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Mapping Values in Life Sciences: Empowering Preservice Teachers through Experiential Learning

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Abstract. There are global trends in curriculum goals that align with the teaching of Life Sciences, not as isolated or standalone content, but as an avenue for nurturing values targeted towards values, education and sustainable citizenship. Preservice teachers often struggle to recognize and explicitly articulate these embedded values and integrate them into teaching practice. This study explored how experiential learning can enhance the competence of 60 preservice teachers within a South African university context to map values embedded in Life Sciences concepts. A qualitative intervention-based design grounded in experiential learning theory was employed. Preservice teachers engaged in structured experiential learning activities involving selected Life Sciences topics, followed by guided reflection and value-mapping tasks. Data collected from policy curricular documents and participants' responses to pre-intervention (baseline) and post-intervention (endline) competency assessment tasks were analyzed using a hybrid of thematic analysis and inductive coding. Findings indicate that experiential learning enhanced participants' ability to identify and interpret values embedded in Life Sciences concepts. Participants demonstrated deeper conceptual understanding, transforming their values by mapping competence from concept-independence to concept-embedded articulation of values. This study concludes that experiential learning supports preservice teachers' competence for value mapping within Life Sciences education. This competence has the potential to foster values-based education by equipping teachers with the skills to nurture learners with appropriate values and contribute to efforts to ameliorate social ills. The study introduces a conceptual framework on how experiential learning processes can align with values pedagogy, leading to the development of value-mapping competence in preservice teachers.

Keywords: competence assessment task; experiential learning; Life Sciences; preservice teachers; value mapping competence; values pedagogy.

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1. Introduction

Studies in literature have previously demonstrated that teachers identify, interpret, and negotiate ethical, social, and scientific values within disciplinary contexts (Sadler & Zeidler, 2004; Zeidler et al., 2005). The present study extends this body of work by conceptualizing these processes as value-mapping although the construct is seldomly used in literature.

1.1 Values, value mapping and school curriculum

Value mapping involves making explicit the values embedded within disciplinary content and integrating them into teaching practice. Values are defined as trans-situational life goals that are significant to people and hence drive their perception and behaviors (Schwartz, 1994; Cieciuch & Schwartz, 2017; Oeschger et al., 2022).

Beyond just transmitting content knowledge, national school curricula are underscored by values considered important within educational jurisdictions and contexts where such documents are utilized (Oeschger et al., 2022). In the same vein, Science-Technology-Society-Environment curricula, which are widely adopted in countries such as Australia, the UK, Europe, and the U.S, incorporate values-driven ethical, social, and environmental dimensions into science-based teaching (Pedretti et al., 2004). Ramnarain (2024) reported a global trend across countries such as Ireland, Turkey, Taiwan, Italy, and South Korea that increasingly emphasizes the need for science curricula to accentuate the nature of science (NOS) for nurturing values incorporated in scientific content and practice.

Similarly, Christian et al. (2023) reported that values are a fundamental aspect of the Australian Life Sciences curriculum, enhancing the cultivation of appropriate values in learners. Therefore, there are global trends in curriculum goals that align with the teaching of Life Sciences, not as isolated or standalone content, but as an avenue for nurturing values targeted towards values education and sustainable citizenship. However, existing research indicates that preservice teachers (PSTs) education programs do not adequately address pedagogical training for mapping and integrating values within subject-specific teaching (Naquines et al., 2025).

1.2 Value-mapping competence, values pedagogy, and Kolb's experiential learning framework

Furthermore, among other reasons, the alarming global prevalence of social ills has been attributed to teachers' lack of competence to conveying positive values to learners (Anass & Louw, 2011). In this study, competence is considered in relation to teachers' ability to apply disciplinary knowledge, pedagogical skills and value orientations to meaningfully map values embedded within disciplinary content for the purpose of nurturing such values in learners. Integrating values within teaching and learning disciplinary contexts is an indication of values pedagogy (Lovat, 2020). Kolb's experiential learning (KEL) cycle (Kolb, 2015), comprising concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE) provides a pedagogical framework through which values pedagogy can be accomplished. This framework provides a methodological platform in this study on which PSTs' competence in values mapping can be empowered.

1.3 Identification of gap

There are limited studies pertaining to value-mapping in literature. Additionally, gaps highlight the urgent need for pedagogical strategies to enhance values mapping in subject teaching (Ajayi & Mavuru, 2025). Such gaps include teachers' limited conceptual understanding of values in education (Ferreira & Schulze, 2014). In essence, if teachers do not clearly understand values, they may not be able to map them from subject content. This may lead to teachers' lack of practical strategies for integrating values particularly in subjects such as Life Sciences (Ajayi & Mavuru, 2025).

1.4 Research objectives/ research questions

The objective of the study is to develop and evaluate PSTs' value-mapping competence in Life Sciences using KEL strategies. The following are the specific research objectives of the study: To (i) examine PSTs' understanding of values mapping in Life Sciences before an experiential learning intervention; (ii) facilitate an experiential learning intervention aimed at enhancing value-mapping competence of PSTs in Life Sciences teaching. (ii) To conceptualize value-mapping within the context of Life Sciences teaching; (iii) to examine the effectiveness of the experiential learning intervention in enhancing PSTs' value-mapping competence in Life Sciences content.

The study contributes to the literature by offering suggestions on the conceptualization and operationalization of value-mapping competence within Life Sciences teacher education. For cultivating such competence in PSTs, a methodological contribution of the study entails how the experiential learning approach can serve as an effective pedagogical strategy. These contributions have both theoretical and methodological implications that can inform value pedagogy pertaining to curriculum design in teacher education programs. The following research questions guided this study:

i. What baseline competence did preservice teachers demonstrate in mapping values embedded within Life Sciences concepts prior to the intervention?
ii. How was value mapping conceptualized in Life Sciences concepts to develop value-mapping competence in preservice teachers?
iii. What changes were observed in preservice teachers' competence for values mapping following the intervention?

2. Literature Review

In this study, value mapping is conceptualized as the process of identifying, interpreting, and linking values embedded within subject content to pedagogical practices. In essence, values mapping is a pedagogical approach involving how values which underpin scientific knowledge can be identified, analyzed, and articulated (Mulder et al., 2025).

2.1 Values mapping and scientific knowledge

Plausibly, scientific reasoning and knowledge usually interplay with personal, societal and environmental values. Hence, teacher-educators should be encouraged to embrace teaching strategies underlined by values pedagogy with

the hope of developing future teachers who can identify map, and nurture values in their learners. With this approach, PSTs can be trained to map values to fulfill values-driven Life Sciences curricular educational goals. Mulder et al. (2025) explored values mapping as a "pedagogical tool to gain a better understanding of the role of values in addressing sustainability challenges" (p. 198). The current study examined value-mapping in the Life Sciences as a pedagogical approach to addressing social ills among youths. Hein et al. (2021) stated that value-mapping serves as a veritable tool to identify and make explicit values that are ordinarily implicit, unnoticed, and seemingly salient.

The Organization for Economic Co-operation and Development (OECD, 2021) through its report on Embedding Values and Attitudes in Curriculum: Shaping a Better Future enunciated how values are embedded in curricular documents worldwide. Life Sciences curriculum comprises concepts such as biodiversity, sustainability, and genetics etc. in which are incorporated, among others, values of responsibility, respect, and social justice. Through values mapping, a broad spectrum of these values encompassing cultural, economic, and environmental dimensions can be acknowledged, identified, and characterized (Harmáčková et al. 2022).

2.2 Empowering preservice teachers' competence for values mapping

Although these values may be implicitly embedded within concepts, value mapping enables PSTs to make them explicit through identifying, articulating, and critically examining them. Making these values explicit opens an avenue through which PSTs can critically engage with ethical, ecological, and socio-scientific dimensions of Life Sciences. Moreover, this study adopted an approach that exemplifies value-mapping in curriculum analysis, and this conforms well to its methodology (Güven & Yumugan, 2025). Empowering PSTs' competence in mapping values entails making them recognize the normative dimensions of Life Sciences content. In addition, by making implicit values incorporated in Life Sciences explicit, PSTs can critically interrogate them and through values pedagogy integrate such values into classroom practice. The South African National Curriculum Statement (NCS) requires teachers to map and nurture values in learners through teaching of all approved subjects (Department of Basic Education [DBE], 2011).

Following a global phenomenon, teachers are thus expected to map and nurture learners' specific values considered significant within the jurisdiction of the curriculum (Karseth et al. 2024). This curriculum and teaching perspective is consistent with global curriculum development efforts at "exploring the place of values in […] education system" (O'Flaherty & McCormack 2022, pp. 773-774) or promoting values pedagogy (Lovat, 2020). This further "gives prominence to the individual learner and competencies needed to navigate towards a future of well-being" (Karseth et al. 2024, p. 1) that may be useful for curbing social ills. How PSTs' competence can be empowered to map the values espoused in a Life Sciences curriculum, with a view to nurturing such values in youth, may suggest ways of addressing social ills in society.

2.3 Values mapping and Kolb's Experiential learning (KEL) cycle

Employing KEL, PSTs' competence in values mapping, can be empowered by exploring their CE about values when analyzing Life Sciences concepts with value-driven implications. Through guided RO, PSTs can critically examine and reflect on the values implicit in Life Sciences concepts in a way to foster awareness of how scientific knowledge interlinks, among other things, personal and social values. AC enables PSTs to articulate, map, and theorize these values embedded within Life Sciences concepts. AE allows them to intentionally apply and enact these values in subsequent Life Sciences teaching.

In this way, the KEL model can be used to empower PSTs' value-mapping competence, enabling them not only towards value identification but value-informed judgment and pedagogical practice. Therefore, within the context of experiential learning, value-mapping not only raises awareness of implicit values embedded within content but also fosters pedagogical competence in addressing value-driven content in Life Sciences classrooms. Consequently, through values mapping, PSTs' competency can be empowered to: (i) identify implicit or salient values in a Life Sciences topic; (ii) justify value identification in relation to Life Sciences concepts; and (iii) link Life Sciences content to value-driven implications.

2.4 Social ills and nurturing values

Across contexts and societies in developed and developing nations, social ills have increasingly become a global phenomenon among youths (Roy, et al., 2022; Delhey & Steckermeier, 2020). Social ills generate anti-social behaviors and values are known to be a defining factor (Türkkahraman, 2014; Jurado et al., 2017). As final implementers of curriculum, teachers play a vital role in nurturing values in learners (Ajayi, 2023; Ajayi & Mavuru, 2025; Kumar, 2025) necessary for "self-fulfillment, and meaningful participation in society as citizens of a free country" (Department of Basic Education [DBE], 2011, p. 4). Therefore, teachers can play a role in mitigating social ills by using Life Sciences teaching to map and nurture social values in learners, with the aim of fostering appropriate behavioral traits in them. In the same vein, the crucial roles that PSTs can play in addressing social ills have been reported (Palmer & Larey, 2016).

3. Theoretical Background

An adaptation of the following interlinked theoretical perspectives underpinned this study: (i) Values pedagogy, and (ii) KEL. These perspectives collectively provide the lens through which we viewed and explored how PSTs' competence was empowered to map the values embedded in Life Sciences concepts to nurture learners. The perspectives also formed the basis for data analysis. Values pedagogy draws attention to the conscious incorporation of values into classroom teaching such that learners develop cognitive, affective and behavioral competencies (Lovat et al. 2011; Lovat, 2017). These three aspects are components of value (Schwartz, 1994; Schwartz et al. 2012). Values pedagogy is guided by the view that education is not only about acquiring knowledge but also about nurturing dispositions that may elicit appropriate values-driven behaviors in the 'transmittee'. Empowering PSTs to map and nurture values embedded within Life Sciences enhances prospective teachers' ability to explicitly align scientific

knowledge with values-driven dimensions of learning. Being able to map both explicit and implicit values embedded in Life Sciences curriculum (content), and nurturing such values in learners, teachers are 'values mediators or facilitators' and not only transmitters of knowledge.

Furthermore, the KEL theory suggests that learning is a cyclical process occurring in four stages of CE, RO, AC, and AE (Kolb, 2015). According to Kolb (1984), learners "must be able to involve themselves fully, openly, and without bias in new experiences (CE). They must be able to reflect on and observe their experiences from many perspectives (RO). They must be able to create concepts that integrate their observations into logically sound theories (AC), and they must be able to use these theories to make decisions and solve problems (AE)" (p. 30). The KEL theory underpinned the study in the following ways: With CE, PSTs are made to learn and experience how the curriculum espouses values embedded within Life Sciences content; how scientific concepts link with values; and how these may be illustrated during classroom practice.

RO indicates how PSTs learn to reflect on how their curriculum and classroom encounters assist them in mapping values, identifying how values emerge and are intricately linked with Life Sciences concepts. Through AC, PSTs learn how to connect their reflections to value-driven principles and philosophies as reflected in policy documents such as the curriculum and the constitution. This stage empowers PSTs to advance their knowledge of mapping values to systematically understand how to nurture them in learners. For AE, PSTs learn how to fast-track pedagogical strategies for nurturing values mapped from Life Sciences content during real-time classroom teaching.

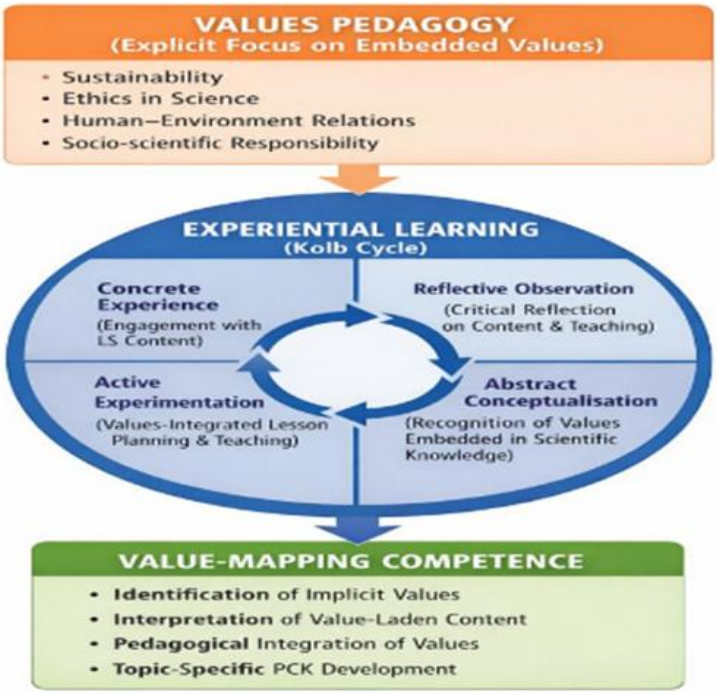

Figure 1: Linking values pedagogy, experiential learning, and value-mapping competency

Overall, the KEL theory positions PSTs as active participants in a learning curve that empowers them to map and nurture values in Life Sciences. The learning cycle involves pre-intervention, intervention and post-intervention phases in a methodological process that allows the theoretical framework to underpin the study. Consequently, the pre-intervention phase, encompassing CE and RO, deals with what PSTs know, feel, or do before the intervention. The intervention phase, covering CE and AC, constitutes the actual teaching/learning activity (authors' intervention). The post-intervention phase relates to RO, AC and AE and pertains to what happens after the intervention, especially how PSTs consolidate the knowledge learned.

4. Methodology

The study, located within the constructivist/interpretivist (Kivunja & Kuyini, 2017) research paradigm adopted a qualitative intervention-based research design. This was informed by the principles of Kolb's (2015) KEL cycle.

4.1 Research setting and participants

The participants were 60 3rd- and 4th-year PSTs registered for a bachelor's degree in education at a higher education institution in South Africa. The participants were purposively selected based on their enrolment for a full-year exit course titled Teaching Further Education and Training Life Sciences. The course aims to help students acquire knowledge, develop teaching skills and competencies, and develop positive attitudes towards science, towards the living world and the teaching and learning of Life Sciences.

Table 1: Demographic profile for the 60 preservice teacher-participants in the study (Demographic characteristics of participants (N = 60)

Characteristic	Category	Demographic characteristics of participants (N = 60)	
		Frequency (n)	Percentage (%)
Gender	Female	38	63.3
	Male	22	36.7
Age Group (years)	20 - 22	18	30.0
	23 - 25	30	50.0
	26 - 28	9	15.0
	29 and above	3	5.0
Year of study	Third year	24	40.0
	Fourth year	36	60.0
Specialization	Life Sciences (Major)	42	70.0
	Life Sciences & Natural Sciences	18.0	30.0

4.2 Design features

The study was carried out in three phases of pre-intervention, intervention, and post-intervention, with iterative cycles structured around the KEL cycle comprising the CE, RO, AC, and AE stages (Kolb, 2015). The participants were asked to complete a baseline competency assessment task during the pre-

intervention phase. This was to examine their CE regarding the initial understanding of the concept of value(s), particularly the perspectives established in curricular and policy documents. In addition, their competence in identifying and mapping values incorporated in Life Sciences concepts was examined. Also, the participants' RO was guided through 'engagement trigger' activities during the interactive lectures employed. For the AC stage established during the pre-intervention and intervention phases, participants were introduced to the systematic articulation of values espoused in Life Sciences concepts. AE, established during the post-intervention phase, involved the application of what was learned during the pre- and intervention phases.

4.3 Data sources and collection

Data were collected from the following sources: (i) Teaching resources such as lecture PowerPoints; and policy statements such as Curriculum and Assessment Policy Statement (CAPS) for Life Sciences and Manifesto for Values, Education and Democracy (MVED, 2001); (ii) participants' responses to pre-intervention baseline (PIB) and post-intervention endline (PIE) competency assessment tasks (Alipanga & Kohrt, 2022). The PIB competency assessment task was administered prior to the intervention to assess participants' initial competence to map values embedded within Life Sciences concepts.

Following the intervention, a PIE competency assessment task, aligned in structure to the PIB task and assessed using the same rubric[†], was also administered. This was to evaluate changes in participants' competence to map values embedded within Life Sciences concepts after intervention. Both competency assessment tasks required participants to create a lesson plan to teach a selected Life Sciences topic. Specifically, the participants' responses to section 2, subsections 2(iii(a) and iii(b) of the lesson plan templates adopted (Figure 2) for the task were noted. The section emphasizes and guides teachers' thinking and preparation with respect to value(s) and their incorporation in LS teaching.

Section 2: Attitudes and Values
Subsection 2(iiia): What does this lesson promote as being good, just and fair?
Subsection 2 (iiib): What are the attitudes and values that you wish to develop or reinforce in this lesson.

Figure 2: Section 2, subsections 2(iii(a) and iii(b) of the lesson plan templates adopted

4.4 Data analysis

Data were analyzed using a hybrid of thematic analysis and inductive coding (Chandra & Shang, 2019). The thematic analysis approach involved six steps of "transcript creation and data familiarization; keyword identification; code selection; theme development; conceptualization through the interpretation of keywords, codes, and themes and, finally, the development of a conceptual

[†] A "rubric" as used in this paper refers to a primary trait rubric which focused on one key dimension, i.e. the ability of the participants to indicate values (and which value(s)) in Section 2, subsections 2(iii(a) and iii(b) of the lesson plan templates adopted.

model" (Naeemet al., 2023, p. 2). For Step 1, the collected data were compiled into a single transcript, with each author receiving an individual copy. Each author, while working separately, skimmed (superficial examination) and read (thorough examination) (Bowen, 2009) through their transcript. This initial step was to familiarize the author with the transcript, during which sections of the data were examined to identify information and patterns pertinent to the research questions.

Step 2 involved the identification of keywords, quotes, and phrases related to information that helped answer the research questions. Such keywords, quotes, and phrases were highlighted on the transcripts or written separately in authors' jotters. Step 3 involved coding keywords, quotes, and phrases to further identify elements related to the research questions. Hence, codes were assigned to these data segments to capture essential messages or themes relevant to the research questions. The coding process, grounded in data captured in the transcript, was conducted using open coding (Chandra & Shang, 2019) without applying predefined categories. Recurrent patterns across distinct types of values emerged through constant comparison. Therefore, societal-transformative values (Details in Table 2 Findings section) were related to concept-independent articulation of values incorporated in Life Sciences concepts. On the other hand, human dignity– and care-oriented value (Details in Table 4 'Findings' section) were related to concept-embedded articulation of values incorporated in Life Sciences concepts.

However, when repeated coding patterns yielded no unique category or articulation of values, and all new instances could be accommodated within the established ones, saturation was considered to have been achieved (Rahimi & Khatooni, 2024). The values were then inductively interpreted and conceptualized, as articulated by the participants within Life Sciences contexts. How the study conceptualized value-mapping and its competence helped distinguish between independent and embedded categories of values. No predetermined categories were considered at the outset; instead, open coding allowed patterns to emerge directly from participants' lesson plans, pre- and post-intervention (See the example in the coding table below).

Table 2: How values emerged through open coding of pre- and post- intervention data

Category	**Operational Definition**	**Type of values expressed**	**Example**
Independent Values	Values identified as general principles without explicit linkage to Life Sciences content	Societal-transformative values	"This lesson intends to promote the development of scientific process skills in order to uphold the values of social transformation through access to quality and higher education…".
Embedded Values	Values explicitly connected to Life Sciences concepts, issues, or phenomena	Human dignity– and care-oriented value	"*Human dignity*, for individuals who suffer from musculoskeletal-related diseases. Promoting the fact that these individuals are treated fairly and are given the help and assistance they need. *Non-discrimination and inclusivity..*"

Theme development, which constituted Step 4 assisted in identifying patterns and relationships within the codes to offer more insight into the research questions. Step 5 involved conceptualization through the interpretation of keywords, codes, and themes. This encompasses delineating the meaning of the themes in terms of describing concepts related to answering the research questions considering prior studies. These steps occurred iteratively throughout the study. After each step, both authors met to compare notes and discuss areas of similarity or differences. The ultimate Step 6, which encompasses development of a conceptual framework is presented on page 19 under the Results and Findings section.

4.5 Validity and reliability

The study's trustworthiness and rigor were achieved through multiple approaches. These include authentic criteria strategies (Lincoln & Guba, 1985) involving qualitative research criteria of credibility, dependability, confirmability, and transferability. Other approaches employed comprise inter-coder reliability (McHugh, 2012), triangulation, and audit trails (Patton, 2015). Credibility was enhanced through prolonged engagement with participants during experiential learning activities and iterative interaction with the data. In addition, member checking was conducted by sharing authors' interpretations with selected participants to confirm whether the findings aligned with their original meanings.

A detailed audit of all research undertakings with respect to the steps described above was maintained to ensure dependability. To enhance confirmability, both authors kept reflexive journals in which their assumptions regarding values mapping in Life Sciences education were acknowledged and monitored. Transferability was supported through thick description of the research context, participant experiences, and experiential learning activities. A detailed description of design features and research settings to provide contextual information enhances the applicability of findings to other teacher education or science curriculum contexts.

As mentioned earlier, and to enhance analytical consistency during the inductive analysis, both authors were independently participated in the iterative process of the 6-step thematic analysis. Intercoder agreement yielded a final coefficient of $\kappa = 0.78$, indicating substantial agreement demonstrating strong consistency in how the themes were interpreted. The authors resolved cases of discrepancy through consensus discussions mutually agreed-upon refinements. Additionally, the use of Intercoder agreement and triangulated data sources ensured that findings were grounded in participant data rather than researcher bias. Collecting data from more than two sources facilitated triangulation to compare patterns across sources. This allowed for the identification of consistent themes through the convergence of evidence across the data sources. Such convergence of evidence across these sources strengthened the validity of the findings, while any discrepancies were further explored to deepen interpretation.

4.6 Ethical considerations

All participants provided informed consent and were informed of the purpose of the study, that participation was voluntary, and their right to withdraw at any time without penalty. While the focus on value-mapping aligns with curriculum

expectations that teachers integrate values across subjects, participation in the study remained entirely voluntary and independent of course assessment or requirements. Ethical clearance was obtained from the university's Human Research Ethics Committee (HREC) - Non-Medical. The ethics clearance number is H25-02-01.

4.7 Limitations of the study

Although a single-group pre–post design was employed in this study, the lack of a control group is considered as a limitation. In the context of teacher education, this is excusable, as all the participants formed an intact cohort that enrolled for the same exit methodology course. In this instance, assigning randomly was difficult. The intervention specifically focused on enhancing value-mapping competence of all the participants. This is consistent with the Bachelor of Education program and curriculum expectations. Hence, withholding such from a subset of participants would have disenfranchised them in their professional preparation. Consequently, to mitigate threats to validity, specific features were incorporated into the research design. Firstly, a pre-post assessment framework, comprising baseline and endline competency assessment tasks, ensured the examination of changes in participants' value-mapping competence over time.

Secondly, the pre-intervention, intervention and post-intervention phases were structured around iterative experiential learning cycles (CE, RO, AC, and AE). This created an avenue for repeated and systematic opportunities for engagement, reflection, conceptual development, and application. As an internal validation mechanism, this approach reinforced experiential learning across multiple phases rather than depending on just a single exposure. Additionally, the idea of triangulation and intercoder agreement, explained above, enhanced methodological rigor and consistency in qualitative analysis respectively. Member checking guaranteed a transparent audit trail through document coding and theme development. Collectively, these strategies strengthened the credibility and dependability of the findings despite the absence of a control group.

5. Results and Findings

The findings are presented in terms of how the themes provided answers to the research questions considering the analysis of pre-intervention, intervention, and post-intervention data. Theme 1 is discussed in relation to how research question (RQ) 1 was answered. RQ 1: What baseline competence did preservice teachers demonstrate in mapping values embedded within Life Sciences concepts prior to the intervention?).

5.1 Theme 1: Pre-service teachers' baseline value mapping competence during the pre-intervention phase

5.1.1 Baseline competency assessment task

Competency refers to an individual's ability to mobilize appropriate knowledge, skills, attitudes and values to effectively perform or complete assigned tasks or achieving its goals (Wong, 2020). Within the context of this study, competency assessment or Competency-Based Assessment (CBA), involves using an examination instrument to measure students' competency regarding a particular

subject matter (Holmes et al., 2021). The baseline competency assessment supported the participants' CE, as each was expected to be individually immersed in the task related to a specific Life Sciences topic. Hence, we consider that real experience was encountered, as each participant engaged with the task, reflecting on their beliefs, values, potential biases, and prior understanding of the concept of value(s), especially in relation to Life Sciences teaching.

Therefore, in preparing their lesson plans, the participants had to reason through and identify values that underline the concepts, depending on the Life Skills topic allocated to each of them. In this way, the participants experienced values as tangible rather than abstract concepts. The competency assessment provided participants with a concrete, foundational baseline experience, as they had to engage with values for comparison with new insights after the intervention. Table 2 below shows sample excerpts (values in italics) derived from participants' responses to the baseline competency assessment task.

Table 3: Sample excerpts and the types of values expressed in participants' responses to the baseline competency assessment task

	Topics	**Excerpts**	**Type of values expressed**
1	Circulatory system	"This lesson intends to promote the development of scientific process skills in order to uphold the values of *social transformation* through access to quality and higher education as expressed in the CAPS document (Department of Education, 2011)"	Societal–Transformative value
~~2~~	Cell	"… helps learners to understand how living things work. when they learn about cells and ecosystems, they start to appreciate how everything in nature is connected and beautifully organised…"	Epistemic-appreciative value
3	Meiosis	"This lesson as being *fair*, promote that all learners will have *equal* access to resources irrespective of their socio-economic background, physical ability, or gender because I will ensure that all learners have access to resources I will be using. Also, to promote *fairness* in giving them similar activities at the same time as well as corrections. Furthermore, this lesson aim on fostering epistemological access for all learners. Learners will know the values of meiosis in humans lives as it brings about variation and responsible for the formation of gametes involved in sexual reproduction"	Equity- and inclusion-oriented value

The prevalence of the types of values expressed in the baseline competency assessment task showed that 15 participants (25%) demonstrated societal-transformative values, 20 participants (33.3%) articulated epistemic-appreciative values, and 25 participants (41.7%) expressed equity and inclusion values (See Table 3 & Figure below). In essence, the excerpts for societal-transformative,

epistemic-appreciative, and equity/inclusion values are representative of patterns observed in 15, 20 and 25 participants, respectively, who linked these values to Life Sciences concepts. Although the values expressed were 'concept independent' (as explained in Table 1 above), all the students articulated values not as standalone constructs. For example, 15 participants mapped societal-transformative values as embedded in the topic of 'circulatory system' in relation to how the lesson may "promote the development of scientific process skills in order to uphold the values of social transformation through access to quality and higher education as expressed in the CAPS document".

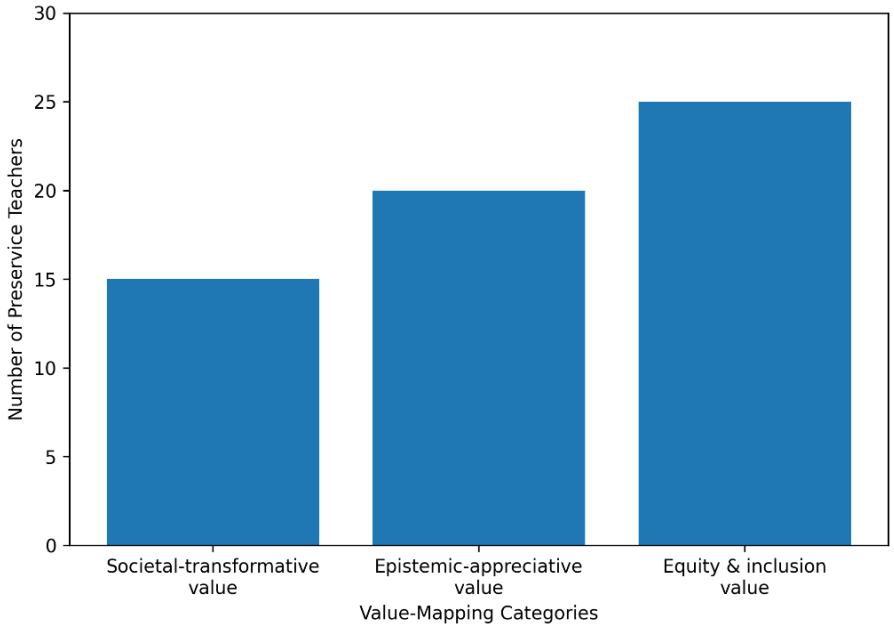

Figure 3: Prevalence of value categories mapped/values articulated by participants during baseline competency assessment activity

Although the excerpts indicate values that signify their pedagogical relevance, they are not derived directly or immediately from specific constituents ingrained in the finer details of the concepts or topics in question. The values expressed in the excerpts are not explicitly referenced to the elementary details embedded in the topics or concepts. For example, the societal-transformative value emphasizes a value that applies broadly across a context and is not specifically tied to intricate elements of the content. Therefore, because the expressed values are articulated at a general pedagogical level, without direct linkage specifically to the Life Sciences concept in question, the excerpts represent concept-independent value articulation. Hence, the values are classified as concept-independent values.

Ultimately, incorporating a competency assessment at the outset gave the participants a meaningful experience about values in relation to LS teaching to build upon CE. This teaching strategy also stimulated the participants to reflect critically on their prior presumptions and knowledge about the concept of values and in relation to Life Sciences teaching. In addition, the strategy established an intrinsic motivation (Kamberi, 2025) for learning since the participants can see

what they understand, need to know and develop further and why. Theme 2 is discussed next in relation to how research question 2 was answered. Theme 2 is discussed in relation to how RQ 2 was answered. RQ 2: How was mapping of values conceptualized in Life Sciences concepts to develop values mapping competence in preservice teachers?).

5.2 Theme 2: Empowering preservice teachers' value mapping competence during pre-intervention.

This encompasses how the mapping of values is conceptualized within Life Sciences to develop PSTs' competence.

5.2.1 Values-mapping pedagogical approach using document review/analysis.

Structured activities related to document review and analysis informed the pedagogical approach. Bringing document analysis or review into the experiential learning cycle, as an engagement trigger provided a powerful way to empower participants to engage with vital policy documents rather than passively reading them. Taylor et al. (2024) defined document analysis as a systematic procedure used to "synthesise and appraise textual data to elicit meaning, gain understanding and develop empirical knowledge" (p. 2). This is not different from document review which is a significant aspect of the systematic analytic strategy (Kayesa & Shung-King, 2020).

Therefore, the documents reviewed/analyzed by the participants (e.g., the CAPS for Life Sciences and MVED) were used as an engagement trigger to foster participants' values mapping competencies or how values are articulated/incorporated within Life Sciences concepts. The analytic interpretations of values as defined in the MVED (e.g. Excerpts 1 and 2 below) assisted the participants' understanding of how such values are embedded within Life Sciences concepts (See Figure 4 below). This guided the development of the participants' value-mapping competence. In the next section, Theme 4, which constitutes how research question 3 was answered, is presented.

> *Excerpt 1: Democracy: "…democracy is at heart a society's means to engage critically with itself..." (MVED, 2001, p. 12).*
>
> *Excerpt 2: Ubuntu: "Ubuntu has a particularly important place in our value system for it derives specifically from African mores: "I am human because you are human" (MVED, 2001, p. 13).*

In the next section, Theme 3 is discussed in relation to how RQ 3 was answered. RQ 3: What changes were observed in preservice teachers' competence for values mapping following the intervention?).

Table 4: Table showing examples of how mapping of values incorporated in 3 Life Sciences concepts was conceptualized

	Concepts/Topics	Content	Values mapped and conceptualized
1.	Musculoskeletal system	i. In human locomotion, muscles, bones, joints, ligaments, and tendons work together as an integrated musculoskeletal system that enables movement. ii. Bones provide the rigid framework that supports the body and act as levers that move when contracted muscles. iii. Joints are points where two or more bones meet and they allow movement such as flexion, extension, rotation, and abduction. iv. Ligaments are tough, elastic connective tissues that connect bone to bone, and they hold joints together and limit excessive or abnormal movement. v. Tendons are connectors between muscle and bone, and they transmit the force generated by muscle contraction to the bones. vi.. Muscles contract and pull-on bones via tendons, causing bones to move at joints, while ligaments hold bones together and stabilize the joints.	i. **Democracy/Ubuntu**: The musculoskeletal system (MSS) functions effectively only when all its components work together. Therefore, bones, muscles, joints, ligaments, and tendons must work interdependently for the MSS to function well. Coordinated action is essential because no single component can bring about movement, i.e. every part has a role and contributes to the whole. ii. **Reconciliation:** The MSS ensures restoration after an injury signaling damage or conflict. For example, where there is a bone fracture or muscle tear, the body can initiate healing and repair processes through bone remodeling and muscle regeneration. This signals restoration of normalcy or harmony rather than permanent damage. iii. **Non-racism & Non-sexism**: The interdependence of the components guarantees that they all work together smoothly with no component superior to the other. That is, none of the components is 'discriminated' against – there is no hierarchy but mutual dependence among them.
2	Filtration in the Bowman's capsule	i. The site where ultrafiltration takes place in the nephron is the Bowman's capsule. ii. Blood enters the glomerulus (a network of capillaries) through the afferent arteriole under high pressure. iii. This causes water and small dissolved substances such as glucose, amino acids, salts, and urea to be forced out of the capillaries and into Bowman's capsule. iii. Large molecules like proteins and blood cells are too big to pass through the	**i. Rule of law**: The ultrafiltration process is governed by established biological rules. These rules rely on physiological principles that control what may pass from the blood into the Bowman's capsule or what must be retained in the blood. For example, selectively permeable membranes, hydrostatic pressure, and molecular size/charge determine processes 1 – 3 in the diagram. ii. **Equity:** Ultrafiltration allows substances to pass or be retained not based on partiality. All molecules are treated fairly according to biological rules using objective criteria such as size, charge, and pressure.

		filtration membrane and therefore remain in the blood. iv. The fluid collected in Bowman's capsule is called glomerular filtrate. v. The filtrate is modified in the nephron through a round of selective reabsorption and secretion and passed out of the body as urine.	iii. **Justice:** Ultrafiltration guarantees that there is a balance between what is removed and what is retained in the body. The body is protected from unnecessary harm by 'restorative justice' through removal of waste products and excess substances, and recovery of useful products. iv. **Accountability/Responsibility/Ubuntu**: Each component of the nephron has a specific function and must perform this role correctly. For example, the glomerulus is a network of capillaries where filtration takes place; the proximal convoluted tubule is the site where selective reabsorption of glucose, amino acids, vitamins, most salts, and large amounts of water back into the blood takes place.

5.3 Theme 3: Changes in preservice teachers' value-mapping competence post-intervention

5.3.1 Endline competency assessment task

Table 3 below shows a sample of excerpts derived from participants' responses to (and the values expressed in them) the endline competency assessment task given after the intervention. In answering RQ 3, the changes observed in the PSTs' competence in mapping values incorporated in Life Sciences concepts after the intervention are underscored by the components of the KEL cycle. As already shown in the findings during the pre-intervention phase, the participants were engaged directly with activities that required them to engage directly with the concepts of values and Life Sciences concepts.

The participants developed CE through structured tasks that involved lesson planning; and required them to identify and explore values espoused by Life Sciences concepts. They were therefore confronted with real instructional challenges related to values mapping, identification and integration. Following this, was RO, wherein participants critically reflected on their initial attempts on value-mapping assessed through the baseline competency assessment task. Learning opportunities were created during pauses between interactive lectures, when engagement triggers were used to prompt participants to share ideas about difficulties encountered and ways of articulating values within Life Sciences content.

Ultimately, through AC, the participants started to synchronize their understanding through drawing on the value-mapping conceptualization approach learned. This enabled them to develop more coherent approaches to mapping values inherent in Life sciences concepts with some level of confidence. This kind of understanding is reflected in their lesson plans developed for the endline competency assessment task. This progression through the four stages of

the KEL cycle showcased how the participants' learning traversed experiential interactions to reflective meaning-making and purposeful pedagogical application in terms of values mapping.

Table 5: Sample of excerpts and the types of values expressed in participants' responses to the endline competency assessment task

	Topics	Excerpts	Type of values expressed
1	Circulatory system	"*Human dignity*, for individuals who suffer from circulatory system-related diseases. Promoting that these individuals are treated fairly and are given the help and assistance they need. *Non-discrimination and inclusivity,* allowing individuals who suffer from circulatory system-related issues to feel included and accepted…	Human dignity– and care-oriented value
2	Cell	"Value the *complexity* and *uniqueness* of every organism and every individual resulting from DNA found in the nucleus. Value the *diversity* in all life forms due to different variations of one gene and the different expressions of that gene. Value *precision* and *accuracy* when determining the genotypes and phenotypes of the offspring… An attitude of intrigue and *enthusiasm* for the possibilities to be found when completing a genetic diagram…"	Scientific appreciation and inquiry-oriented value
3	Meiosis	"*Ubuntu* sometimes translated as "I am because we are" is valued in the main topic of meiosis. Meiosis ensures continuity of species…individual existence contributes to collective survival through production of gametes ….generic recombination creates variation"	Relational–communal value

Unlike values expressed in excerpts derived from the baseline competency assessment task (Table 2 above), the excerpts in Table 3 above indicate values directly or immediately infused within the concepts or topics in question. Therefore, the values of Human dignity, care-oriented value, scientific appreciation and inquiry-oriented value, and relational–communal value are concept-embedded articulated values. The prevalence of these values as reflected in the endline competency assessment task showed that 15 participants (25%) demonstrated Human dignity– and care-oriented value; 20 (33.3%) expressed scientific appreciation and inquiry-oriented value; 13 (21.7%) articulated relational–communal value; while the remaining 13 participants (20%) still expressed concept-independent values. The excerpts related to these values are representative of the patterns observed in participant numbers in relation to the

respective Life Sciences topics. Although 48 participants (80%) articulated concept-embedded values, 13 (20%) of them still expressed concept-independent values (See Figure 4 below).

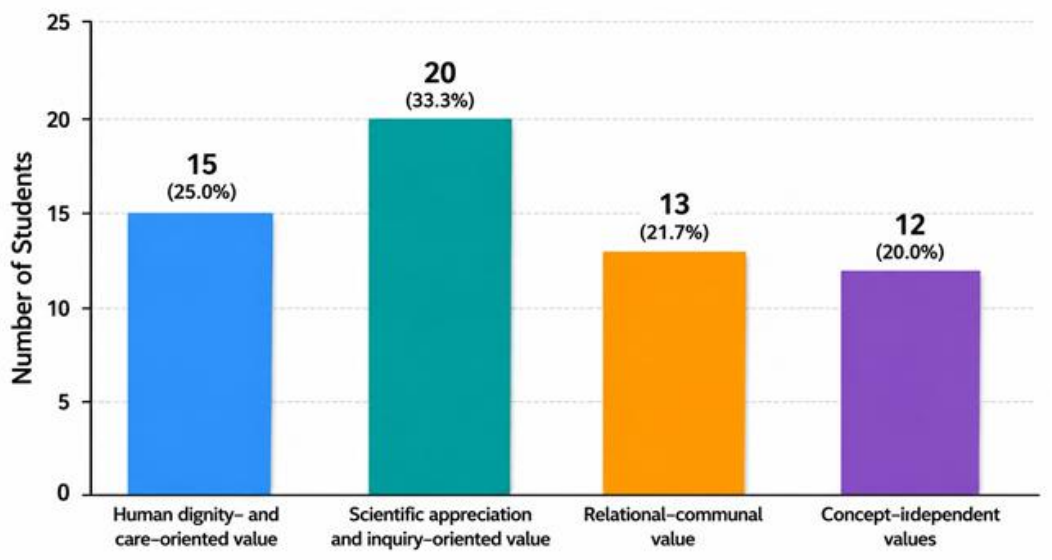

Figure 4: Prevalence of value categories articulated by participants during endline competency assessment activity

The distribution of value articulation categories suggests that PSTs were more inclined to identify values associated with scientific appreciation and inquiry than values explicitly embedded within Life Sciences concepts. The prominence of scientific appreciation and inquiry-oriented values (n = 20) indicates a strong recognition of the intrinsic nature of scientific knowledge and investigation. In contrast, the lower frequency of concept-embedded values (n = 12) suggests that fewer participants were able to directly integrate values within specific disciplinary content.

This pattern highlights a potential gap in PSTs' value-mapping competence, whereby values are more readily recognized as general educational ideals than as integral components of Life Sciences concepts. The findings therefore reinforce the need for targeted pedagogical interventions to support the transition from independently identifying values to meaningfully embedding them within subject-specific teaching and learning contexts. Figure 5 represents the diagram to demonstrate participants' shift from concept-independence to concept-embedded articulation of values. In the next section, Theme 4 constitutes the conceptual framework developed in the study.

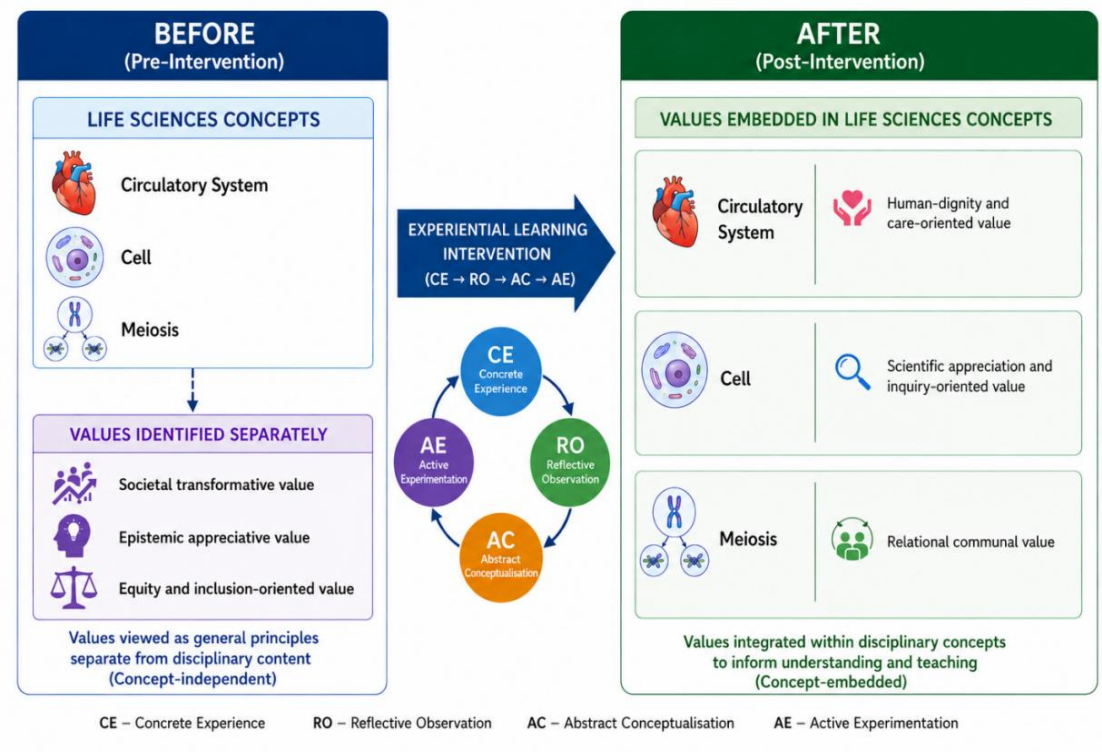

Figure 5: Participants' shift from concept-independent to concept-embedded articulation of values

5.4 Theme 4: Development of conceptual framework

The conceptual framework developed in the study is grounded in Kolb's KEL theory, which views learning as an iterative cycle of experience, reflection, conceptualization, and experimentation. The framework integrates KEL with values pedagogy, which inspires values mapping. In this, experiential learning is conceptualized as the mechanism by which PSTs develop value-mapping competence in Life Sciences education.

Moreover, the participants progressively moved from articulation of values as concept-independent constructs towards concept-embedded values within disciplinary content. Value-mapping competence is thus conceptualized as a measurable pedagogical capability demonstrating the progression from general values awareness to discipline-embedded values integration. The framework, therefore, illustrates how experiential pedagogical processes facilitate the development of value-oriented teaching competencies. This study makes a relatively novel contribution to Life Sciences teacher education literature.

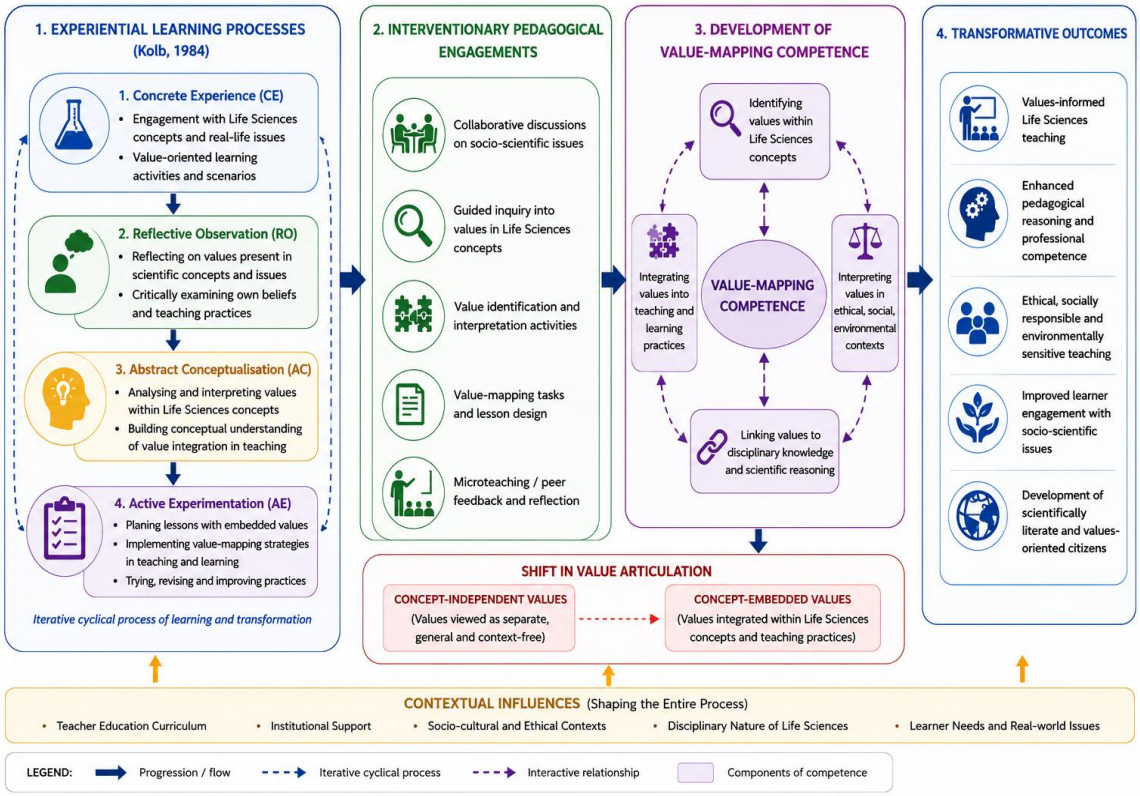

Figure 6: Conceptual framework developed in the study

6. Discussions

6.1 Integrating Experiential Learning into intervention design for values mapping

The findings of this study make a notable contribution in addressing a significant gap in the literature regarding how experiential learning can be integrated into intervention design to explore values mapping within Life Sciences education. Although values in education have been explored extensively in existing literature (Ferreira & Schulze, 2014), few studies have conceptualized or empirically investigated how teachers map values within subject-specific knowledge contexts such as Life Sciences. Ajayi and Mavuru (2025) reported PSTs' strategies of nurturing values in learners through classroom teaching of Life Sciences.

The current study demonstrated how experiential learning can facilitate PSTs' progression from identifying values as independent constructs embedding them meaningfully within Life Sciences concepts. The four phases of CE, AC, RO, and AC in experiential learning collectively played a significant role in empowering PSTs' value-mapping competence. Through CE, PSTs actively engaged with Life Sciences concepts and classroom-oriented activities that exposed them to the values embedded within them. RO created an awareness of values in Life Sciences education and empowered the PSTs to critically reflect on how values were embedded within disciplinary content During AC, the PSTs developed a more structured understanding of how values are embedded within Life Sciences concepts, moving beyond viewing values as isolated or standalone constructs.

Ultimately, AE allowed them to apply these understandings in value-mapping activities, thereby strengthening their competencies to transform from concept-independent to concept-embedded articulation of values. Collectively, the iterative nature of these phases facilitated the progression from identifying values independently to viewing them as being intrinsically tied to Life Sciences concepts. The use of an experiential learning framework in teacher education, particularly for developing professional competencies in learning contexts, is well supported in the literature (Klassen et al., 2023; Mechouat, 2024; Voon et al., 2023). Klassen et al. (2023) examined how an intervention-based experiential learning programme influenced PSTs self-efficacy, professional identity, and career intentions. Therefore, contemporary intervention studies demonstrate that experiential learning contexts offer powerful approaches for examining and transforming pedagogical practice in teacher education.

6.2 Transformation in values mapping articulation (Improving value mapping competency)

Prior to the intervention, PSTs identified values incorporated into Life Sciences concepts as standalone ideals, sperate from Life Sciences content. Hence, the expression of a concept-independent value, such as Societal–Transformative value, in the baseline competence task. However, the PSTs showed a shift from concept-independent to concept-embedded values mapping articulation post-intervention. This represents a fundamental transformation in how values are integrated in Life Sciences education/concepts; and thus, a good indication of values pedagogy.

According to Lovat (2020), values pedagogy refers to the "orientation of the learning discourse being around values, the values inherent in curriculum content, rather than merely the 'facts and figures' or most easily measurable features of the content" (p. 7). Lovat et al (2011) stated that values pedagogy may have been overlooked during pre-service teacher education, so much so that the necessary support for PSTs to develop skills of being able to identify and map values to enable them to teach with a value focus are lacking. This necessitates certain changes to happen in teacher education with a view to "raise preservice teachers' awareness of values and of their roles" (Pala & Yildiz, 2021, p. 14).

Such awareness is underscored in this study by the PSTs integrated values into specific Life Sciences concepts following the intervention. This indicates PSTs' understanding of the relationship between content knowledge and values. Considering the shift from independent to embedded articulation of values, the PSTs can understand that ethical, environmental, and social values are directly interwoven within Life Sciences concepts rather than treating them as standalones.

6.3 Theoretical Implications

By demonstrating its explanatory tendencies, the study extends knowledge on the KEL theory regarding how PSTs internalize and map values embedded in Life Sciences concepts. Deeper integration of value dimensions in scientific knowledge through articulation of concept-embedded values is facilitated by concrete engagement with subject matter, followed by reflection and conceptualization. As

a contribution to values education theory, the study shows that values are not merely standalones but actively constructed through interaction with disciplinary content and lived experience. This is consistent with buttresses constructivist perspectives that consider learning not as information acquisition but rather as meaning making. In addition, the findings enhance understanding of pedagogical content knowledge (PCK) by highlighting "value-mapping competence" as an emerging dimension of teacher knowledge, bridging conceptual understanding with ethical and contextual awareness in Life Sciences education. Ajayi and Nyamupangedengu (2025) reconceptualized the pentagon model of PCK as a value-driven approach to science teaching.

6.4 Future research

In future research, it is suggested that the findings can be built upon by exploring how value-mapping competence develops across different stages of teacher education from preservice to in-service practice. Insight could also be provided into how contextual and cultural factors may shape value mapping and integration within Life Sciences education through comparative studies across institutions or countries. The effectiveness of different experiential learning designs can be investigated to enhance PSTs' ability to identify and articulate embedded values in scientific concepts. Another important direction is to investigate the impact of value-mapping competence on classroom practice and learner outcomes. Ultimately, studies of this nature would help refine theoretical models linking experiential learning, values pedagogy, values education, and science teacher preparation.

7. Conclusions

This study found that experiential learning supports PSTs' empowerment for value mapping within Life Sciences education. Through structured reflection and engagement with scientific content that employed the components of the KEL, participants demonstrated enhanced awareness of the value dimensions of disciplinary knowledge. Hence, the development of value-mapping competence shifted from concept-independent to concept-embedded articulation. Theoretically, the study extends experiential learning theory and values education by showing that values are actively constructed through disciplinary engagement rather than passively transmitted or standalone. Value mapping is also proposed as a separate competence within teacher preparation thereby contributing to PCK knowledge.

As a practical means to improve Life Sciences education, the findings highlight the importance of integrating experiential activities into values pedagogy to buttress values-oriented teaching. Value-mapping competence equips PSTs to intentionally articulate the ethical, social, and ecological dimensions embedded in Life Sciences concepts. This enables values to be taught in a more explicit and reflective manner. Considering this, values-driven classroom practices can nurture moral reasoning, empathy, and civic responsibility in learners. Such value-driven practices are essential for addressing and mitigating prevailing social ills. Consequently, it is recommended that teacher education programs embed structured, values-pedagogy-driven experiential tasks to deepen values

integration and articulation. Future research should examine, among others, longitudinal development of value-mapping competence and its application in classroom practice.

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