling a doctor that something is prescribed incorrectly seems unrealistic… nobody really stops to think about it."* (ES01) This observation exemplifies the normalisation of silence within placement hierarchies, where questioning antimicrobial decisions feels beyond a student's remit. Yet they also expressed a growing moral awareness of antimicrobial resistance: *"Antibiotics command a lot of respect from me… I've seen much resistance, multi-resistance and I don't think it's given the importance it deserves*." (ES05).

The lack of consistent, individualised educational guidance, effectively a learning bottleneck, was buffered via social and collective support which, unfortunately, could also be a double-edged sword. Student ES02 emphasised the role of teamwork in overcoming the 'quicksand' effect, mitigating fragmented learning and individual insecurities: *"you can ask for advice"*. However, when a team did not facilitate such learning, or made it difficult to "integrate" theoretical ideals with the realities in practice, students described constantly feeling *"in the end… you have the fear of doing something wrong."* (ES02).

These narratives reveal a paradox: students internalise stewardship almost as a moral imperative but lack the systemic backing to act decisively.

4. Discussion

Our study offers insights into how undergraduate nursing students experience antimicrobial stewardship during their clinical placements across two European settings. Participants consistently experienced antimicrobial stewardship learning as unstructured, fragmented and socially mediated. The metaphor of 'educational quicksand' captures the shifting and uncertain landscape on which stewardship knowledge is constrained: expectations are opaque, learning is self-directed and responsibilities are unevenly distributed. Instead of clear pedagogical pathways grounded in interprofessional norms and stewardship science, students find themselves wading through an unstable field of rituals and silences, where tacit routines dominate and clarity emerges sporadically.

The first theme, essentially the hidden curriculum of stewardship, illustrates how AMS remains absent in name but present in practice. Actions such as urinalysis, swabbing, or antibiotic administration were performed as unremarkable tasks, rarely accompanied by reflection or explanation. The embedment of these tasks as antimicrobial stewardship was largely absent, neither consistently recognised as a core competency nor prioritised within supervision or assessment. Overall, this aligns with evidence on poorly defined and undervalued nursing contribution to antimicrobial stewardship (van Huizen et al., 2021). The lack of explicit language and conceptual anchor points limited students' ability to identify, articulate or make sense of stewardship within their developing professional identity.

These findings are also consistent with a growing body of literature highlighting the influence of hidden curricula and informal learning processes in shaping clinical practice (Hosseini et al., 2023; Raso et al., 2019), as well as the persistent disconnect between theoretical antimicrobial stewardship education and its application in practice (Manning et al., 2022; Sumner et al., 2018). However, our findings extend this literature by showing how the invisibility of AMS is actively sustained through tacit norms, routine practices and hierarchical dynamics within clinical placements, even in contexts where stewardship is formally emphasised within curricula and policy frameworks.

Students frequently engaged in improvised and self-directed learning strategies, drawing on mobile applications and peer discussions in the absence of structured support. This was particularly evident around urinalysis, reflecting broader diagnostic stewardship concerns regarding the normalisation of low-value testing (Strebe et al., 2025; Laan et al., 2021). The normalisation of these unexamined practices early in training highlights how entrenched routines can overshadow later evidence-based reasoning despite evolving policy frameworks, reinforcing the influence of tacit norms and informal learning over formal guidance.

Rather than entering clinical training as neutral learners, many students had prior exposure to healthcare environments, most commonly as healthcare assistants in the UK, or as laboratory technicians in Spain. This early exposure socialised students into existing routines and misconceptions surrounding antibiotics and may shape students' developing professional identities and readiness for practice, consistent with literature on professional socialisation and transition shock (Duchscher and Windey, 2018). In this context, fear of "doing something wrong" emerged as a significant emotional driver, constraining students' confidence and willingness to question established practices unsupported by evidence.

This relational nature of antimicrobial stewardship education is captured by this informal learning from trusted mentors, in line with theories of situated learning (O'Brien and Battista, 2020; Lave and Wenger, 2012) and evidence on role modelling in nursing (Baldwin et al., 2014). Where mentors verbalised their decision-making, students anchored that reasoning and linked it to action. Conversely, the absence of such modelling positioned student within institutional and team hierarchies where decision remained unquestioned (Bonaconsa et al., 2021; Charani et al., 2013). Silence, prompted by hierarchy, uncertainty, or fear of negative judgement, proved as formative as observable action.

The final theme highlights students' ethical motivation to contribute meaningfully to antimicrobial stewardship despite systemic barriers. Many participants went beyond formal requirements to learn more, as reported previously, showing that nursing students are motivated to engage in stewardship if and when given the opportunity (Chater et al., 2022). Yet gaps between role expectations and educational preparation, particularly evident in Spanish context, left students feeling underprepared. Without structural support, professional readiness remains aspirational rather than actionable (Lim et al., 2024; McGarity et al., 2023).

These themes suggest that antimicrobial stewardship learning is not experienced as a clearly defined or systematically delivered component of nursing education, but rather an emergent and uneven process shaped by access to mentorship, local practices and implicit norms. The 'educational quicksand' metaphor captures this instability: while moments learning and clarity exist, they are inconsistent and highly dependent on individual clinical environments rather than structured educational design. Educational models such as situated learning and communities of practice could support redesign efforts to make antimicrobial stewardship reasoning explicit, legitimate and socially grounded (Stoffels et al., 2022).

These findings also carry direct implications for three audiences. For universities and nurse educators, treating AMS as a knowledge domain alone would be inadequate. AMS content that is taught but not assessed is systematically deprioritised by students (Theme 1). Embedding AMS within formative and summative clinical placement assessments, rather than confining it to pharmacology lectures, would elevate its status as nursing competency. Simulation-based scenarios and structured preparation of clinical mentors in AMS represent feasible and evidence-supported routes (Manning et al., 2022; Bonacaro et al., 2024; Camerini et al., 2024).

For clinical learning environments, the study highlights the formative power of role modelling (Theme 3). Services that embed AMS champions as named contacts for student placements and that designate interprofessional AMS case discussions as a routine placement activity, could disrupt the transmission of rituals documented here. For national and regulatory bodies, the consistent gap between the aspirational AMS framing in nursing competency frameworks and the lived reality of placements suggests that structural accountability is missing. Recommendations to include AMS-specific competencies within placement documentation would create the scaffolding students identify as absent. The convergence of this pattern across UK and Spain suggests the problem is not idiosyncratic to one health system.

Strengths and limitations

This study has several strengths. The dual-country design provides comparative grounding across two nationally distinct but structurally comparable nursing education systems, extending the reach of findings beyond a single context. Purposive sampling sought diversity, supporting theoretical breadth. Bilingual data collection and coding avoided translation artefacts. The extended recruitment period captured accounts from successive cohorts, rather than a single moment in time. The use of reflexive thematic analysis, with ongoing memo writing and team discussion of positionality, supported analytical rigour.

Several limitations should also be acknowledged. The sample, while appropriate for qualitative inquiry, cannot support claims of representativeness. Transferability to other contexts would be affected by sociocultural and professional conditions. The study relies on self-reported accounts from students; triangulation through observation or mentor perspectives would deepen understanding of real-world stewardship. Variations in placement settings, local AMS governance and mentorship quality across and within sites may have shaped experiences in ways not fully captured. Finally, students' prior healthcare experience and stage of training may also have influenced how stewardship was perceived

and articulated.

In contrast to earlier studies which focused primarily on knowledge gaps, which may have indeed existed and even remain, our findings point to structural and pedagogical deficits, particularly in how antimicrobial stewardship is situated within clinical workflows, placement cultures and nursing identity formation. Addressing these issues may require not only curriculum revision and development, principal driving forces in antimicrobial stewardship education reform until now, but also the redesign of the structural and cultural conditions that make stewardship visible, relevant and actionable for future nurses. The convergence of themes across two nationally distinct contexts suggests that the 'educational quicksand' may not be context-specific and warrants investigation across a broader range of nursing education systems.

CRediT authorship contribution statement

Aina Huguet-Torres: Writing – review & editing, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Enrique Castro-Sánchez:** Writing – review & editing, Writing – original draft, Supervision, Software, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Miquel Bennasar-Veny:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis. **Yáñez-Juan Aina:** Writing – review & editing, Supervision, Project administration.

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Declaration of Competing Interest

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Appendix A. Topic guide

Objective 1: Exploring the professional, organisational and team drivers of AMS education during placements, highlighting inconsistencies or misalignments

- Have you heard of the term 'antimicrobial stewardship'?
- Can you tell me about the different ways in which you have learned about antimicrobial stewardship during your clinical placements?
- What do you think are the most important things that nursing students need to learn about AMS in class and during clinical placements?
- If you think about the learning you have gained during your clinical placements, how aligned would you say that it is with the AMS education that you have received in the classroom?

Objective 2: Investigating what information, education and roles about AMS if any are transmitted to nursing students on clinical placements

- What information about AMS do you feel you have received during your clinical placements?
- Can you give me examples of how this information has been delivered to you?
- Thinking about the multidisciplinary team and AMS, who have you learned from?
- What roles do you think that nursing students and nurses in general play in antimicrobial stewardship?

Objective 3: Characterising experiences surrounding AMS for nursing students, together with their views on this process and experience

- What have been your experiences of learning about and acting as an AMS steward during your clinical placements?
- How have you felt supported in your role as an AMS steward?
- What are your views on the overall process and experience of learning about and acting as an AMS steward?

Objective 4: Identify whether these experiences of learning are consistent across placements

- Compared with other students in your set, would you say that you have similar experiences to them regarding your learning about AMS?
- If so, what are these differences?
- How do you think these differences affect nursing students' learning about and experience of AMS?

Objective 5: Identifying potential areas for improvement and co-develop interventions with nursing students

- What suggestions do you have for improving the education and support that is provided to nursing students on antimicrobial stewardship in classrooms and during clinical placements?
- Are there any specific interventions that you think would be helpful?
- What are your thoughts on the feasibility of implementing these interventions?

Appendix B. Selected illustrative participant quotes by analytic theme and subtheme

Theme	Subtheme	Description	Illustrative quote
1. AMS is marginalised in both practice and pedagogy	Invisibility in clinical discourse	AMS-related actions (e.g. administering antibiotics) occur without explicit naming or framing.	*"I've never heard that term [AMS] on placement."* (UK01) *"Never heard about this stewardship, you know, combined with the antibiotic."* (UK03) *"At university we did cover the topic of antibiotics… but then in the hospital, in practice, it ends up a bit blurred."* (ES07) *"It's treated like a job. You give it [antibiotic] and that's it."* (UK07) *"IV antibiotics are seen as urgent, but no one explains why. You just give them within the golden hour."* (UK01)
	Absence in university teaching	AMS is rarely addressed in formal curricula or assessments, leaving students conceptually adrift.	*"The term AMS was pushed quite hard by the university—but in practical placements, that's a hard no."* (UK04) *"At the faculty it is very theoretical and superficial, just*

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Theme	Subtheme	Description	Illustrative quote
			pharmacology" (ES06)
2. Learning is self-directed and fragmented	Reliance on informal resources	Students seek out guidance through peer learning, apps and informal questioning due to lack of formal scaffolding.	*"It is not evaluated, so you don't prioritise it."* (ES02) *"It's up to us… self-directed knowledge that I've like cleaned myself… going away and trying to develop understanding alone."* (UK01) *"Revise as well of study… I had to read more about these antibiotics [in the BNF, British National Formulary]."* (UK09) *"[Most learning] comes from clinical practice"]* (ES07)
	Urinalysis as an unquestioned ritual	Dipsticks and urine cultures are used routinely without clear rationale, often prompted by non-specific signs.	*"Poor urine output… murky… very offensive… would always be sent to the lab."* (UK04) *"Now I think, why am I dipping? It's just because they're confused?"* (UK07) *"[urine analysis] It's more or less automatic; in the end, I think that after seeing so many people you just say, right, I think this person yes, this person no and based on the judgement of whoever is doing it, they either do it or they don't. But I think that in general, yes, it's something that's a bit automated."* (ES03)
3. Embodied learning and the role of modelling: between hesitation and enactment	Learning through role modelling	Students learn best when mentors verbalise decisions and include them in stewardship thinking.	*"When you see a nurse flush the line and explain why, it sticks."* (UK08) *"Sometimes you're lucky and the nurse will explain why the patient's on it."* (UK06) *"She made me look at the medication sheet and explained the timing of administering the antibiotic."* (UK10)
	Insecurity and deference in stewardship decisions	Students fear challenging authority, even when they sense a decision may be inappropriate.	*"I thought, maybe it's not my place."* (UK09) *"It didn't seem right to me, but I also wasn't sure if I was wrong, so I did it."* (ES05) *"They just told me to do it—I didn't ask why."* (UK02)
4. Students aspire to stewardship roles despite systemic constraints	Desire for understanding and responsibility	Students express strong intrinsic motivation to contribute meaningfully to safe and effective AMS.	*"I wanted to know why they were giving that antibiotic, but no one explained it. In the end, I looked it up myself."* (ES04) *"It's up to us… self-directed knowledge that I've like cleaned myself."* (UK01) *"I wanted to understand what went wrong, so I investigated it myself."* (ES07)
	Systemic under-preparation and frustration	Participants feel let down by gaps between their ethical intentions and the support provided.	*"I didn't know if I was doing it right, because no one explained anything to me about it." (ES05)* *"At university it is very theoretical and superficial."* (ES06) *"It's basically give as directed… nothing on how they work or the side effects."* (UK04)

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