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University Teachers' Change Readiness to Implement Education for Sustainable Development through Participation in a PBL-Based PD Program

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Abstract: This study investigated university teachers' perspectives on their change readiness to implement education for sustainable development (ESD) through their participation in a problem-based learning (PBL) pedagogical development (PD) program. Theoretically, the study connected a systems-thinking approach to change readiness literature and proposed a four-dimensional conceptual framework, including intrapersonal, relational, and environmental dimensions. Q methodology was adopted to collect and analyze data both qualitatively and quantitatively. Four significantly different viewpoints emerged among the 25 participants regarding what they considered most important for their change readiness towards ESD, namely (1) improvement of teaching and learning performance, (2) personal learning and conviction, (3) applying PD learning to practice, and (4) student learning engagement and professional practice. Revealing a complex and interrelated connection between the four dimensions of change readiness, these results also observed university teachers' expression of learning gains and engagement in prospective change. Nevertheless, such change readiness was mainly within their micro teaching practice environment, with little anticipation of commitment to a wider institutional scale of change. Such restrictions on their change readiness were attributed to constrained institutional conditions and supports for long-term improvement. Results of the study suggested that it is essential to facilitate both individual awareness and efforts, as well as institutional readiness for the goal of implementing ESD in higher education (HE). In this regard, both systemic and systematic professional learning activities are recommended.

Keywords: change readiness; education for sustainable development (ESD); problem-based learning (PBL); professional learning; Denmark; Colombia; systems thinking

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1. Introduction

Higher Education (HE) systems are undergoing multiple changes in response to compounding challenges related to growing technological development, complex societal changes, and global sustainability demands [1,2]. To respond to these challenges, HE systems are beginning to address the sustainable development goals of quality education (SDG4), which requires students to develop several competences, including systems thinking, critical thinking, anticipatory thinking, integrated problem-solving and collaboration, all of which contribute to a life-long learning perspective [3,4]. Accordingly, many HE systems have strived to embed education for sustainable development (ESD) principles [5], which advocate a holistic approach to education developed through transformative, democratic, and emancipatory learning experiences. ESD demands change at multiple levels

of HE systems, particularly the need for university teachers to adopt new pedagogical approaches and models [2,4,6,7].

A major observation over the decades has been universities' engagement and commitment to pedagogical development (PD) that promotes learner-centeredness as a means to equipping graduates with critical competences demanded by diverse professions and societies [8]. To achieve such demands, university teachers are considered as change agents who play a key role in changing their teaching practices and maximizing student learning outcomes. Various forms of PD activities are provided as a means to support such change. Despite various aims, modes, duration, and delivery forms, research in the field of evaluating outcomes of such PD activities provide little evidence on their effectiveness. Therefore, inconclusive findings on university teachers' professional learning from PD activities and the sustainability of change afterwards remain inconclusive [9–12].

One of the major critiques towards current PD is the linear way of organizing activities through information transmission modes that assume university teachers would automatically learn and implement change directly into their classrooms, and consequently lead to improving student learning outcomes [10,13]. Recent interest in university PD has emphasized the complexity of university teachers' professional learning, as they enact professional agency and interact with their surroundings [10–12]. Thus, a systems-thinking approach was adopted in this study to conceptualize and design the PD program, and incorporate multiple interrelated dimensions that supported individuals' readiness for change through adjusted pedagogical beliefs and improved teaching practices [9,11]. The PD program further aimed to bring university teachers together in collaborative teams to facilitate a wider scope of individual and collective change, create momentum for the sustainability of change by engaging diverse individuals over time, and develop mechanisms for handling emotions throughout the change process [2,14,15].

Prior literature has shown that ESD is supported by pedagogical approaches such as inquiry-based methods, collaborative learning, place-based learning, experiential learning, and self-directed learning [2–4,16]. Accordingly, a problem-based learning (PBL) methodology—defined as "an instructional learner-centered approach that empowers learners to conduct research, integrates theory and practice, and applies knowledge and skills to develop a viable solution to a defined problem" ([17], p. 7)—is increasingly adopted as a pedagogical choice across all fields of HE, and addresses targeted student competences for the 21st century, including those pertaining to ESD [18]. For example, PBL has been used to support the development of student sustainability thinking in engineering programs [16,19–21]. While previous studies have established an association between PBL methodology and the achievement of ESD principles in HE, there is a need for more conceptual thoughts and empirical evidence on how PBL can be adopted as a methodology to support change readiness of university teachers, such that they are ready for accomplishing large-scale educational change towards sustainable development.

The current study grounds PD efforts in a systems-thinking approach with a long-term goal of cultivating change at a large scale. University teachers who participate in PD are considered change agents whose responsibilities are not only to develop individual pedagogical competence, but also to influence others and create a larger scope of change within their contexts. Therefore, the notion of change readiness becomes relevant in understanding PD participants' learning. Originating in organizational studies, change readiness can be understood as individual's beliefs regarding the suitability of, support for, and significance of a change [22]. Analyzing in which way individuals are ready for a desired change is essential to enhance confidence of teachers to implement change, in particular in response to emergency and complexity in a pandemic context, and ensure successful change outcomes sustainably [23]. In an HE context, university teachers' efficient learning through their participation in PD is core to support their readiness to change, not only in their own micro settings, but also to influence a larger scope of change. Alternatively, when change readiness is lacking from PD participants, there is a higher risk of negative

attitudes and resistance toward change at the institutional level, which will ultimately lead to a failure to change [24].

The context of this study was a PD program that aimed to develop change agents for pedagogical innovation. The program was organized by PD developers from Aalborg University in Denmark, where PBL has been practiced at a systemic level for over 40 years. ESD has also been an important part of its strategy, education, and research [25]. Within this environment, the PD program was designed by adopting systems-thinking and PBL approaches. In practice, the overall program incorporated a holistic mode, including participants working in teams, identifying real-life problems (i.e., issues related to student learning in their given contexts), working on new PBL-inspired teaching designs, implementing these new teaching designs, and evaluating their implementation. Through the program, participating university teachers were exposed to the complexity of multiple interrelated factors that influence change. A framework was proposed to explore complex factors influencing PD participants' change readiness within nested systems including individual, sociocultural, structural, and societal systems [1,13,14,26]. To explore the university teachers' views of what influenced their individual readiness for change, Q methodology (henceforth Q) was adopted to collect and analyze data both qualitatively and quantitatively. Q has been increasingly used to explore the complexity of subjective perceptions on educational issues [27], and was deemed a suitable methodology for this study. This study was guided by the research question: *What do university teachers perceive to be the most important factors supporting their change readiness through their participation in the PD program?* Empirical data were drawn from Q-sorts collected from 25 university teachers from Colombia who participated in the online PBL-based PD program.

2. Theoretical Framework

2.1. Systems Thinking

Systems thinking is a field of research that embraces diverse discipline-related theories and methodologies [28]. It refers to a systematic approach to seeing an organization as a whole with interdependent parts. Systems thinking, as an approach to change, appropriates current reality and takes responsibility for leveraging small scale change that leads to larger scale change [29]. For example, university teachers' professional learning through PD activities may generate other changes in the system. Emphasizing the connections and relationships between components of an organization including people, culture, infrastructure, among others, systems thinking provides an inclusive approach to exploring the complexity of change enaction. A systems-thinking approach provides opportunities to see different sub-systems, perspectives, relationships, and actors within a system as distinguished yet connected [28]. As individuals remain core to any organizational change, it is common that change initiatives start with them. The emphasis on part–whole structure also allows space to see how individuals are constantly interacting with their surroundings as an essential part of the change process.

In a HE setting, a system-thinking approach has been useful to support goals for ESD [1,2]. In particular, university teachers remain an initial target group who can initiate change on a larger scale to integrate and educate sustainable development principles. Accordingly, effective PD should not only focus on how university teachers as individuals learn but should also place them in a larger nested system to see how their learning interacts with other parts of the overall HE system and how they can extend change in their surroundings. Employing a system-thinking approach to designing and organizing PD activities can help establish alignment between an institutional strategy towards ESD and individuals' change processes and engagement with long-term change sequences [15]. Such an approach will also support the change management strategy by highlighting the role of change agents in response to their institutional conditions, and to incorporating social interactions among all actors within the HE system, which increases the chance of long-term change towards ESD [14].

2.2. Change Readiness

The significance of readiness for change has been consistently stressed in the field of change management research, in particular, for the purpose of coping with potential resistance to change and enhancing successful change [30]. In order to enhance the chances of acceptance and adoption of change, before further aspiring for the institutionalization of change, there needs to be readiness among all stakeholders [31]. As widescale change was the ultimate goal, the concept of readiness for change became relevant to understanding university teachers' perceptions and experiences through their participation in the PD program.

A model of change readiness proposed by [22] was based on Lewin's model of unfreezing, moving, and freezing and Bandura's social learning theory. This model proposes five key cognitive beliefs for institutions to create and to communicate the change message, namely: discrepancy, appropriateness, efficacy, principal support, and valence. Discrepancy implicates explaining the need for change required by the recipients, as well as the presence of a gap between the current status of the institution and an anticipated state. Efficacy pertains to confidence levels in the organization. For one, change recipients need to have confidence that both the institution and individuals have the ability to successfully implement the change, and they need to have confidence that their leaders are serious about the change and will provide the necessary support for successful implementation. Lastly, the change recipients need to be clear about the benefits of the change so they may believe in personal gains as an outcome of successful implementation [32]. Over the decades, the readiness for change model has proven to be a useful framework for initiating change [30,33], as it provides the means for analyzing and assessing whether or not change recipients are prepared for the projected change [32,33]. Over the decade, the model has been criticized for its overstress on individual cognition, further work has suggested the importance of including factors involving affection and social interaction pertaining to change attitudes, as they can be differentially related to change behaviors [23,32,34].

2.3. Systems-Thinking Approach to Pedagogical Change Readiness towards ESD

While extant literature has focused on how individual change readiness can be assessed, it has also been suggested that understanding the factors influencing and supporting individuals to achieve readiness is equally meaningful. Connecting a systems-thinking approach to the literature on readiness for change as discussed above, this study argues that creating university teachers' readiness for change involves not only individual cognitions and affections, but also how they interact with other actors and institutional factors in their context. Therefore, a systems-thinking framework was developed for investigating university teachers' perspectives on their change readiness to implement ESD through participation in a PBL-based PD program. The framework included three interrelated dimensions, namely intrapersonal, relational, and environmental dimensions.

The intrapersonal dimension emphasizes individual cognitive beliefs [22,23,32], and affective attitudes [34]. It includes the extent to which an individual or collective is cognitively and emotionally inclined to acknowledge, accept, and enact a plan that will purposefully alter the status quo [23,32]. Relating to university teachers' readiness to become change agents through participating in a PD program, it is central to support them to: (1) understand PBL and its importance in their teaching practices in order to reach desired goals (discrepancy), (2) believe the implementation of PBL will close the current gap and be appropriate to help their organization reach anticipated goals (appropriateness), (3) feel competent in their own and the organization's capability to implement PBL effectively (efficacy), (4) have faith in the organization's ability to support their implementation of PBL (principal support), and (5) believe that implementing PBL will provide them with benefits and achievements on a personal level (valence). Such beliefs can be seen as the core mechanism developing their sense of agency, actions, stance, and confidence in their capability to achieve the desired goals of change [23,35,36], while lacking such beliefs may generate hurdles in implementing change [23,34]. In addition to these key beliefs, individu-

als' positive affective and emotional responses to a large-scale change may impact their prospective engagement [34,37]. Their emotional reaction through acceptance or resistance are associated with their agency forms, either proactively and constructively or passively and de-constructively [35–37].

The relational dimension emphasizes the interplay among individuals and their contacts. For university teachers, students' reactions in terms of understanding and acceptance are considered highly important to adopting new teaching practices [24,38]. Receiving positive student feedback and observing improved learning outcomes also serve as motivators for university teachers to further engage in change [11]. In relation to colleagues, mutual understanding, efficient communication, peer supports, collaborative efforts, and a sense of trust in the environment are essential for university teachers to feel secure in implementing change [37,38]. Change agents are not only active in advancing their own teaching practices, but more importantly commit themselves to influencing a larger group of colleagues in developing change strategies collaboratively [12]. In addition, a supportive PD learning environment, which offers opportunities for setting common goals, collaborative work, experiential learning, constructive feedback, also contributes to the development of a sense of readiness for change [35].

The environmental dimensions include diverse contextual factors that influence the change process. Whether or not change recipients decide to implement PBL may be contingent upon external requests, including educational reform demands and societal needs, or upon internal policies, such as leadership directives, improving the current low achievement levels, or students' diverse needs [10,13]. Further structural factors, which include the institutional conditions such as policy guidance and facilities, whether they are considered to either promote or hinder the implementation of change, influence the readiness of individuals and of the organization [30,33]. Implementing pedagogical change in HE demands support for developing a sense of autonomy for individual teachers to make choices and take action, balancing workload and changing systems such as class size, examination regulations, resources for physical space and materials, and policy encouragement (e.g., parameters on reward, promotion, or appraisal) [1,35,36]. In addition, disciplinary and academic traditions may result in divergent norms and practices of teaching and learning [26]. Such sociocultural, institutional, and structural factors may further enable or constrain the choices and opportunities available to educators for change readiness. In addition, societal values and prevailing ideology of being a university teacher may also largely influence individuals' motivation or hesitance to change [11]. To create readiness at this level, training and development can be of great support, in addition to efficient communication, and involving actors in the process of decision making and preparing for change [8,10,30].

3. Method

3.1. Research Context and Participants

The PD program design incorporated a system-thinking approach and social learning theories that emphasized the role of interaction in university teachers' learning and change [14]. The program was requested by the participants' home university as part of its long-term change goals of sustainable development. A PBL approach, which has been practiced in the hosting university for over 40 years to enhance learner-centeredness and to address educational sustainability [19–21], was adopted to organize the PD program. Based on social constructivism, this pedagogical approach highlights that meaningful learning takes place in a social cultural process in which learners are exposed to real-life problems and participate in interactive activities to collaboratively solve these problems [17]. Characteristics of projects further enhance deep learning as learners work together on a common product (e.g., a project report) [18]. While both concepts of problem-based and project-based learning are used in extant literature, PBL is used in the current study to refer to the principles practiced in the hosting university [19–21]. That is, participants' learning process followed three major elements: (1) it starts with a problem, (2) it is organized through

a project (with project report as an outcome), and (3) it requires teamwork. Following the hosting university's model, the PD program embraced problem orientation, project organization, and teamwork, and aimed to offer participants the opportunity to experience PBL as learners. Participants were required, for example, to identify current issues in teaching and learning, including existing constraints and barriers for change; and design, apply, and evaluate new pedagogical designs using the above mentioned PBL principles. Ultimately, the program aspired to drive the motivation and engagement of participants in becoming change agents of ESD. In particular, the program had the following intended learning outcomes, as participants were expected to (1) reflect and revisit concepts on university pedagogy, (2) restructure their current course plans and design new teaching practices following PBL methodology, targeting student competences and ESD principles, and (3) implement and self-evaluate the new PBL-inspired practices and prospects for future improvement at a larger scale.

Involving a workload of 150 h in total, the six-month-long PBL certificate program comprised four modules, namely (i) introduction and preparation, (ii) thematic workshops (six in total), (iii) experimentation and evaluation, and (iv) examination. The program was delivered in November 2021–June 2022, via a blended mode with asynchronous online activities (e.g., module (i)), synchronous online activities (e.g., modules (iii) and (iv)) and face-to-face activities (e.g., module (ii)). A total of 28 participants were selected from diverse disciplines to join the program. They worked in five cross-disciplinary project teams. Their project report, which was used as an assessment tool, included common sections documenting their team-based work on rethinking overall pedagogy, as well as a cluster of their individual teaching design and self-evaluation. Each project team was assigned a facilitator from the program organizing team in order to support participants' learning processes throughout the program.

Among the 28 program participants, 25 participated in the Q sorting activities described below (female = 11, male = 14). Being selected as change agents from different colleges, participants had diverse disciplinary backgrounds ranging from linguistics, culture studies, geo-science, economics, computer science, civil engineering, industrial engineering, to gynecology, nursing, medical science, and pharmacy, and academic titles. Participants' teaching experience ranged from 4–30 years (average 20 years), with 22 participants having over l0 years of experience.

3.2. Research Design

A mixed-methods design, Q methodology [27,39], was adopted in this study for data collection and analysis for the purpose of exploring insights of participants' collective subjective perceptions. As a methodology often involved in small-scale research, Q is recently well-used in various fields within HE research, including university teachers' subjective experiences and opinions, incorporating both quantitative and qualitative features [40]. In this study, Q was designated to explore university teachers' perspectives of their change readiness towards ESD through their participation in a PD program. Conceretely, the study was guided by the synergized procedures in [41]'s systematic review on Q methodology within educational research. The guideline includes six steps: (1) constructing concourse, (2) developing Q-set, (3) conducting Q-sorting and (4) post-sorting activities, (5) computing Q factor analysis, and (6) interpreting the results.

Steps 1 and 2: Concourse and Q set development

As Figure 1 illustrates, a list of statements relevant to the topic, which is termed concourse [27], was developed based on intensive literature studies as discussed in the previous sections (an initial deductive inquiry) and initial interviews with the participants (which allows for the inductive emergence). This step was followed by a process of expert review, in which three educational research experts who were familiar with PD and the program design, and two Q experts were invited to give comments on the statements. Afterwards, two rounds of piloting were conducted. Revisions and reductions were made accordingly, which resulted in a 32-item Q-set, as presented in Table 1.

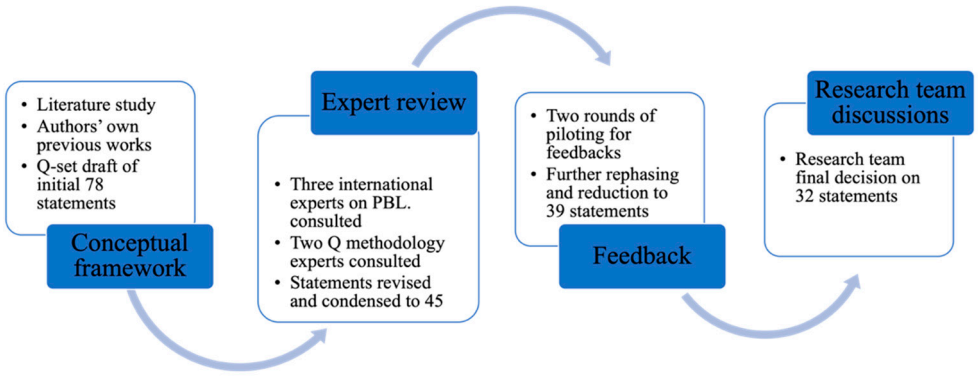

Figure 1. Q-sort development.

Steps 3 and 4: Q-sorting and post-sorting activities

Q-sorting and post-sorting activities were administrated online at the end of the PD program (June 2022). All participants were invited to a program reflection seminar, which included completing a Q sort. Ethical approval was received for this study and an email was sent to all targeted participants introducing the research aims, format, and procedure. During the online seminar, the purpose and procedure of the Q methodology were re-explained through a demo. The research team stood by to answer individual questions and ask explanatory questions. A total of 25 (of the 28) participants' responses were received (response rate 89%).

Q Method Software [42] was used for online Q sorting, through which participants provided demographic information in a pre-sorting survey. During the actual sorting activity, participants were invited to rank the statements following their individual viewpoints regarding the Q sorting question: Based on your experiences of participating in this PD program, which of the following do you think are most important in supporting your change readiness for prospective engagement with PBL in your context? In particular, they were guided to drag and drop each statement in a grid ranking from "most important" (+4) to "least important" (−4) (a sample sees Table A1). Through the forced-choice process, each participant generated a holistic assembly.

This was followed by open-ended questions in a post-sorting survey to obtain participants' elaborations and explanations behind their choices of the two statements they ranked on opposite ends of the sorting grid, including the statements they ranked as most important and those they ranked as least important.

Step 5 and 6: Q factor analysis and interpretation

All data were imported into KADE, a tool for computing Q analysis [43]. The most informative factor solution was found using Centroid Analysis and Varimax rotation. Combining the outcome of the analysis with the qualitative value and theoretical significance, four factors were confirmed using decision-making criteria of eigenvalues of 1.00 or above, and two or more significantly loading participants per factor [39]. Moreover, factor intercorrelations were generally moderate showing significant differences and connections between the identified factors. Q factor analysis results with loading sorts flagged are illustrated in Table A2. Of the 25 respondents, 14 loaded significantly on one of the four factors. One respondent loaded significantly on a 5th factor, which was excluded due to the criteria of requiring two or more participants per factor [39]. Seven participants were non-significant. Three participants loaded significantly on two rotated factors, which were considered as compounded sorts, were, therefore, also excluded because they made the factor arrays less distinct.

To interpret the factors, a qualitative approach was adopted to narrate the characteristics of each factor holistically, including information across the range of factor arrays (a weighted average of values per item within one factor), abductive and iterative interpretation within factors in connection with demographic and post-sorting information, and across-factor interpretation highlighting distinguishing statements.

Table 1. Q set construction (N = 32 statements).

Domain	Themes	Sub-Themes	Random No
Individual (Antecedent, present and conse-quent/prospects) (n = 13)	Cognitive components (5 beliefs) (18, 19, 21, 22, 23, 24, 25, 26, 31, 32) (n = 10)	Prior experiences	31
		A sense of discrepancy: change is needed	22
		Appropriateness: The projected change is suitable to address the current issues	32
		A sense of efficacy: Individuals' perceived competencies to implement the anticipated change	26
			24
		Principal support: Individuals' belief that the institution will have the capability to provide the needed support for change (i.e., resources and information)	18
			21
		Valence—seeing benefits: Individuals' perceptions on their own potential gains as an outcome of the overall change	19
			25
			23
	Affective components (4, 17, 30) (n = 3)	Emotions—love, hate, delight, sadness, happiness, acceptance, job satisfaction: Emotionally accept and adopt a plan; current and future-oriented emotions	4
			17
			30
Relational and collegial aspects (n = 9)	Peer support (1, 3, 13, 20, 29)	From the PD program	20
			13
		Collegial at home institutes	1
			29
			3
	Students (2, 6, 27, 28)	Acceptance	2
		Improved learning engagement	28
		Improved outcome	6
		Shared belief	27
Environmental aspects (n = 10)	Leadership (8, 11, 15)	Belief	8
		Understanding	11
		Prospects	15
	Institutional culture (5, 7, 9, 14)	Shared goals	7
		Common practice	5
	Policy	Reward	14
		Request	9
	Society (10, 12, 16)	Professional demands	10
		Community	16
		Societal values	12

4. Results

This section reports interpretations of the factors that have been identified from the Q factor analysis. As the term 'factors' is used in Q analysis, the word 'Viewpoints' are used to highlight the subjective character of each factor [41] symbolizing participants' own perceptions on their change readiness for PBL implementation. To report the interpretations of the results, each viewpoint is described in the form of a holistic narrative that included quantitative attributes and factor interpretation. Each statement's number is specified in brackets, together with its given value in the particular factor array. Each statement is referred to by its item number and rated on a scale from −4 to +4 (e.g., '#7/4′ refers to

statement 7 with the value of 5). 'D', 'distinguishing statements' ($p < 0.05$), is used after the value number to emphasize statements in which the viewpoints significantly differed, and D* is used to indicate 'significantly distinguishing statements' ($p < 0.01$). Table 2 provides an overview of the results.

Table 2. Factor values for statements from most consensus to most disagreement (V = viewpoint).

Statement	V 1	V 2	V 3	V 4
14. There are rewards for implementing new teaching practices at my institution.	−1	−3	−2	−3
17. I enjoyed my initial PBL implementation.	1	1	3	3
22. There is a need to change the prevailing teaching methods in my institution.	0	−1	1	−1
5. My institution has the culture to encourage innovative teaching.	−2	0	0	−3
13. The PD program organizers inspired me to proceed further with PBL implementation.	1	2	2	0
8. My leaders have a common understanding that PBL is appropriate for our institution.	−2	1	−1	−1
29. My institutional colleagues provide constructive feedback on my PBL implementation.	−1	−1	0	−2
30. I appreciate new ways of thinking about education.	1	1	3	0
1. My institutional colleagues understand why I seek to implement PBL.	−1	−3	−1	−2
16. Implementing PBL provides opportunities for students to be connected to the community.	0	3	2	1
32. PBL is appropriate to solving the current students' learning problems I have experienced.	3	2	0	1
27. My students share the belief that PBL is beneficial to their learning.	0	−2	−1	1
26. I am capable of implementing PBL.	2	0	2	3
7. There is a common understanding in my institution of its educational goals.	−2	−1	−3	−1
4. I value my learning gains from this program.	2	4	3	1
3. My institutional colleagues show interest in joining me in future PBL implementation.	−4	1	−2	0
21. I anticipate receiving sufficient information about my institution's implementation plans to implement PBL.	0	−3	1	0
18. I anticipate receiving the support required from my institution to implement PBL.	0	−4	0	−1
19. Engaging in the PBL implementation enhances my qualifications for academic promotion.	1	−4	0	−4
15. My institutional leaders are interested in extending PBL implementation.	−3	0	−4	1
12. There is a societal trend toward adopting pedagogical methods that suit the younger generation's learning needs.	−3	4	0	2
2. My students react positively to PBL.	3	−2	−2	2
10. Implementing PBL is suitable for addressing professional practice demands.	−1	2	−1	4
25. Engaging in PBL implementation is beneficial for my future job opportunities.	2	−1	−1	−1
11. My institutional leaders understand what it means to implement PBL.	−1	1	−4	−3
9. My institution requests that I further implement PBL.	−3	0	1	−2
6. My students' learning performance is improved with PBL implementation.	4	0	1	2
20. My PD program teamwork inspires me to proceed further with PBL implementation.	3	−1	−3	0
24. My institution is capable of implementing PBL with the needed resources.	−4	3	−3	0
28. My students' engagement in learning is improved with PBL implementation.	0	0	1	4
31. I am able to relate my own learning experience in this PD program to my new teaching practice through implementation of PBL.	1	−2	4	3
23. Implementing PBL will improve my teaching competence.	4	3	4	−4

4.1. Viewpoint 1: Improvement of Teaching and Learning Performance

A total of four participants loaded significantly on Viewpoint 1, accounting for 11% of the explained opinion variance. Including two females and two males, the participants had different discipline backgrounds and academic titles, with teaching experience ranging from 10 to25 years. These participants generally highlighted the importance of PBL implementation on improving teaching and performance, despite a lack of peer and institutional support.

Generally, these participants considered a few relational aspects as most important in supporting them to get prepared for PBL implementation, specifically their teamwork experience from the PD program inspired them to proceed further (#20/3D*) (contrasting other viewpoints), as one participant wrote in the post-sorting activity, "*I have found that PBL implementation leads to better learning, our teamwork in the program was important for me to understand that*" (V1–4). Collectively, they highlighted the importance of enhancing their teaching performance through learning about PBL. For example, they believed their initial PBL implementation improved their teaching competence (#23/4) and solved their current students' learning problems (#32/3). Equally important were their perspectives on students' positive reactions to PBL (#2/3) and their improved learning performance (#6/4). As one wrote, "*The students have had a good receptivity and attitude to implement the PBL approach and it is important to learn and apply new teaching–learning methods since time has changed and new generations require more efficient methods*" (V1–3).

While they shared their views on the positive impact of the PD program on improved teaching and learning practices, they were uncertain about their institutional readiness. They agreed that institutional readiness was important for their change readiness, but since this was unavailable, they relied on their individual readiness and considered this to be more important. As one explained, "*I consider the institution cannot improve in the PBL application if the professors are not ready to advance in this methodology*" (V1-5). In addition to institutionally related aspects, they also collectively ranked peer-related statements low, including leaders' common understanding of PBL appropriateness (#8/−2) and what it means for implementation (#11/−1), as well as peer understanding of PBL (#1/−1), constructive feedback (#29/−1), and interest in joining the PBL initiative (#3/−4). In elaborating their choices, one participant wrote, "*I believe that these are the areas where greater effort and support is needed, to the extent that many colleagues and institutional leaders are required to be committed to the changes that are required both at the administrative level and in mentality*" (V1–2). Therefore, they expressively agreed that their institution was not yet capable of implementing PBL (#24/−4D) (contrasting other viewpoints), because "*it takes time for the university to make decisions about teaching approaches, therefore it is important to take personal initiatives without waiting for the university to say so*" (V1–3). This also explained their low rank of the institution's requests for individuals to further implement PBL (#9/−3). Prospectively, they agreed on the importance of policy for further institutional change readiness. One example could be a larger scope of PD efforts, as suggested by one participant, "*the institution need to give the opportunity to all teachers to engage in this kind of course (the PD)*" (V1–4).

4.2. Viewpoint 2: Personal Learning and Conviction

Viewpoint 2 included four participants and accounted for 8% of explained variance. Including two female and two males, the participants had different discipline backgrounds and academic titles, with teaching experiences ranging from 15 to 30 years. These participants valued their personal learning with new pedagogical beliefs.

In concrete terms, they appreciated the support from the PD program organizers (#13/2) and believed in their personal learning gains from the program (#4/4), which also improved their teaching competency (#23/3). These personal learning gains were also reflected in their new pedagogical beliefs that PBL methodology is compatible with the societal trend of adopting pedagogical methods that suit the younger generation's learning needs (#12/4). As elaborated by one participant, "*without understanding and adapting to how*

youngsters learn and communicate, it will be more difficult to teach the necessary skills and abilities in the different professional fields" (V2-2). Further, they developed beliefs that implementing PBL will solve their current students' learning problems (#32/2), address professional practice demands (#10/2), and provide opportunities for students to be connected to the community (#16/3). These were further detailed in their post-sorting elaborations, as one participant wrote, "*Before I did not know PBL, now I am convinced that it is the most appropriate way to bring knowledge and practice together, so I especially value the opportunities it allows*" (V2-1).

Unlike Viewpoint 1, which highlighted relational aspects with students, Viewpoint 2 participants considered these less important for their change readiness, including students' shared beliefs about (#27/−2) and reactions towards (#2/−2) PBL. On the other hand, they shared views with Viewpoint 1 regarding colleagues' understanding of (#1/−3) and constructive feedback on their PBL implementation (#29/−1).

Institutionally, these participants ranked high their perspectives on institutional capability of implementing PBL (#24/3D*), which contrasts other viewpoints, in particular, Viewpoint 1. Further, they considered it less important whether or not PBL implementation may enhance academic promotion (#19/−4) and provide rewards (#14/−3). Contrasting other viewpoints, they ranked low the importance of obtaining sufficient information about their institution's implementation plans (#21/−3D*) and receiving the support required (#18/−4D*).

In their explanations of such choices, the participants recognized the university's commitment to teaching improvement, but nevertheless an institutional approach to gaining knowledge and skills was lacking. Therefore, they chose to focus on their personal development, as one participant wrote, "*I profoundly believe that devotion to teaching is a personal decision and a life-long purpose regardless of whether there's an economic incentive or institutional support. Implementing PBL or any other innovation is motivated by the conviction that it will be beneficial for learning and constructing better and responsible citizens*" (V2–4).

4.3. Viewpoint 3: Applying PD Learning to Practice

Viewpoint 3 had an explained variance of 7%, with three significantly loaded factor arrays. Including two females and one male, the participants had different discipline backgrounds and academic titles, with teaching experiences ranging from 8 to 21 years. Prioritizing individual competency to implement PBL over institutional capability, these participants generally believed that it is highly important for their change readiness when they can take actions on applying what they had learned in the PD program to actual PBL implementation.

In concrete terms, these participants considered having the capability of PBL implementation (#26/2) as most important. This capability could be constructed through multiple aspects including personal and relational aspects, such as their appreciation of learning gains (#4/3) (aligning with Viewpoint 2), inspiration from the program organizers (#13/2), teaching competence improvement (#23/4) (aligning with Viewpoint 1), new ways of thinking about education (#30/3), and most importantly, through actions of relating their own learning experience in this PD program to new PBL practice (#31/4) and initial PBL implementation (#17/3).

While focusing on individual competency, Viewpoint 3 participants did not emphasize institutional aspects. Aligning with Viewpoint 2 but contrasting Viewpoint 1, they ranked institutional capability of PBL implementation low (#24/−3), which may be attributed to the overall lack of common understanding of educational goals in the institution (#7/−3D).

Collegially, Viewpoint 3 participants considered relational aspects less important, specifically with regards to students' shared beliefs (#27/−1) and reactions (#2/−2) (aligning with Viewpoint 2 but contrasting Viewpoint 1). They shared views with Viewpoint 1 and 2 regarding colleagues' understanding (#1/−1) and interest in joining PBL implementation (#3/−2). For them, leadership was considered least helpful for readiness due to the current missing points of leaders' understanding of PBL appropriateness (#8/−1),

what PBL implementation means (#11/−4), and interest in extending PBL implementation (#15/−4D).

In their post-sorting survey, these participants highlighted their appreciation of the program in supporting their application of what they had learned to the redesign of their course, and consequently the implementation in actual practice. As one participant wrote, "*. . . the tools received did help with reflections and modifications regarding the structure of my subjects so that I can make the change happen*" (V3-1). Nevertheless, they also elaborated on the lack of further change readiness from surroundings, which explained why they ranked both relational and institutional aspects low. As one participant wrote, "*In reality, it is not that they (governance and the role of the institution) are not important for the implementation. It is very important to not only at the subject level but even for the curricular transformation to implement (PBL) . . .* " (V3-3). While at the moment, "*there is no clear management policy to apply new pedagogical trends*", (V3-2), they also agreed on the role of leadership support at a policy level for prospective implementation.

4.4. Viewpoint 4: Student Learning Engagement and Professional Practice

Viewpoint 4 accounted for 11% of explained variance and included three significantly loaded factor arrays. Including two female and one male, the participants had different discipline backgrounds and academic titles, with teaching experiences from four to 23 years. These participants prioritized PBL benefits on students.

In concrete terms, Viewpoint 4 participants believed that there is a societal trend toward adopting pedagogical methods that suit the younger generation's learning needs (#12/2). Following this, they accentuated how PBL enhances students' learning engagement (#28/4D*) (contrasting other Viewpoints), professional practice (#10/4), and connection to the community (#16/1). Students' positive reactions were also emphasized (#2/2) and improvement of learning performance (#6/2). Prioritizing students were further elaborated, as one participant wrote, "*because in the 21st century, learning is more important than teaching. And for the learners to achieve their goals, I'm to be able to implement PBL in a way that encourages and motivates students*" (V4-1).

Aligning with Viewpoint 3, they also underscored their capability of PBL implementation (#26/3D). For them, such capability may be supported through relating their own learning experience in this PD program to new PBL practice (#31/3) and their initial PBL implementation (#17/3). As one elaborated, "*I believe that in order to continue implementing PBL I need to feel that I am capable of doing it and this experience allowed me to do so. I now feel that I have the theoretical basis (Constructive Alignment) to plan, develop and reflect on my Reading and Writing course. This experience allowed me to observe my students' learning and listen to their reflections*" (V4-3).

While highlighting PBL values on students, these participants did not consider their own benefits regarding receiving rewards (#14/−3), academic promotion (#19/−4), future job opportunities (#25/−1), and improved teaching competence important (#23/−4) (contrasting Viewpoint 1). As one explained, "*I did not do this to get more recognition, but to be able to transform and continue to grow as a person and a professional*" (V4-4).

Further, negatively ranked statements also addressed relational and institutional aspects. For example, they did not highlight leaders' understanding of PBL appropriateness (#8/-1) and what implementation means (#11/-3), as well as colleagues' understanding (#1/-2) and constructive feedback (#29/-2), which may be attributed to a lack of institutional culture that encouraged new teaching methodology (#5/-3). As explained, "*there is a lack of institutional knowledge related to PBL implementation. The current directions on teaching are out of context, isolated and not coordinated . . . academic leaders should also be educated in PBL learning philosophy*" (V4-3).

4.5. Consensus

Despite the extensively different opinions, participants from the four viewpoints reported noteworthy consensus. While participants agreed on the importance of their

positive experiences from initial PBL implementation (#17/Viewpoint 1: 1, Viewpoint 2: 1, Viewpoint 3: 3, Viewpoint 4: 3), they did not consider it important to have rewards for implementing new teaching practices (#14/Viewpoint 1: −1, Viewpoint 2: −3, Viewpoint 3: −2, Viewpoint 4: −3).

5. Discussion

This study investigated university teachers' perspectives on their change readiness to implement ESD through their participation in a PBL PD program in one HE setting. Q analysis identified four significantly distinctive viewpoints among the 25 participants regarding their perspectives of their change readiness. The outcomes revealed that the participants emphasized (1) improvement of teaching and learning performance, (2) personal learning and conviction, (3) applying PD learning to practice, and (4) student learning engagement and professional practice.

In general, the results revealed a complex overview relating to the proposed framework adopting a systems-thinking approach to change readiness [14,26,28,29]. The participants alluded to multiple aligning or contrasting perspectives towards all the identified supports of their change readiness. Accordingly, the same statement was considered as more important or less important within the diverse viewpoints. Additionally, these diverse perceptions covered the three dimensions of intrapersonal values, actions in practice and interactions with the environments. Such results support the arguments for the study of change readiness towards ESD from a systems-thinking perspective [1,2], and can be seen as a useful approach to connect the change readiness literature from organizational studies [30,32,34] to the examination of educational change [23,31,33]. Such results further verify the theoretical discussion on the interrelations and interactions between personal characteristics and capacities [23,32,35,38], which influence and are influenced by university teachers' agentic actions, and the surrounding contexts and environments within which they engage in professional learning [8,10,36,37,44].

While it was not the focus of this study to scale or measure the levels of change readiness, the results revealed different plans. While Viewpoints 1, 2, and 3, respectively, highlighted teachers' self-development regarding their teaching competences, learning gains and development of beliefs and practices, which are essential for their own professional learning [9,10,23,32,45,46], yet how to extend their individual learning to influence peers and the institutional context is not yet considered as important to them. Individual efforts to source agentic actions in order to make a difference within the institutional context were not accentuated by these participants. It takes a longer time of change readiness development, in particular, with opportunities to exercise educators' professional agency, before they are able to proactively make further influences at work by leading their colleagues and contributing to institutional prospective development [30,33,35–37]. This reveals that deep change targeting long-term effect takes longer than what this program has offered [11,13,44]. Viewpoint 2 emphasized the importance of student learning and benefits, which echoes a group of university teachers' viewpoint from a previous study in a Chinese context [24,47].

In general, institutional conditions and policies were ranked low in this study, nevertheless, the participants reported these aspects as missing points in their current surroundings regarding the goal of larger scale change. For future perspective, the participants highlighted in their writing that leadership knowledge and institutional support on policies and conditions were essential to reach the long-term change plan [8,10,35,48].

Outcomes of this study also supported suggestions from previous studies on using PBL as a methodology to support university teachers to experience PBL as a learner in order to better develop their beliefs and competences of PBL implementation [12,24,47]. Reflecting on preparing for change readiness towards ESD, this study outcome shows that PBL can be a methodology supporting such a purpose in that the university teachers reported their learning about multiple experiences, such as systems thinking, problem solving, and teamwork [2–4]. This learning was considered helpful to support their own students' development of these competences in response to the overall call for sustainability through

further PBL implementation [16,19–21]. Nevertheless, there is no direct evidence in the current study to support such a connection in that in the current PD design, sustainability in HE served as an ultimate goal of change readiness and institutional change but was not directly included in the contents of the program due to the diversity of participants' disciplinary backgrounds.

The results of the study provided a few implications for further improvement of supporting change readiness towards ESD. First of all, to support long-term change at an institutional level targeting ESD, it is highly important for institutional leadership to provide policy, as suggested by the participants, including missions and long-term plans for change. Second, as also recommended by participants of this study, to better support their meaningful implementation of change, it is critical that their line managers, including middle leadership to also have opportunities to experience such types of PD so that a common ground of the ultimate goals, values, and actual plans for change can be established within micro-settings of the institutions. Third, for PD organizers, systemic and systematic professional learning activities are essential for university teachers from all backgrounds, addressing both generic prerequisites and discipline-specific connections to sustainable development in HE. Further, to enhance the success of PD activities, it is essential to both highlight the individual awareness of personal learning gains and competence development, but also common understanding of the institutional goals of long-term change towards sustainable development. Future PD design is recommended to include sustainable development as a clearly defined learning goal to better support university educators with a closer connection to their daily practice. To achieve long-term success in educational change towards sustainable development in HE, it is essential to connect all these efforts.

In retrospect, the study has a few limitations that need to be addressed in future research. First, while the empirical outcomes of the study echoed all aspects of the proposed theoretical framework, multiple methods of research should be followed to further verify and enrich the framework. For example, the professional identities and agency of university teachers in a context of becoming change agents of ESD in HE are crucial, yet not addressed in the current study due to the limited scope. For example, integration of ESD requires not only pedagogical training and change, but also the capability of teachers to contextualize and relate with discipline teaching content with sustainable development. Second, although the majority of the program participants were included in this study, the overall number of 25 participants makes the study outcome limited in its transferability. Thus, the study remains small-scaled and exploratory, so the results should be further revisited in a long-term scope. Longitudinal studies are recommended to identify how these participants enact further changes and how they cope with the complexity of institutional change at a later stage. Future studies may also apply the Q statements developed in this study to different settings in order to further validate how tools developed in one study may contribute to research and literature on change in HE in other settings.

6. Conclusions

Guided by a proposed theoretical framework connecting systems-thinking approach to change readiness, the present study examined university teachers' perspectives on the conditions that supported their readiness to implement ESD as an outcome of their participation in a PBL-designed PD program. Theoretically, the study connected a systems-thinking approach to change readiness literature and proposed a four-dimensional conceptual framework. Q methodology was adopted to collect and analyze data both qualitatively and quantitatively, through which four significantly different viewpoints were identified among the 25 participants regarding what they considered most important for their change readiness towards ESD. Specifically, the results highlighted (1) improvement of teaching and learning performance, (2) personal learning and conviction, (3) applying PD learning to practice, and (4) student learning engagement and professional practice. The results revealed a complex and interrelated connection between the three dimensions of change

readiness, namely among the intrapersonal, relational, and environmental dimensions. The study also observed university teachers' appreciation of learning gains and willingness to engage in prospective change. Nevertheless, such change readiness was mainly within their micro teaching practice environment, with little anticipation of commitment to a wider institutional scale of change. Constrained institutional conditions were considered as the biggest obstacles to university teachers' commitment to long-term educational change. Results of the study suggested that it is essential to facilitate both individual awareness and efforts, as well as institutional readiness for the goal of implementing ESD in HE. In this regard, both systemic and systematic professional learning activities are essential.

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Appendix A

Table A1. A sample grid by Factor/Viewpoint 1.

				27				
			29	22	30			
			11	28	31			
	12	7	14	18	17	25	20	
3	15	5	10	21	13	4	2	23
24	9	8	1	16	19	26	32	6
−4	**−3**	**−2**	**−1**	**0**	**1**	**2**	**3**	**4**

Table A2. Q factor analysis results with loading sorts flagged.

Factor Group	Factor 1		Factor 2		Factor 3		Factor 4		Factor 5		
F1-1	0.67		0.1821		0.0229		0.4665		−0.1438		compounded
F1-2	0.638	0.638	Flagged	−0.1925		0.1023		0.0403		0.0546	
F1-3	0.6	Flagged	0.1603		0.1842		0.137		0		
F1-4	0.534	Flagged	−0.1496		0.0706		0.0121		0.0751		
F1-5	0.471	Flagged	0.1891		−0.0472		0.2756		−0.115		
F1-6	−0.38		0.1027		0.2266		0.3448		0.2266		non-significant
F1-7	0.321		0.0319		-0.0149		−0.0965		0.2944		non-significant
F2-1	0.027		0.6338	Flagged	0.09		0.2002		−0.027		
F2-2	−0.13		0.6101	Flagged	0.2363		−0.1155		−0.0287		
F2-3	−0.07		0.5057	Flagged	−0.2576		0.4327		0.2878		
F2-4	0.339		0.4585	Flagged	−0.2046		0.23		0.348		
F3-1	0.209		−0.0364		0.597	Flagged	0.2074		0.3732		
F3-2	0.266		0.2955		0.5421	Flagged	−0.0262		0.0772		
F3-3	0.303		0.1232		0.482	Flagged	0.1618		0.1365		
F3-4	0.147		0.4068		0.4819		0.4531		0.0567		compounded
F3-5	−0.1		-0.021		0.3768		−0.0773		-0.1413		non-significant
F4-1	0.196		0.1668		0.2378		0.6498	Flagged	−0.1579		
F4-2	0.466		0.3915		0.1726		0.6361		−0.1434		compounded
F4-3	−0.11		0.0742		−0.0023		0.6116	Flagged	0.0902		
F4-4	0.19		0.0772		−0.1868		0.5382	Flagged	−0.251		
F4-5	−0.06		0.2455		0.0809		−0.4222		−0.2562		non-significant
F4-6	0.093		0.0099		0.0559		0.3916		0.0085		non-significant
F5-1	−0.05		0.1346		0.0778		0.0989		0.4861	Flagged	
F5-2	−0.06		0.1099		0.0879		0.1195		−0.443		non-significant
F5-3	0.085		−0.0134		−0.2985		0.0192		−0.4322		non-significant

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