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Inclusive Pharmacology: Using Objective Structured Practical Examinations (OSPEs) to Identify Knowledge Gaps in Pharmacology Undergraduates

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Abstract

This paper explores the learning benefit of an inclusive Objective Structured Practical Examination (OSPE) in a second-year biomolecular integrative pharmacology course to identify gaps in student knowledge and evaluate their confidence in applying their knowledge in the laboratory setting. The OSPE was co-designed through incorporating input from students and staff. Its introduction aimed to aid formative feedback as students transition from different levels of pharmacology study. While further research is needed to fully evaluate the long-term impact of this approach across our student cohorts, this project suggests that OSPEs can effectively identify key gaps in student practical skills and provide valuable feedback on how improvements can be made in an applied pharmacology setting. We anticipate that wide-spread sharing of best practices learned from different OSPE formats will be an inclusive educational resource for the wider pharmacology educator community who must teach the discipline as part of an integrated curriculum.

Keywords: *Higher education, Pharmacology education, Inclusive Assessment.*

1. Introduction and Background

There is growing recognition that inclusive education must meet the needs of all learners (Koenig & Tucker, 2025), a principle that strongly aligns with Education for Sustainable Development (ESD). While higher education plays a vital role in advancing ESD, creating a truly inclusive environment for diverse student populations remains a struggle. Scientific literacy is a critical component of ESD, emphasising the crucial role of education in promoting

a more sustainable future (Iyengar & Caman, 2022). However, integrating ESD principles, particularly within STEM fields, imposes significant challenges, including the need for inclusive educational practices that facilitate deeper student learning. In Howell (2021), active learning (AL) is highlighted to be a practice that enables higher-cognitive levels through problem-based tasks, inherently integrating ESD principles and promoting critical thinking. Given that AL is an umbrella term for pedagogical techniques that engage students in an activity, encouraging them to reflect upon material and how they are using that material (Linton et al., 2014), Objective Structured Practical Examinations (OSPEs) can be considered an AL technique and have been used in combination with problem-based learning (PBL) and competency-based pharmacy (Dymek et al., 2022). These approaches require students to apply knowledge practically, fostering deeper cognitive processing beyond surface-level recall.

As Batty & Reilly (2022) highlight, despite increased diversity in UK higher education institutions (HEIs), STEM fields often fail to create inclusive environments, particularly within the laboratory. Ensuring the inclusivity of the UK pharmacology curriculum is a key objective, by addressing decolonisation, democratisation, diversification, and accessibility (Tucker et al., 2022). This aligns with the broader understanding that inclusive education must be accessible to all students, whilst also meeting the needs of specific groups (Bain, 2023). One way to achieve this is by identifying and integrating core concepts (CCs) and associated sub-concepts within pharmacology (Guilding et al., 2023). CCs offer a framework for inclusive pedagogy therefore effective integration necessitates inclusive assessment strategies. Assessments are key to student learning, offering feedback and identifying knowledge gaps (Bain, 2023). This study develops a second-year biomolecular pharmacology OSPE to pinpoint knowledge gaps as part of their introduction to CCs in pharmacology. Literature supports that practical application enhances learning (Brinkman et al., 2018), potentially increasing attainment and deepening understanding, which CCs can structure within inclusive assessments.

1.1. Aligning IUPHAR-Ed Core Concepts with Accreditation Requirements within the Evolving Landscape of Pharmacology

The International Society for Basic and Clinical Pharmacology Education (IUPHAR-Ed) Section group (Santiago et al., 2021) has developed a comprehensive list of CCs as a standardised tool for pharmacology curriculum benchmarking. These CCs align with the Quality Assurance Agency (QAA) benchmarks for UK biomedical science programmes (QAA, 2023). Currently being developed are resources for teaching, learning, and assessment (Guilding et al., 2024; Babey et al., 2025; Kelly-Laubscher et al., 2025), informed by identified student misconceptions (Figure 1). This knowledge could help with the development of more inclusive strategies to support the diverse learning needs of different student cohorts who are taught pharmacology. Inclusive assessments cannot be planned in isolation (Bain, 2023) and instead should be integrated into curriculum and refined through feedback. This demands a

collaborative approach that considers various pedagogical considerations, taking all aspects of teaching and learning into account, and translates theoretical frameworks into practical applications. This project highlighted the use of Braun & Clarke's (2006) inductive analysis for identifying course knowledge gaps within OSPE performance data. Furthermore, a well-designed inclusive assessment has the potential to assess the attainment and application of CCs. Simple measures could be achieved by providing extended time for students with additional learning requirements, offering alternative formats, and ensuring clear language in all instructions to accommodate diverse language backgrounds. With the appropriate analysis methods, these assessments can identify misunderstandings, contributing to the development of more effective educational resources.

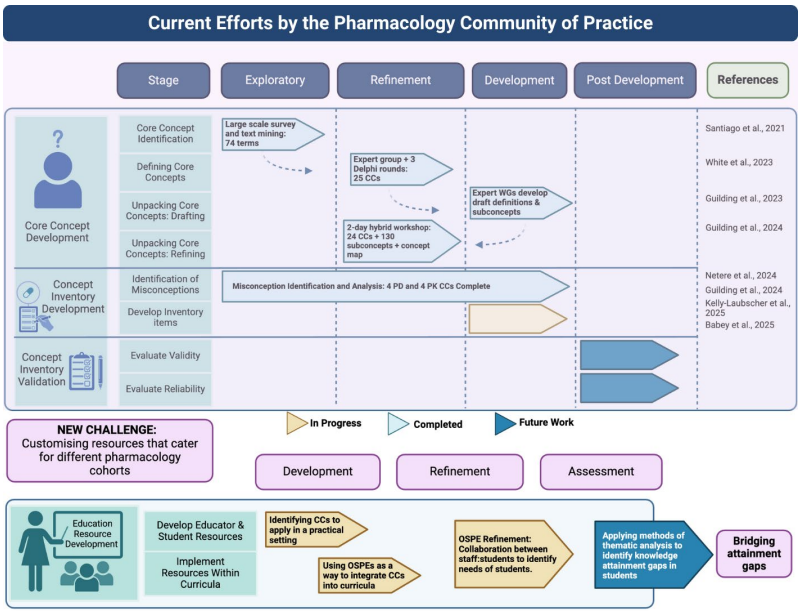

Figure 1. New Challenge: Customising Resources for Diverse Pharmacology Cohorts
The Pharmacology Community of Practice, guided by IUPHAR-Ed, is focusing on core concept development. The 'New Challenge' panel highlights a shift towards tailored resources for diverse cohorts to support application of concepts in the practical setting. Figure created in BioRender.

2. Moving Towards an Inclusive Curriculum

Through acknowledging the diversity within the pharmacology community, the British Pharmacological Society (BPS) is committed to innovating pharmacology teaching by making it more inclusive and equitable (Tucker et al., 2022). Beyond the UK, a professional network called the Teaching Innovation Network in Pharmacology (TINP) has advanced pedagogical

practices towards innovative ways of teaching pharmacology, with one of the shared objectives being to encourage critical thinking in students (Baños et al., 2024). The need to move beyond traditional teaching and assessment methods is incentivised by the understanding that assessments often struggle to bridge theory and practice and effectively engage students.

2.1. Implementation of OSPE

Typically used in clinical degrees as a practical assessment, OSPEs provide a versatile foundation for inclusive assessment. They provide an objective framework that allows students to be examined on individual practical skills, helping to identify gaps in student knowledge. By determining these gaps, OSPEs have the potential to direct teaching approaches and curriculum modifications through regular feedback between educators and students to enhance student learning (Lakum et al., 2023). Our stationary OSPE (rather than OSPE stations), where students did not move and instead were given individual trays with the necessary equipment, was developed for a second-year cohort of biomolecular pharmacologists (151 students). This format accommodated the large cohort side. With an appreciation for collaboration, our OSPE was developed with consultation between administration staff, PhD students, technical staff and teaching staff (Figure 2).

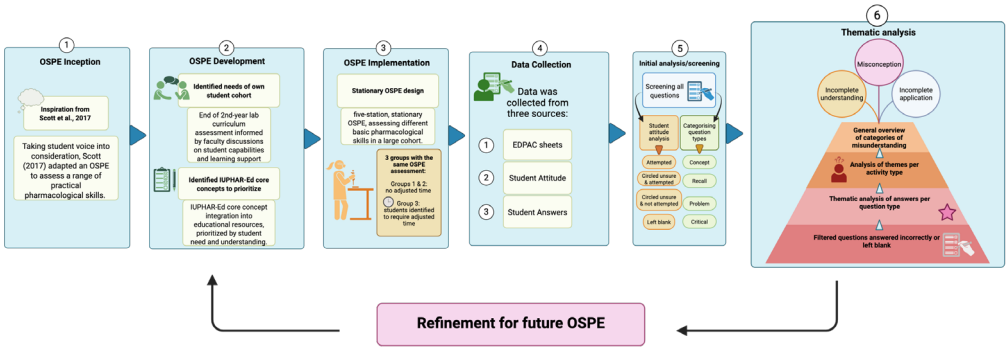

Figure 2. OSPE Development Workflow: Refining and integrating OSPE into the curriculum included identifying misconceptions through various analyses. Students completed the OSPE in three groups. Initial screening explored student attitudes and categorised question types. Thematic analysis then identified key areas of misunderstanding. Figure created using BioRender.

OSPEs have been well received in other degree disciplines (Brinkman et al., 2017), further evidenced in Makwana's (2025) recent study, which revealed 70.84% of students who completed a traditional assessment and an OSPE, one week apart, preferred OSPEs, with only 4% disagreeing. OSPEs also resulted in significantly higher marks. However, it should also be

noted that feelings of 'embarrassment' or 'intimidation' with assessor observation were also acknowledged in that study. This should be considered in OSPE design. To address identified gaps in student skills and knowledge, as observed by teaching staff, this OSPE assessed basic skills, like pipetting, and foundational knowledge, such as dose-response relationships. The OSPE was set as an informal assessment and allowed students to opt out of answering the question by including a 'circle unsure' option, aiming to reduce anxiety around assessment. Technical staff were integral in designing the stationary aspect of this OSPE, and other members of teaching staff were given checklists to objectively assess the students. This approach helped to minimise bias and ensure that all students have an equal opportunity to demonstrate their competence, knowledge and understanding of concepts fundamental to pharmacology. In one of the tasks, (Figure 3), students were first asked to define EC_{50} and then asked to highlight the EC_{50} on a concentration-response curve. This was a fundamental measurement the students had to derived from laboratories across the semester and is an essential term pharmacology students should understand. EC_{50} itself is a sub-concept of CC5: dose / concentration-response relationships and CC8: drug potency. The visualisation of the EC_{50} example used here clearly highlights the diversity in misconceptions across a single student cohort. Out of 151 students who completed the OSPE, 66.2% answered correctly. Out of the 33.8% of students who answered incorrectly, obvious knowledge gaps were identified (Panel B-G), with students unable to estimate EC_{50} placement on a sigmoidal curve (Panel H-I). This highlights the diversity in misconceptions across a single student cohort.

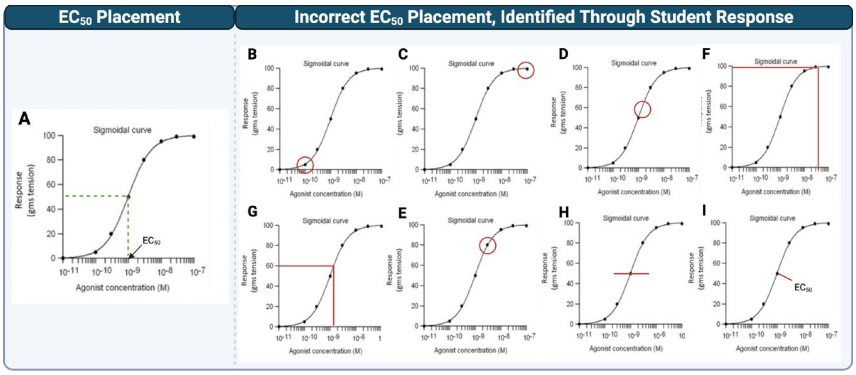

Figure 3. Student representation of EC50 on a Sigmoidal Concentration–Response Curve: (A) Correct EC50 labelling. (B–G) Incorrect labelling, revealing knowledge gaps. (H–I) Technically correct labelling, but explanations showed limited understanding. Figure created in BioRender.

3. Discussion

Our project holds importance for the greater higher education and pharmacology community as OSPEs provide a versatile framework for inclusive educational resources. Given that pharmacology is an ever evolving, multidisciplinary field, it is unsurprising that it is a global struggle to decide how to inclusively teach and assess pharmacology. The expected *information overload* is the result (Guilding et al., 2023), and in turn, there has been an overdependence on traditional didactic teaching and rote learning. As OSPEs are adaptable, they can be tailored to assess a range of fundamental practical skills, learning objectives and competencies. Varying literature supports the use of OSPEs across clinical disciplines, as they can be used for formative and summative assessments (Dhar et al., 2023). OSPEs have received positive feedback both from students and staff (Hultgren et al., 2023). Opinion-based data, gathered from pre- and post-OSPE surveys, can then help to develop future OSPEs further, aiming to improve student experience, engagement and performance overall and will be incorporated into our OSPE as part of future developments. This OSPE effectively identified knowledge gaps in the cohort's understanding of fundamental course content. Building on this knowledge, the development of future OSPEs can integrate the IUPHAR-Ed CCs to identify misconceptions of these.

Using Braun & Clarke's (2006) inductive thematic analysis, we aim to identify any misunderstandings revealed in student responses to OSPE questions. This method, which allows for coding data without preconceived themes, is particularly valuable for exploring the nuanced and complex qualitative data generated by student answers within the practical assessment. By systematically analysing how students articulate their responses and identify potential errors, inductive analysis can pinpoint specific areas of conceptual difficulty. Furthermore, this approach can highlight common behavioural patterns, such as 'competence with a lack of confidence' (Akbari & Sahibzada, 2020), where students possess the knowledge but express uncertainty in their answers. This identification can inform strategies to improve attitudes and inclusivity (Bain, 2023). Scaling OSPEs for larger cohorts or other disciplines that are integrated with pharmacology presents logistical challenges, particularly concerning laboratory space due to their traditional station-based design. Stationary OSPEs, using individual trays, suit basic skill assessments; however, equipping numerous students for advanced skill assessments is a challenge. Individual specialised equipment could hinder sustainable practices.

While our primary focus at this early stage is on exploring the viability of OSPEs as an inclusive assessment tool for identifying knowledge gaps, we recognise the importance of quantitative data and comparative studies for evaluating their effectiveness. Makwana (2025) has demonstrated significantly higher scores with OSPEs compared to traditional assessments, suggesting a positive impact of OSPEs on student performance. Although further research is needed to assess long-term effects, our current findings indicate that OSPEs effectively identify student misconceptions and gaps in understanding of core concepts, while also providing

targeted feedback. This approach has the potential to improve student engagement, enhance learning outcomes, and contribute to a more inclusive and accessible learning environment across pharmacology curricula.

References

Akbari, O., & Sahibzada, J. (2020). Students' Self-Confidence and Its Impacts on Their Learning Process. *Am. Int. J. Soc. Sci. Res.*, 5, 1-15. https://doi.org/10.46281/aijssr.v5i1.462

Babey, A. M., Koenig, J., et al., (2025). Evaluating student understanding of core pharmacokinetic concepts. *Eur. J. Pharm.*, *990*, 177256. https://doi.org/10.1016/j.ejphar.2025.177256

Bain, K. (2023). Inclusive assessment in higher education: what does the literature tells us on how to define and design inclusive assessments?. *J. Learn Dev. High Educ.*, (27). https://doi.org/10.47408/jldhe.vi27.1014

Baños, J. E., Blanco-Reina, E., et al., (2024). Beyond lectures and practical courses: Teaching pharmacology using imaginative pedagogical tools. *Pharm. Res.*, *202*, 107130. https://doi.org/10.1016/j.phrs.2024.107130

Batty, L., & Reilly, K. (2022). Understanding barriers to participation within undergraduate STEM laboratories: towards development of an inclusive curriculum. *J. Bio. Edu.*, *57*(5), 1147–1169. https://doi.org/10.1080/00219266.2021.2012227

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol.*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Brinkman, D. J., Tichelaar, J., et al., (2017). Pharmacology and Therapeutics Education in the European Union Needs Harmonization and Modernization: A Cross-sectional Survey Among 185 Medical Schools in 27 Countries. *Clin Pharm. Ther.*, *102*(5), 815–822. https://doi.org/10.1002/cpt.682

Brinkman, D. J., Tichelaar, J., et al., (2018). Key Learning Outcomes for Clinical Pharmacology and Therapeutics Education in Europe: A Modified Delphi Study. *Clin Pharm. Ther.*, *104*(2), 317–325. https://doi.org/10.1002/cpt.962

Dhar R., Dalvi A., et al., (2023), OSPE as a Method of Learning and Assessment for Undergraduate Practical Pathology versus Traditional Learning and Assessment. *J. Med. Sci Health*, 9(2):146-151. doi:10.46347/jmsh.v9i2.22.445

Dymek, J., Kowalski, T.M., et al., (2022), The influence of OSPE and PBL on competency-based pharmacy student self-assessment. *BMC Med. Educ.* **22**, 190 https://doi.org/10.1186/s12909-022-03246-5

Guilding, C., Kelly-Laubscher, et al., (2023). Developing an international concept-based curriculum for pharmacology education: The promise of core concepts and concept inventories. *Br. J. Clin Pharm.*, 10.1111/bcp.15985. Advance online publication. https://doi.org/10.1111/bcp.15985

Guilding, C., White, P. J., et al., (2024). Defining and unpacking the core concepts of pharmacology: A global initiative. *Br. J. Pharm.*, *181*(3), 375–392. https://doi.org/10.1111/bph.16222

Howell, Rachel. (2021). Engaging students in education for sustainable development: The benefits of active learning, reflective practices and flipped classroom pedagogies. *J. Clean. Prod*. 325. 129318. 10.1016/j.jclepro.2021.129318.

Hultgren, C., Lindkvist, A., et al., (2023). Students' performance of and perspective on an objective structured practical examination for the assessment of preclinical and practical skills in biomedical laboratory science students in Sweden: a 5-year longitudinal study. *J. Educ. Eval. Health Prof.*, *20*, 13. https://doi.org/10.3352/jeehp.2023.20.13

Iyengar, R., & Caman, O. K. (Eds.). (2022). *Rethinking education for sustainable development: Research, policy and practice*.

Kelly-Laubscher, R., Koenig, J., et al., (2025). Evaluating student understanding of pharmacodynamics core concepts. *Eur. J. Pharm.*, *990*, 177257. https://doi.org/10.1016/j.ejphar.2025.177257

Koenig, J., & Tucker, S. (2025). What do We Mean by an Inclusive Pharmacology Education?. *Pharm. Res. Perspect.*, *13*(1), e70050. https://doi.org/10.1002/prp2.70050

Lakum, N. R., Maru, A. M., et al., (2023). Objective Structured Practical Examination (OSPE) as a Tool for the Formative Assessment of Practical Skills in the Subject of Physiology: A Comparative Cross-Sectional Analysis. *Cureus*, *15*(9), e46104. https://doi.org/10.7759/cureus.46104

Linton, D. L., Pangle, W. M., et al., (2014). Identifying key features of effective active learning: the effects of writing and peer discussion. *CBE Life Sci. Edu.*, *13*(3), 469–477. https://doi.org/10.1187/cbe.13-12-0242

Makwana, A. H., Patel, J., et al., (2025). Traditional physiology practical examination versus OSPE in first-year MBBS: A comparative study. *J. Adv. Med. Pharm. Sci. 7*(1), 808-810. https://doi.org/10.47009/jamp.2025.7.1.159

Santiago, M., Davis, E. A., et al., (2021). Defining and unpacking the core concepts of pharmacology education. *Pharm. Res. Perspect.*, *9*(6), e00894. https://doi.org/10.1002/prp2.894

Scott, D. A., & Jenkinson, A. (2017). Adapting Objective Structured Practical Examinations (OSPE's) to assess laboratory science skills. Paper presented at HEA STEM Annual Conference, Manchester, United Kingdom.

Tucker, S. J., Zecharia, A., et al., (2022). Recognising and redressing inequity and bias through pharmacology education: a modern, practical and inclusive curriculum. *Pharmacology Matters*. Retrieved from: https://www.bps.ac.uk/publishing/pharmacology-matters/august-2022/recognising-and-redressing-inequity-and-bias-throu

White, P. J., Guilding, C., et al., (2023). Identifying the core concepts of pharmacology education: A global initiative. *Br. J. pharm.*, *180*(9), 1197–1209. https://doi.org/10.1111/bph.16000

Whitworth, D.E. and Wright, K. (2015), Case study: melding traditional and e-assessment. *Br J. Educ. Technol.*, 46: 1201-1213. https://doi.org/10.1111/bjet.12193

Quality Assurance Agency. (2023). *Subject benchmark statement: Biomedical science and biomedical sciences*. Retrieved from: https://www.qaa.ac.uk/the-quality-code/subject-benchmark-statements/subject-benchmark-statement-biomedical-science-and-biomedical-sciences#