# Exploring Learning Effectiveness in Education for Sustainable Development (ESD): Identifying Emerging Sustainability Competencies- A Case Study

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**Abstract**

This study aims to investigate students' learning effectiveness by identifying the emergence of Rounder Sense of Purpose (RSP) sustainability competencies in the curriculum of a 3rd year B.Ed. course in Thailand titled Literary Works for English Language Teaching. This research adopts the New World Kirkpatrick Model (NWKM) as a framework to evaluate students' learning using the RSP competency-based approach. The research proposes a competency-based framework of assessment, which adopts the RSP framework and adapts NWKM, to identify and evaluate salient ESD competencies in pre-service teacher education. The empirical findings can be applied to evaluate ESD competencies in Educational Studies curricula. Due to the lack of research regarding competency evaluation frameworks, it could be an effective assessment tool for evaluating ESD competency attainment in Tertiary Education for pre-service teachers.

**Keywords:** education for sustainable development (ESD), sustainability competencies, competency evaluation, Kirkpatrick model, learning assessment

## 1. Introduction

Sustainable development has been defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Cassen, 1987). Education for Sustainable Development (ESD) entails two complimenting aspects, the first one being the promotion of learning for sustainable development, supported by values and skills that can lead to change, and the second one being the exploration of what it means to live sustainably and its inherent contradictions, by promoting critical thinking to challenge established dogmas regarding sustainable development (Vare & Scott, 2007). ESD refers to the inclusion of sustainability themes into teaching practices to motivate learners to take meaningful action that advances sustainable development by fostering key competencies such as critical thinking, future scenarios and collaborative decision making (UNESCO, 2012, p.2).

ESD has an essential role in the Agenda 2030, the culmination of UN's efforts to promote sustainable development across the globe. This coordinated action plan consists of 17 Sustainable Development Goals (SDGs), whose complexity, interrelatedness, and synergistic nature emphasizes a holistic approach, where each goal affects the other (Tremblay et al, 2020). Education plays a critical role to promote these goals, and as a result ESD has been integrated into many frameworks that link to sustainability issues as a vital part of the quality education equation (Rosa, 2017; Leicht et al, 2018).

Sustainable development is relevant to the Thai context since there is a significant overlapping between the SGDs and the National Strategic Plan of Thailand (Kuhavichanun, 2017) which was influenced by the principles of Sufficiency Economy Philosophy (SEP) as well as the SDGs (Sethakul & Utakrit, 2019). The principles of SEP are deeply rooted within the country's 5-year Economic and Social Development plan as well as its 20-year National Strategy Plan, while simultaneously aligning with the 2030 Agenda for Sustainable Development and is often seen as a mechanism to promote ESD (Ministry of Foreign Affairs, 2016a).

ESD requires the fostering of sustainability competencies and a competency-based approach that includes a learner centered pedagogy focused on the application of knowledge. Although specific ESD competencies have been identified to assist towards a holistic competency-based reorientation of the educational system, research on the integration of ESD practices is still ongoing. Considering the interdependency among ESD competencies, an apparent lack of consensus poses as an obstacle. In a Delphi study regarding future-oriented higher education, the relevance regarding key sustainability competencies varies between global North and South, as different experts place different value on the relevance of such competencies (Rieckmann, 2012).

To bridge this gap, the ESD competency framework chosen for this study is the Rounder Sense of Purpose (RSP) Framework (Millican, 2022), a practical competency framework that can be applied to a variety of educational contexts aimed at in-service and pre-service educators. The main reason for choosing this framework is its practicality and its direct connection with the UN's SDGs that have been officially adopted and promoted by Thailand's Ministry of Education (Mongkolnchaiarunya & Suntigul, 2024).

The aim of this study is to investigate the emergence of RSP sustainability competencies within ESD-based education in the curriculum of a 3rd year B.Ed. students' course in Thailand, titled Literary Works for English Language Teaching. The study's findings can shed some light on students' learning effectiveness, defining it as "the degree to which participants acquire the intended knowledge, skills, attitude, confidence, and commitment based on their participation" (Kirkpatrick & Kirkpatrick, 2016, p. 42), through a competency-based approach using the New World Kirkpatrick Model (NWKM) as an evaluation framework. Since sustainability competency evaluation is still under researched, this study attempts to bridge the gap between competency-based education and evaluation of sustainable development competencies by providing a framework that future researchers can expand upon to further ESD evaluation tools and strategies.

## 2. Literature Background

When sustainable development is applied in education, it promotes democratic, self-determined participation toward actions regarding global issues, and encompasses pedagogies and approaches that create agents of change through the competences it fosters (MGIEP, 2017). It is, thus, necessary to understand the interconnectivity and multidimensionality of environmental and sustainability issues which go far beyond a simplistic 'problem-solution' or 'cause-effect' way of thinking (Tilbury & Wortman, 2004). This means that simply by raising awareness we cannot touch upon the level of complexity that encompasses such issues.

Advancing sustainable-related competencies can be an effective approach to transform students into agents of change, and a competency-based approach towards ESD is the most appropriate method of advancing sustainability efforts in education. A competency-based model aligns with Gibbons' (1998) mode of knowledge that is characterized by knowledge production in the context of collaborative, transdisciplinary application. It is also characterized by learner-centered pedagogy, placing competencies ahead of knowledge, thus structuring the curriculum 'backwards' since knowledge depends on the competencies chosen.

Adopting a competency-based approach however requires a competency-oriented learning assessment. The Commonwealth Secretariat has proposed a curriculum framework for the SDGs that assist towards a competency-based approach with different learning outcomes being categorized across the SDGs and across educational levels (Osman et al, 2017). In another framework, suggested by UNESCO, the learning objectives are categorized into cognitive learning objectives, socio-emotional learning objectives, and lastly behavioural learning objectives. Together with a different set of key competencies, this framework also proposes topics and examples of learning approaches for each SDG to help towards the implementation of ESD integration (Rieckmann, 2017).

In Thailand, the notion of sustainability and sustainable development has existed for more than 20 years. As an answer to the economic crisis in 1997, His Majesty King Bhumibol Adulyadej proposed a set of principles that would guide Thai society towards a sustainable future (Ministry of Foreign Affairs,2016b). Those principles were codified under the Sufficiency Economy Philosophy (SEP), which promotes moderation and balanced development practices for individuals, families, and communities. It allows innovation and modernity while safeguarding against global crises, while advocating for prudence and caution against new untested theories (NESDB, 2002).

Recent studies highlight the importance of a more consistent approach towards developing pre-service teachers' ESD competencies due to the inherent complexities and conflicts that teachers must navigate to internalize such concepts (Chaaban et al., 2023). There is a plethora of ESD frameworks regarding educator's competencies, however they have issues regarding their applicability. The most prevalent ones are UNECE (2011), Key Competencies in Sustainability

(Wiek et al, 2011) and A Rounder Sense of Purpose (Millican, 2022). This research adopts the Rounder Sense of Purpose (RSP) competency framework due to its simplicity and its link with the SDGs, since each competency aligns with each of the Sustainable Development Goals. Millican (2022) compiled a framework of 12 competencies, arranged in a grid with three columns and 4 rows. Each competency is accompanied with an explanatory descriptor and three learning outcomes that guide the educator towards making these competencies attainable (Millican, 2022).

**Table 1.** The Rounder Sense of Purpose (RSP) Framework

| | **Think Holistically** | **Envisioning Change** | **Achieving Transformation** |
|---|---|---|---|
| Integration | Systems | Futures | Participation |
| Involvement | Attentiveness | Empathy | Values |
| Practice | Transdisciplinary | Creativity | Action |
| Reflexivity | Criticality | Responsibility | Decisiveness |

Assessing ESD competencies is another fundamental issue that remains unresolved. According to Redman et al. (2021, p. 118), "reliable and valid tools for assessing competencies fulfil an important function in supporting structured teaching efforts and student learning for sustainability". Similarly, studies also highlight the need for innovation regarding assessment tools that extends beyond self-assessment instruments by redesigning the structure of the curriculum to accommodate a more holistic approach towards ESD (Hammer & Lewis, 2023). According to a literature review study regarding tools for assessing competencies (Redman et al, 2021), eight distinct assessment tools have been identified and are categorized under three clusters: self-perceiving-based assessment procedures, observation-based assessment procedures and test-based assessment procedures. Such tools include scaled self-assessment, reflective writing, scenario or case test, interview, performance observation, concept mapping, conventional tests, or regular course work. This research includes evaluation tools from all the previous clusters, thus providing multiple perspectives in the evaluation process. This study aims to contribute to the ESD scholarly discourse by identifying emerging RSP sustainability competencies within ESD-based education by using the New World Kirkpatrick Model of evaluation (NWKM).

There are four distinct levels in the NWKM: Reaction, Learning, Behavior and Results. The first level, Reaction, refers to "the degree to which participants find the training favorable, engaging, and relevant to their jobs" (Kirkpatrick & Kirkpatrick, 2016, p. 39). The second level, Learning, consists of 5 sub-levels, namely (1) Knowledge, (2) Attitudes, (3) Skills, (4) Confidence, and (5) Commitment and pertains to "the degree to which participants acquire the intended knowledge, skills, attitude, confidence, and commitment based on their participation in the training" (Kirkpatrick & Kirkpatrick, 2016, p. 42). The third level, Behaviour, focuses on "the degree to which participants apply what they learned during training when they are back on the job" (Kirkpatrick & Kirkpatrick, 2016, p. 49). Finally, level four, Results, refers to "the degree to which targeted outcomes occur as a result of the training and the support and accountability package" (Kirkpatrick & Kirkpatrick, 2016, p. 60) which can be achieved by identifying leading indicators that contribute to results.

Although the NWKM model is most widely associated with corporate training, it has also been adapted for educational settings to evaluate teacher's performance (Mahmoodi et al, 2019), or in a higher education environment (Cahapay, 2021). There have also been cases where this model was used to evaluate ESD projects (Calvo et al, 2020; Chiang et al, 2022). Despite its criticism, the use of this evaluation process has been previously used in various trainings, well-regarded for its "clarity of its focus on program outcomes and its clear description of outcomes beyond simple learner satisfaction" (Frye & Hemmer,2012), and there are various examples of evaluation tools that can easily be adapted to combine the complexity of a competency-based approach, making it a suitable framework under which sustainability competencies can be evaluated.

## 3.Research Design

This study employed a case study methodology with a mixed-methods evaluation strategy, integrating qualitative and quantitative tools to assess learning effectiveness within an ESD-competency-based course, guided by the New World Kirkpatrick Model (NWKM).

### *3.1 Research Design and Framework*

The purpose of this mixed methods study is to assess learning effectiveness by identifying the emergence of sustainability competencies within an ESD-competency-based course, using the NWKM as the guiding framework.

In this evaluation design, the assessment was structured across four domains of learning: knowledge, skills, attitudes, and confidence. Drawing on Redman et al. (2021), this study adopted a competency-based evaluation framework in which multiple instruments were selected from pre- established clusters of assessment tools, ensuring adequate representation from all three cluster types (see Figure 1 and Table 2). This design allows for alignment between NWKM's learning domains and the RSP framework while also being grounded in ESD-based evaluation methods.

**Table 2.** Overview of Evaluation Tools

| | **Cluster Types** | **Self-perceiving-based assessment** | | | **Observation-based assessment** | | **Test-based assessment** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Assessment Tools** | Scaled self-assessment | Reflective Writing | Focus group/ interview | Performance Observation | Course Work | Concept Mapping | Scenario/ case test | Conventional test |
| **NWKM Learning Sub-levels** | **Knowledge**<br>To evaluate the degree to which participants acquire the intended knowledge based on their participation | | | | | Animal Farm Project- Once, as a group task (Video output/Script) | Concept Map- Once, as an in-class activity | | |
| | **Skills**<br>To evaluate the degree to which participants acquire the intended skills based on their participation | | Student Reflection- Once, individual, the end of the course | | | | | | |
| | **Attitudes**<br>To evaluate the degree to which participants acquire the intended attitudes based on their participation | | | | | | | Community Action Plan- Once, group task | |
| | **Confidence/ commitment**<br>To evaluate the degree to which participants acquire the intended confidence and commitment based on their participation | Retrospective pre-post assessment - Once, individual, at the end of the course | | | | | | | |

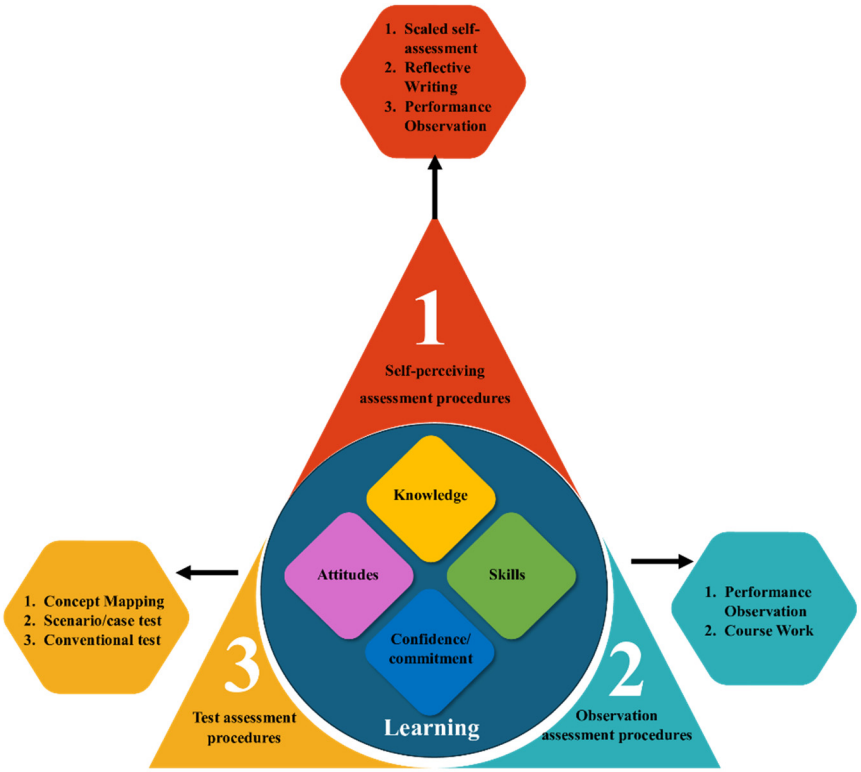


**Figure 1.** Competency-Based Learning Framework

In the overall evaluation of the four learning domains, the mixed methods designs were convergent and sequential designs, and both quantitative and qualitative data were collected and analyzed in each domain (Creswell & Clark, 2017). The qualitative aspect consisted of student-produced materials including reflection essays, project action plans, concept maps, and group projects, which were thematically coded using the 12 RSP competencies as a conceptual framework. These coded results were converted into frequency counts to allow comparisons across the four learning domains. The quantitative strand consisted of a survey measuring students' confidence and commitment in each of the 12 competencies, providing a scaled self-assessment of learning outcomes. The justification for using mixed methods is to best understand the depth of the knowledge domains in relation to students' emerging RSP competencies to determine the effectiveness of the ESD-embedded literature course in fostering sustainability-related knowledge, skills, attitudes, and confidence.

*3.2 Participants and Context*

The course chosen for ESD integration is titled "Literary Words in English Language Teaching" and is being taught to 3rd-year B.Ed. students at a HEI in Thailand. The course curriculum has been structured around a competency-based approach, guided by the RSP competency framework that defines key learning outcomes for pre-service teachers. Content and assignments have been adapted to integrate ESD-focused pedagogies, aiming to equip future Thai teachers with the knowledge, skills, and professional values to foster sustainability in their teaching practices. The participants were the students who enrolled in the course. In total, 58 students signed and returned both consent forms, and they constitute the final participants of this study.

*3.3 Data Collection Tools and Procedures*

Although the NWKM consists of four levels (Reaction, Learning, Behavior, and Results), this study focuses exclusively on Learning (Level 2), as it aligns with the scope of the study. Level 2 consists of five sub-domains: Knowledge, Attitudes, Skills, Confidence, and Commitment. For the purposes of this study, Confidence and Commitment were combined into a single domain. The following sections describe the data collection tools used for each domain, their purpose, and their alignment with the RSP competency framework.

3.3.1 Knowledge

Students' knowledge was assessed through two tasks: a concept mapping exercise and the Animal Farm group

project. In the concept mapping, an exercise modified from an ESD toolkit exercise titled 'Seeing your community through a Sustainable Lens' (McKeown et al, 2002, p. 72), students were asked to construct a concept map as the focal point (Pache & Rouiller, 2022). The concept map was organized into three main themes (Economy, Society, and Environment), following the Wedding cake Framework, created by Folke et al (2016). The purpose of this research tool was to analyze and identify keywords/sentences directly linked to specific RSP competencies. The Animal Farm Group Project was an in-class group activity where students analyzed and reflected critically upon the lessons learned from the novella "Animal Farm" by George Orwell. Participants created a group video which was posted on the Flipgrid platform, and the script was sent separately on Microsoft TEAMS.

3.3.2 Attitudes

Data collected comprised of students' reflection essays after the completion of their community-based project. Its purpose was to analyze and identify keywords/sentences directly linked to specific competencies of the RSP Framework.

3.3.3 Skills

Students' skills were collected through action plans created using ESD Tool 2: Action Planning for Change, guiding students to design objectives, teaching strategies, timelines, potential risks, and anticipated outcomes (UNESCO Office Bangkok and Regional Bureau for Education in Asia and the Pacific, 2018, p. 57).

3.3.4 Confidence and Commitment

Data was collected using a retrospective pre-post assessment where students rated on a Likert scale their confidence and commitment levels based on each of the twelve RSP competencies. This questionnaire was taken from the suggested evaluation tools from the Kirkpatrick's model, and the researchers defined the learning objectives as the 12 RSP competencies, asking students to self-report their levels of confidence/commitment in each competency.

*3.4 Data Analysis*

Qualitative data collected throughout the course was analyzed using deductive thematic analysis. For the domain of Knowledge (concept maps and Animal Farm project), the analysis was completed with the 12 RSP competencies as predetermined themes, and students' identified keywords were aligned to specific SDGs as well as RSP competencies. For the domain of Attitudes and Skills, the thematic analysis targeted specifically the RSP competencies that emerged from students' action plans and reflection essays, allowing consistency towards identifying trends regarding the RSP competencies across NWKM Learning domains. Quantitative data was collected through a retrospective pre-post Likert-scale survey on students' confidence and commitment. The SPSS program for statistical analysis was used to identify any statistical significance between the students' scores, comparing students' confidence and commitment before and after the course retrospectively, thus opting for a paired sample T-test.

For a more comprehensive view of the effectiveness of student's learning, the researchers employed a convergent design where both qualitative and quantitative findings were presented on each NWKM level to identify areas of alignment or divergence. Qualitative data were transformed into frequency counts of competencies and were compared with survey results, with paired-sample t-tests used to determine whether changes in students' confidence and commitment before and after the course were statistically significant. This synthesis provides an integrated view of NWKM's Learning level and allows for a deeper understanding of students' competency development across knowledge, skills, attitudes, and confidence. The results of this convergence are presented in Table 4, which reports both qualitative and quantitative findings for each RSP competency, thus enabling the identification of patterns of convergence or divergence across the NWKM's domains.

## 4. Findings

*4.1 Knowledge*

In the concept map task, students were asked to construct concept maps centered on the human activity of burning crops, an activity relevant to the Thai context due to its major environmental and social impacts. Analysis focused on the 18 concept maps produced during group work. Across the Economy theme, nine competencies emerged, with Criticality appearing most frequently, largely linked to SDG 8: Decent Work and Economic Growth. Within the Society theme, eight competencies were identified, making it the most interlinked category, with Systems as the predominant competency, supported by seven SDGs and highlighting its multi-faceted nature. Similarly, in the Environment theme, six competencies emerged, again with Systems as the most frequent competency, linked to seven SDGs, emphasizing its cross-thematic relevance.

As seen from the following Overview chart (Figure 2), there are four main competencies that emerge from the concept map activity. These are the RSP competencies of Systems, Criticality, Attentiveness and lastly Transdisciplinary. These four competencies constitute the main category of Thinking Holistically and each one represents a different theme of Integration (systems), Involvement (attentiveness), Practice (Transdisciplinarity) and Reflexivity (Criticality).

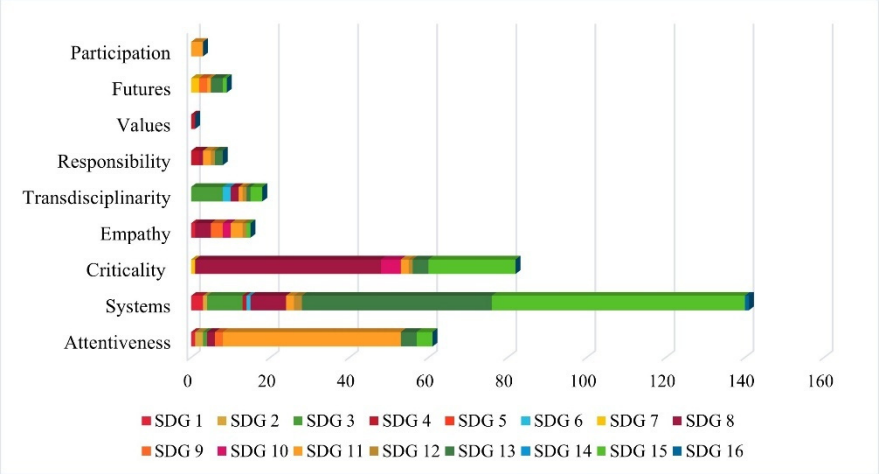


**Figure 2.** Concept Map Competencies

In the Animal Farm task, the students' 17 group projects were analyzed and specific quotes from their scripts that aligned with the SDGs as well as the RSP competencies were chosen. The column "Achieving transformation" as well as the row "Practice" were omitted from the analysis since they focus on action which does not relate to the purpose of the assignment. The most prevalent competencies (Figure 3) that were touched upon referred mostly to Systems, Attentiveness, and Criticality. All six predetermined competencies were present in the Animal Farm activity, covering both "Thinking Holistically" and "Envisioning Change" RSP columns.

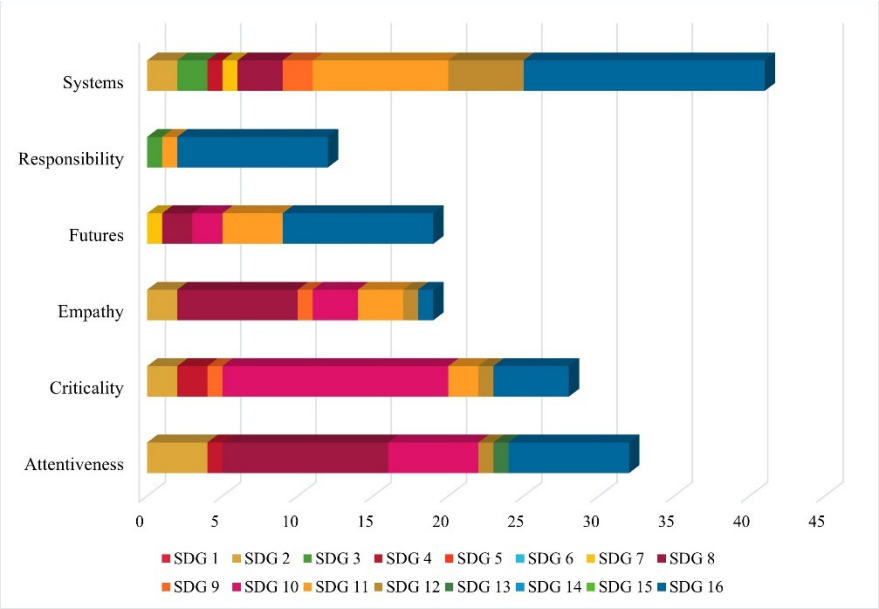


**Figure 3.** Animal Farm Competencies

*4.2 Skills*

Based on 16 group community projects, the students' reflection essays were analyzed and specific quotes from their scripts were chosen that aligned with the RSP competencies. The most prevalent competencies (Figure 4) present in self-reflection are Decisiveness, Participation, and Values, which also constitute the domain of "Achieving Transformation" according to the RSP framework.

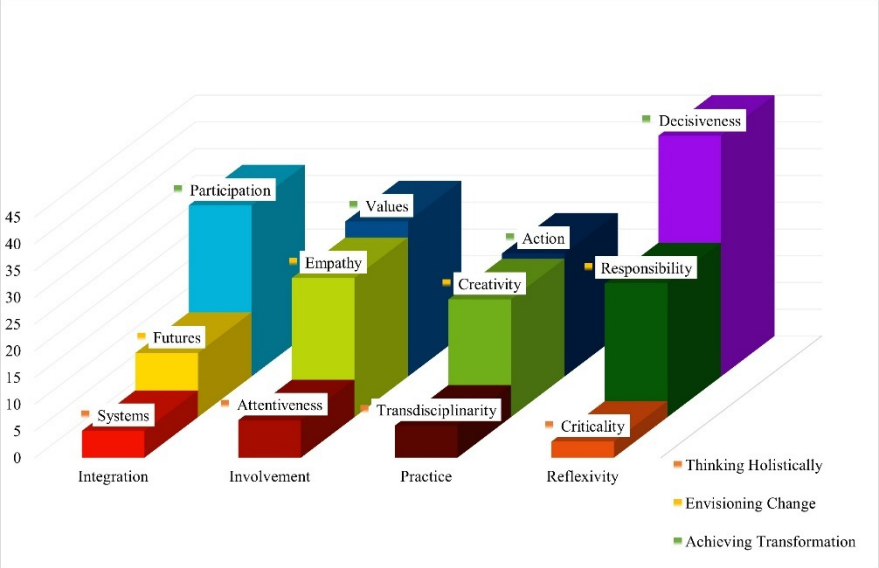


**Figure 4** Personal Reflection Competencies

*4.3 Attitudes*

Based on 16 group community projects, the students' action plans taken from the ESD tool *Action Planning for Change* were analyzed, and specific quotes were aligned with the RSP competencies. Figure 5 presents all community-based projects that pre-service teachers designed and implemented. The most prevalent competencies in the action plans are three: Decisiveness (14 projects), Participation (8 projects), and Action (12 projects). As seen from Table 1, the categories of these competencies refer to "Achieving Transformation".

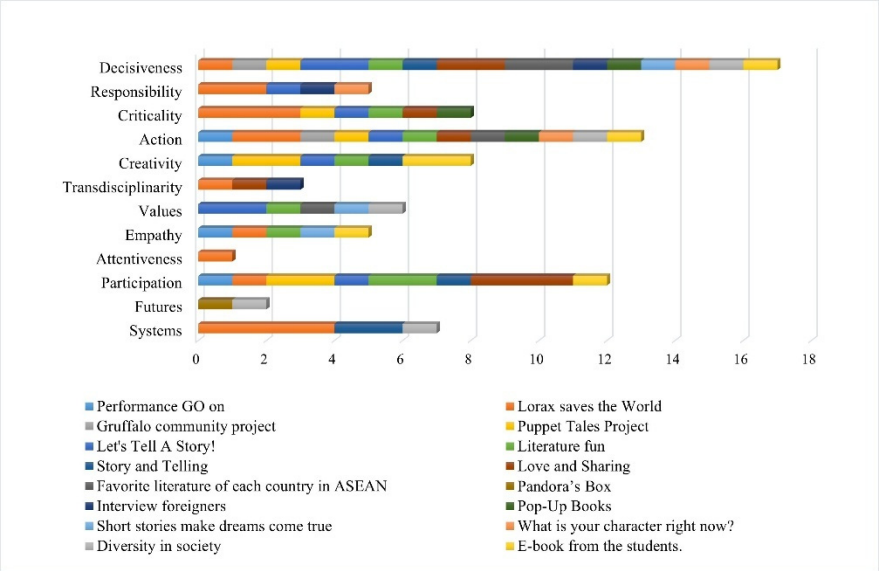


**Figure 5.** Action Plan Competencies

*4.4 Confidence & Commitment*

Confidence and commitment were measured by a Retrospective Pre-post Survey to identify whether there is a statistically significant difference between students' confidence and commitment before and after the course for each variable in the entire population (Table 3). The number of respondents is n=23. This is achieved using the paired sample T-test rather than a non-parametric test due to the type of data (Likert scale data). We are dealing with a one-tailed test where our hypotheses are as follows:

$H_0$: There is no statistically significant difference between before and after.

$H_1$: There is a statistically significant difference.

**Table 3.** Retrospective Pre-post Survey Results

| | Paired Differences | | | | | | | Significance | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 95% Confidence Interval of the difference | | | | | |
| Components | Mean | Std. Dev. | Std. Error Mean | Lower | Upper | t | df | One-Sided p | Two-Sided p |
| Systems Before-After | -.522 | .898 | .187 | -.910 | -.133 | -2.787 | 22 | .005 | .011 |
| Futures Before-After | -.304 | .470 | .098 | -.508 | -.101 | -3.102 | 22 | .003 | .005 |
| Participation Before-After | -.174 | .650 | .136 | -.455 | .107 | -1.283 | 22 | .107 | .213 |
| Attentiveness Before-After | -.391 | .656 | .137 | -.675 | -.107 | -2.859 | 22 | .005 | .009 |
| Empathy Before-After | -.217 | .600 | .125 | -.477 | .042 | -1.738 | 22 | .048 | .096 |
| Values Before-After | -.217 | .736 | .153 | -.536 | .101 | -1.417 | 22 | .085 | .171 |
| Transdisciplinarity Before-After | -.261 | .619 | .129 | -.529 | .007 | -2.021 | 22 | .028 | .056 |
| Creativity Before-After | -.435 | .662 | .138 | -.721 | -.148 | -3.148 | 22 | .002 | .005 |
| Action Before-After | -.304 | .635 | .132 | -.579 | -.030 | -2.299 | 22 | .016 | .031 |
| Criticality Before-After | -.565 | .843 | .176 | -.930 | -.200 | -3.214 | 22 | .002 | .004 |
| Responsibility Before-After | -.522 | .790 | .165 | -.863 | -.180 | -3.166 | 22 | .002 | .004 |
| Decisiveness Before-After | -.435 | .896 | .187 | -.822 | -.047 | -2.328 | 22 | .015 | .030 |

To determine if there is a statistically significant difference between before and after, it suffices for the p-value to be greater than the level of significance 'a', where a = 0.05 in this specific test. From the 12 RSP pairs of competencies analyzed, the researchers do not reject the initial hypothesis (H0) in the Participation and Values RSP competencies, which translates to no significant difference being found. However, in the remaining ten RSP competencies, the researchers reject the initial hypothesis and claims the H1 hypothesis to be true, which translates to the fact that there is indeed a significant difference in the students' confidence and commitment towards those competencies compared to before and after the course.

*4.5 Convergent Analysis of RSP Competencies Across Learning Dimensions*

To integrate the findings from both qualitative and quantitative data, a convergent design was employed to combine the quantitative results measuring students' confidence and commitment before and after the course with the emergence of RSP competencies. Table 4 presents a joint display of RSP competencies across the four learning domains (Knowledge, Skills, Attitudes, and Confidence/Commitment) and integrates the qualitative coding of students' work with quantitative p-values indicating whether students' confidence and commitment in each competency changed significantly from before to after the course. Overall, the table highlights both where competencies are concentrated in students' work and where their confidence and commitment developed most strongly throughout the course. One notable emerging pattern refers to competencies that are more applied, or action-oriented such as Participation, Values, Empathy, Creativity, Action, Responsibility, and Decisiveness which tended to show the largest gains in students' confidence and commitment. In contrast, cognitive or abstract competencies, like Systems, were predominantly expressed in Knowledge and showed smaller relative increases in students' confidence.

**Table 4.** Joint Display of RSP Competencies Across Learning Dimensions and Changes in Confidence/Commitment

| | RSP Competencies | Knowledge | Skills | Attitudes | Confidence/ Commitment | Comparison/ Interpretation |
|---|---|---|---|---|---|---|
| **Integration** | Systems | 34.5% | 2.1% | 1.7% | .005 | Highly skewed to Knowledge (Δ≈32.8 pp). Significant difference ($p < .05$). |
| | Futures | 7.65% | 5.1% | 5.2% | .003 | Balanced (Δ≈2.6 pp). Significant difference ($p < .05$). |
| | Participation | 1.45% | 13.6% | 15.7% | .107 | Skewed to Skills/Attitudes (Δ≈14.3 pp). No significant difference ($p > .05$). |
| **Total** | | **43.6%** | **20.8%** | **22.6%** | | Strongly Knowledge-driven overall, but Skills/Attitudes contribute. |
| **Involvement** | Attentiveness | 19.6% | 3.0% | 1.7% | .005 | Skewed to Knowledge (Δ≈17.9 pp). Significant difference ($p < .05$). |
| | Empathy | 8.5% | 11.1% | 8.7% | .048 | Balanced (Δ≈2.6 pp). Significant difference ($p < .05$). |
| | Values | 0.5% | 12.3% | 14% | .085 | Skewed to Skills/Attitudes (Δ≈13.5 pp). No significant difference ($p > .05$). |
| **Total** | | **28.6%** | **26.4%** | **24.4%** | | Fairly balanced overall, slight Knowledge lead. |
| **Practice** | Transdisciplinarity | 2.65% | 2.6% | 7% | .028 | Moderately balanced (Δ≈4.4 pp), Attitudes lead. Significant difference ($p < .05$). |
| | Creativity | - | 9.4% | 14% | .002 | Skewed to Attitudes (Δ≈14.0 pp). Significant difference ($p < .05$). |
| | Action | - | 9.8% | 10.5% | .016 | Skewed to Skills/Attitudes (Δ≈10.5 pp). Significant difference ($p < .05$). |
| **Total** | | **2.65%** | **21.8%** | **21.5%** | | Skewed toward Skills/Attitudes, Knowledge minimal. |
| **Reflexivity** | Criticality | 21.4% | 1.3% | 3.5% | .002 | Highly skewed to Knowledge (Δ≈20.1 pp). Significant difference ($p < .05$). |
| | Responsibility | 5.2% | 10.6% | 10.5% | .002 | Moderately balanced (Δ≈5.4 pp), Skills≈Attitudes. Significant difference ($p < .05$). |
| | Decisiveness | - | 19.1% | 3.5% | .015 | Skewed to Skills (Δ≈19.1 pp). Significant difference ($p < .05$). |
| **Total** | | **26.6%** | **31%** | **17.5%** | | Skewed to Skills, Knowledge moderate, Attitudes lower. |

## 5. Discussion

This study investigates the assessment of learning effectiveness to identify the emergence of RSP sustainability competencies within an ESD-competency based course using the NWKM as an evaluation framework. As seen by figure 6, the majority of RSP emerging competencies are categorized under the "Thinking Holistically" group, as well as the "Integration" group. The area of "Reflexivity is the second most prevalent category of competencies that also moves towards "Achieving Transformation". The area of "Involvement" can also be seen to expand in the direction of "Envisioning Change" on a higher level compared to others, and finally the area of "Practice" is balanced between the three columns of the RSP competencies.

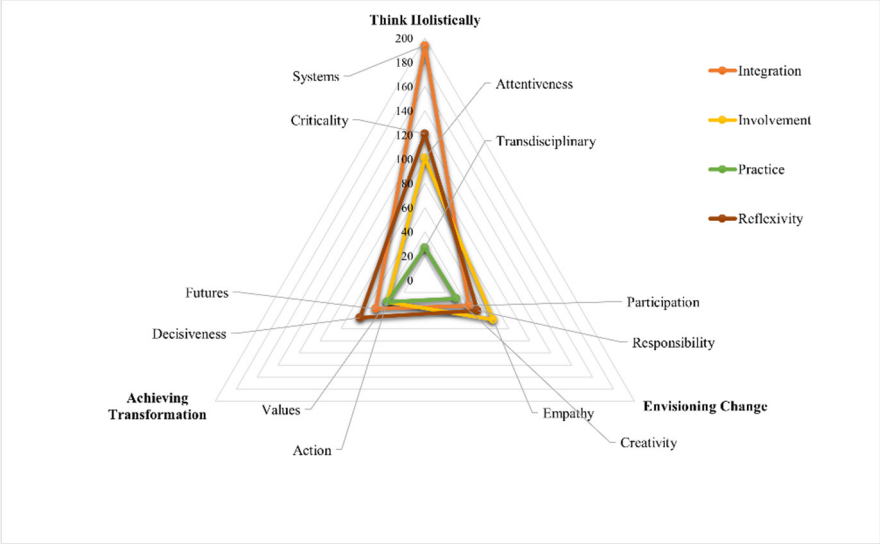


**Figure 6.** Overview of RSP Competencies

In this research, the use of a concept map highly promotes the competence of criticality and by allowing educators to choose relevant topics, cultural awareness can also be promoted substantially. It can be argued that such activity addresses the gap in previous research regarding ESD integration in the BELL project (Du et al, 2013), where critical reflection and cultural awareness were found lacking. The focus on meaning-making and the structuring of concept maps around the three predetermined themes of Economy, Environment, and Society aligns closely with holistic approaches to concept-map analysis. These approaches prioritise qualitative interpretations that clarify how students organise and understand knowledge within a specific topic (Jackson et al., 2024). However, the quality of students' understanding becomes clearer when examined through a competency-based lens. Beyond systems thinking, students demonstrated the ability to critically evaluate the reliability of their beliefs and assertions. Attentiveness emerged as the third most prominent competency, drawing attention to how students recognise the urgency of addressing unsustainable practices, an indirect call for action and involvement. Finally, Transdisciplinarity challenges students to rethink their roles and act collaboratively beyond disciplines and across different perspectives. Previous research has shown that educators consider Transdisciplinarity as essential for ESD, despite the lack of opportunities to efficiently develop and implement this competence (Corres et al., 2024) Thus, cultivating such skills helps pre-service teachers embed key sustainability competencies within their professional identity, a process that strengthens their capacity apply teaching practices through a sustainability-oriented lens. The results from the animal farm role-play assignment present a different set of salient competencies. Although role-playing activities are recommended for teaching sustainability issues (Cotton & Winter,2010) there is scarce evidence regarding learning outcomes related to attitudes that support their effectiveness (Oulton et al., 2004). When examined through a competency-based approach, role-playing activities such as the Animal Farm assignment can shed light on the depth of the engagement as well as identifying the attainment of specific competencies withing a specific scenario.

As seen from the in-class tasks, although the salient competencies are categorized under each of the four RSP rows (Integration-Involvement-Practice-Reflexivity), their competency development is only limited to the low end of the RSP competencies (Farioli et al, 2017, p. 4964). The only situation where the competencies expand across the RSP high-end competencies is when the activity was based on action-oriented pedagogy. This finding can bridge the gap in lack of research regarding developed competencies in community-based forms of learning (Mulà et al, 2022), while

also agreeing with previous research indications that community-based learning is an appropriate pedagogical strategy to improve sustainability competences (Lozano & Barreiro-Zen, 2022).

Regarding students' action plan, most emerging competencies are categorized under Achieving Transformation, although we can see evidence of competencies from the other two columns. One reason for the emergence of competencies across all columns may be because planning is a complex procedure that touches upon a multitude of competencies. According to Redman & Wiek (2021), "systems-thinking, futures-thinking, values-thinking, and strategies-thinking enable crafting sustainability action plans" where such competencies are grouped and labeled as planning competencies. In this sense, the study's findings highlight the potential of action plans to activate multiple competencies as well as the need for detailed assessment methods that can distinguish between internalized competencies and task-based driven performance.

Finally, the students' emerging competencies as identified from their reflection essays align with competencies from both Envisioning Change as well as Achieving Transformation. These competencies target students' learning skills and are mostly activated in the higher-level competencies, such as Decisiveness ($\Delta \approx 19.1$ pp). Reflective writing expands upon the competencies demonstrated in the students' action plans, thus supporting their internalization and further development. Introspection has been identified as a prerequisite for the acquisition of metacognitive competencies, so the emergence of a variety of competencies linked to both RSP categories is expected (Weinert, 2001).

At this point it is suggested that there is a correlation between certain activities and certain competencies that is worth exploring. This is an important finding as previous research in aligning competencies with learning activities mentions that usually teachers are not confident regarding the choice of learning activities for each competency (Guerrero-Roldán & Noguera, 2018). Despite the importance of a clear competency framework, effective implementation in classroom practices also requires concrete task-based assessment tools as well as examples of how such competencies can be evaluated through observable student performance. The need for a competency assessment has also been highlighted in a recent study (Annelin & Boström, 2023) which points out that educators lack knowledge about students' sustainability competencies and formative assessment tools would be valuable to help evaluate key sustainability competencies. The RSP website offers a variety of activities aligned with the SDGs and each of its twelve competencies, which explains why many articles highlight the importance of this online resource (Kadji-Beltran & Zachariou, 2022; Shephard, 2022).As a criticism, however, it is mentioned that a more detailed description of the examples would make the framework easier to use (Zachariou & Kadji-Beltran, 2022). The importance of the RSP website is thus neglected and despite the existence of activities that relate to each RSP competency and each SDG, there is no research to support that those suggested activities indeed promote the competencies they claim to promote.

This highlights a broader gap regarding the applicability of the RSP framework. Its lack of practical assessment strategies despite a strong theoretical foundation prevents teachers from actively embedding ESD competencies into their teaching practices. The present study addresses this need by demonstrating how specific activities and assessment strategies support the attainment and evaluation of specific RSP competencies, thus providing educators with a more practical model for competency evaluation.

## 6. Conclusion

This study explored the potential of an ESD-oriented curriculum to provide concrete evidence of students' sustainability competency acquisition.By identifying links between pedagogical activities and specific ESD competencies, this study addresses the gap between theoretical frameworks and practical classroom implementation by providing directions to educators that seek to design meaningful learning experiences that equip students with high-order competencies and skills for the 21st century. The study's findings also underscore the importance of integrating quantitative and qualitative evidence, as the convergent analysis reveals growth in applied and high-end competencies supported by action-oriented pedagogical approaches. Students demonstrated high confidence and commitment in competencies such as Decisiveness, Participation, and Empathy, which indicates that future instructional designs may build on these areas and implement strategies to broaden and deepen their development.

ESD competencies are transformative in nature and encapsulate the notion of a process, which can complicate the assessment procedure. It is understood that competences are difficult to evaluate (Scherak & Rieckmann, 2022), so a suggested alternative is to identify observable assessment points that can serve as sufficient evidence that teacher education increases the possibility of such transformations to take place. (Farioli et al, 2022, p.177). For this to be achieved, educators and institutions need to reconsider the notion of assessment despite the inherent complexity of

evaluating such multifaceted learning outcomes. It is the authors' opinion that the NWKM is an effective starting point that can provide an in-depth look into the acquisition of competencies from multiple perspectives.

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**Authors contributions**

Mr. Balis conceptualized the study, designed the research framework, implemented the ESD-competency-based course, collected the qualitative and quantitative data, conducted the data analysis, and drafted the manuscript. Dr. Vungthong provided methodological guidance, contributed to the evaluation design, critically reviewed the data analysis, and revised the manuscript. Both authors read and approved the final manuscript.

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No additional data are available.