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Exploring How to Optimise Transformative Pro-Environmental Behaviour Changes via Nudging on Shared Values Crystallisation

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Abstract: Transformative learning processes that can trigger deep and long-lasting behaviour changes are highly sought after for targeted improvements ranging from human diet and health to pro-environmental behaviours. A step forward was the reporting of a method that reliably produces transformative learning outcomes (TLOs) as an (incidental) effect of group shared values crystallisation, but the theme of the TLOs could not be targeted, e.g., for pro-environmental behaviours. A recent exploratory study bolted on environmentally themed pre-Nudging and unexpectedly produced a heavy bias towards pro-environmental behaviour changes. Here, we investigated more systematically the influences of different Nudging types upon TLO themes produced using two further case study designs created for comparability with earlier studies and using the same process (*WeValue InSitu*) and post-event data collection of TLOs categorised as environmental/not and behavioural/not. Our findings show that most Nudging had no effect, including raising the profile of environmental photos and the materials used in the crystallisation process, having participants reflect on their environmental identities, or emphasising environmental topics before going home. However, Nudging which involved answering written questions on specific personal pro-environmental actions such as recycling, applied early on, was linked to desired results. This has pragmatic significance for sustainability practitioners and raises questions for further research on the mechanisms of both active learning and Nudging.

Keywords: shared values crystallisation; *WeValue InSitu*; transformative learning outcomes; pro-environmental behaviour change; nudging

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1. Introduction

Transformative learning is defined as, and specifically designed to produce, learning which will lead to re-evaluations of pre-assumptions (including beliefs and/or values), so that the learner will have a significant (i.e., transformative) shift in perspective or way of thinking [1]. Transformative learning processes are highly sought after in many fields, in the hope that they will lead to prescribable behaviour changes, for example, in better eating, less smoking, or pro-environmental behaviours [2]. However, it has not been easy to prescribe the characteristics of the learning environments in which transformative learning can reliably be expected to occur. For this reason, there is much ongoing research in experimenting with different learning environments or processes which might produce such effects (e.g., review of refs. [3,4]). The work reported here contributes to the following research question: which learning environment and processes can reliably facilitate not only transformative learning, but specifically that leading to behaviour changes regarding targeted topics such as pro-environmental behaviour changes?

The theoretical framework for transformative learning is encapsulated in [1] foundational Transformative Learning Theory (TLT). Mezirow outlined ten different possible processes of transformative learning and four classifications of possible outcomes [5]. He also made suggestive notes on the learning environments or conditions that were likely to be needed in order to produce learning of a transformative nature. Since then, this work has seen several significant critiques, including modifications and extensions of the theoretical framework [6–9]. However, there has been consistent reference to the need for a disorienting dilemma resulting in a critical reflection, which would then lead to a non-superficial shift in perspective (which may or may not further result in a shift in behaviour) [6]. Notwithstanding these developments, it is still not clear which processes are always needed, and what effect the interplay of the learning environment can have on these processes.

It is encouraging that a new type of learning approach to incidentally but reliably produces a particular type of long-lasting transformative learning was recently found [10,11]. Unlike traditional methods, which focus on delivering knowledge in a way that can trigger reflective learning, this new method focuses on helping participants to make better sense of their *own existing shared values* by 'crystallising' them, and transformative learning (TL) was found to be an incidental effect (including producing long-term behaviour changes) [12]. However, it does not usually produce the transformative learning types especially sought after, i.e., targeted behaviour changes in smoking, diet, or pro-environmental action. Participants are guided through several subprocess stages to negotiate and crystallise 'what is important to them', and the transformative learning outcomes (TLOs) observed are found to be linked to the topics deemed important to the group—which may not include the targeted topics. On the other hand, because the crystallisation process is reliable, it can be repeatedly studied with variations to build up our theoretical understanding of the pathways to transformative learning, which can help to evolve prescriptive designs in order to produce targeted changes.

Here, we report on a study applying Nudging at different stages of the shared values crystallisation process in order to specifically target pro-environmental behaviour changes. Nudging is the shifting of the focus of an individual towards a particular specific behaviour, induced here by influencing staged learning environments in different ways. This was conducted using two qualitative case studies (Design#2 and Design#3) which are designed for comparison with studies using the original, No-Nudging, design (which we designate as Design#0) and a recent study which explored Pre-Nudging [13] (designated as Design#1). It was not expected that Pre-Nudging would have any effect on the TLOs, because all the crystallisation sub-processes involve critical and reflective learning centred on participants' embedded shared values. However, when a bolted-on Pre-Nudging item of an environmental nature was applied before the crystallisation event (e.g., a questionnaire about current recycling activities), the TLOs produced were found empirically to be heavily biased towards pro-environmental behaviours [13]—a result of great pragmatic value for sustainability research, but without theoretical understanding. In this work, we examine more closely what choice spaces could have been influenced by Nudging in the study and create two further case designs to allow for a wider investigation of the impacts of other types of Nudging on the other stages.

This approach allows for a systematic qualitative comparison across the Design types, contributing to a more general understanding of the linkages between the Nudging types and the staged learning environments and processes, which can be taken forward for future testing towards prescriptive designs.

2. Methods

In order to explore how Nudging might be used to influence the final outcomes of a transformative learning process through its effects on different choice spaces, which could influence the learning environments, we set out two qualitative case study designs [14]. Since the factors are not yet identified or well-defined, the study cannot test for causal

inferences, but rather should be designed to narrow down the definition of the relevant factors. This requires the study to be exploratory, not explanatory, and to be qualitative, not quantitative [9]. Our Nudging designs were made to be suitable for comparisons with the previously published Pre-Nudge study [13] and No-Nudge studies [10], which both used multiple independent case groups of participants. Firstly, the same learning approach was used as that in those prior studies [10]. It is called the *WeValue InSitu* shared values crystallisation approach [15,16]. It focuses on the crystallisation of the shared values of a pre-existing group [10,17], using several specific meaning-making processes for group members within their shared tacit knowledge space, leading to an articulation of their key shared values, as found latent in their actions (e.g., [11,18]). Details are provided in a section below. The *WeValue InSitu* groups must be chosen such that the members have some practice-based activity type in common, e.g., teachers or students, in the same environment. Within that selection criterion, any groups can be assembled, and in this case, they were convenience samples. We also recruited two or more independent groups for each Design so that the inter- and intra-group results could be considered.

Although several of these sub-processes have been studied in detail and related to theories such as Polanyi's Personal Learning Theory [17,19], where learners embed new information in different ways, it is not yet clear how they are influenced by the choices that participants make during that process, which can be modified via the learning environment. By choosing to use the same approach as the previous studies, our methodology will allow us to synthesise learning across the cases, involving various choice spaces and sub-processes.

Secondly, we identified where the choice spaces for participants existed in the *WeValue InSitu* stages and proposed types of nudges that could, in principle, influence them (within practical limits for us to perform) (Figure 1). We then specified three case study design specifications (Designs #1, 2, and 3) of Nudging, which spanned the different stages of the *WeValue InSitu* process and were pragmatic for implementation. The implementation included a plan for obtaining data from participants on subsequent changes in their perspectives and/or behaviour, which could provide insights into the pathways that led to those, through a series of post-event interviews.

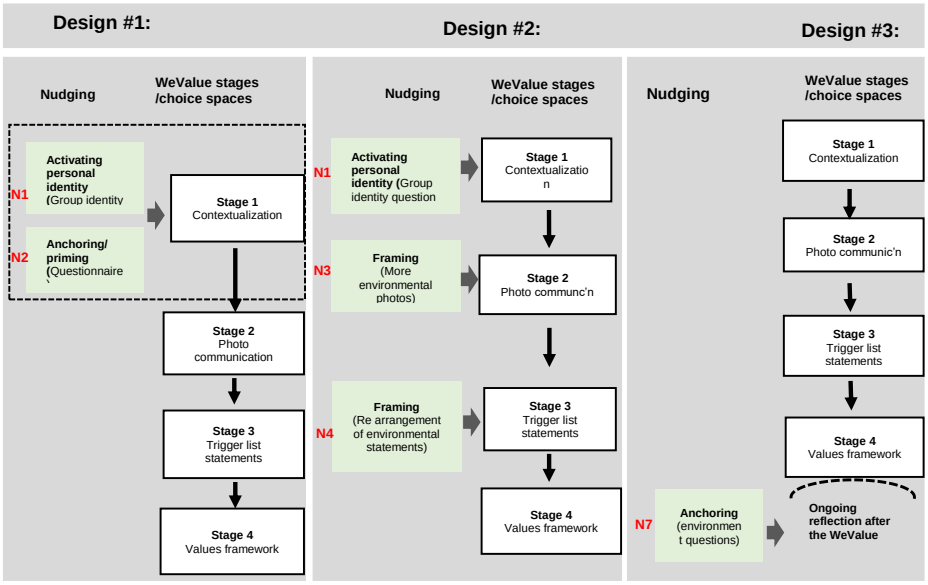

Figure 1. The Nudging used in Designs #1, #2, and #3. Each was carried out with two or more independent groups of participants where possible, to allow qualitative indicative comparisons of outputs.

Below, we briefly overview the Nudging method, then the stages of the *WeValue InSitu* approach, and how we identified the choice spaces and possible nudges in it. Finally, we present our Case Study Design, with three Designs for this study, and data collection methods.

2.1. Nudging Methods

The concept of Nudging comes from behavioural economics literature, aimed at leading individuals towards certain actions but without affecting their personal agency of choice [20]. It can involve approaches like the use of different types of cues via printed words, visual images, or sometimes sensations [21], reminders, and/or ambient displays [22–24]. Policy makers have used Nudging for influencing citizens on a range of issues, including lowering their energy usage [22,25,26]. It usually only works when carried out very close to the point of decision regarding a very specific behaviour. An example might be picking up a chocolate bar while waiting at the checkout area in a shop. Critical reflection is not required during Nudging interventions, and the resulting behaviour changes or choices are usually only short-term and minor [27].

2.2. The WeValue InSitu Process and Nudging Spaces Within It

The WV process was originally designed to assist local civil society groups in 'crystallising' what was important to them and articulating that in written representations with high face validity and authenticity [28]. It accomplishes this by taking groups through its four stages of meaning making regarding their actions, and, thus, their values-in-actions, which begin with more tacit and progressively develop into more explicit verbalisations [17,19]. It is this series of activities which increases self-awareness, which seems to lead to transformative learning, which sometimes leads to behaviour changes.

Each stage involves active learning through self-reflection and comparison, intersubjective engagement and/or negotiation, and the choice of topics. Table 1 describes them.

Table 1. Choice spaces within the WV process and ways they can be potentially manipulated. Stage 1 was manipulated in [13]; the others are newly reported here.

WeValue Stages/ [Manipulated Choice Spaces]	**The Context of the Critical Reflection Taking Place, and Choice Space**
Stage 1: Contextualisation [external emphasis on a particular aspect of their identities or commonalities]	Participants express why they feel belong to the group—they choose what to emphasise about who they 'are' collectively as a group in the room, and how they are connected as individuals to others within this group. (For example, we are all students on this course, and I go to see those two for help with homework and those three for social activities.) Their range of overlapping interactions or commonalities with each other provides the choice pool.
Stage 2: Photo communication [modify the types of photos available]	Participants choose one or two photos (from c60) that strongly resonate with what they think is important, and share these ideas with other group members. (For example, we are all so different but we do things together, like in the picture of this jigsaw puzzle.) Their range of thoughts, overlapping with the range of photos provided, provide the choice pool.
Stage 3a: Trigger list reading [modify the order of the trigger statements to emphasise a particular topic]	Participants choose trigger statements (from a long list of c70) that strongly resonate with what they think is worthwhile about what they do in the group. The list provides the choice pool.
Stage 3b: Discussions and negotiations [the facilitator could emphasise a topic, e.g., by raising it in addition, or challenging others]	Participants share, discuss, and negotiate their thoughts and ideas regarding the statements they have chosen. This leads to unique statements being further developed by and for the group members. The choice pool is the initial list but then any triggered thoughts from the participants.

Table 1. *Cont.*

WeValue Stages/ [Manipulated Choice Spaces]	**The Context of the Critical Reflection Taking Place, and Choice Space**
Stage 4: Framework construction [not much manipulation possible here]	Participants collectively decide the structure of their values framework, which they form from linking together their written statements. The choice pool is their completed statements and the discussed linkages between them.
Post-event: Immediate reflections [Facilitator could emphasise some topics over others—even ask why some are not present]	Participants discuss the headline thoughts they take away with them from the process; the topics discussed here are sometimes known to have been correlated with later perspective or behaviour changes. The choice pool is all the topics discussed in the entire workshop and the linkages participants might bring in here by themselves.

Each stage also offers possibilities for the introduction of Nudging in some manner, which has not been previously explored. In Table 1, we list the choice spaces identified in each stage and give examples of practical Nudges which might have the potential to nudge participants—in this case, towards the target of deeper pro-environmental self-reflections and, ideally, behaviour changes.

2.3. Case Study Design

The three designs for the WeValue Plus Nudges are shown schematically in Figure 1. They are as follows:

Design #1

The Design #1 results were published recently [13], and in our study, are a reference for comparison with Designs#2 and 3. Design #1 aimed to influence the Contextualisation stage, in order to consider the effects of the group's self-chosen identification of who they were (the group context). A group of four international students studying at an international-level university in China had Nudge N1 and Nudge N2 added to the *WeValue InSitu* method used. This was repeated for a second, independent set of such students for qualitative comparison.

Nudge N1 consisted of adding an extra question at the end of the Contextualisation stage, immediately after the normal question asked, as follows:

Standard contextualisation question: "Please tell me who you are and what you are studying, as international students at this university." (The participants answered one by one.)

Additional contextualisation question: "Did you have any program related to the environment or any experience related to environmental sustainability?" (The participants answered one by one).

Nudge N2 consisted of the following short written questionnaire:

Please indicate to what extent you agree with the following sentences:

Strongly disagree (−3) −2 −1 0 1 2 (3) Strongly agree

(a) I act environmentally friendly, e.g., saving water, waste sorting, turning off lights and air conditioners
(b) Acting environmentally friendly is an important part of who I am
(c) I see myself as an environmentally friendly person

How would you describe yourself with regard to being environmentally friendly and environmental sustainability practices: would you say you are environmentally friendly?

Design #2

Design #2 aimed to provide Nudging on several choice spaces to ensure that, if the effects of any one were small and short-lasting, as is typical in all Nudging, that this Design would allow for the possibility of those consecutive effects leading into each other and possibly building up into a significant Nudging towards at least some impact on the targeted learning output (new environmental behaviours). For this Design, a group of five international students studying at an international-level university in China had Nudge

N1, Nudge N3, and Nudge N4 applied to the *WeValue InSitu* method. The entire setup was repeated for a second, independent group of such students for a qualitative comparison of the final transformative outcomes.

Nudge N1: the same as in Design #1.

Nudge N3: the inclusion of a larger number of environmentally themed photos within the set of 60–70 used for photo elicitation.

Nudge N4: changing the order of the 138 Trigger List statements used so that those which were environmentally themed were read first.

Design #3

Design #3 aimed to influence participants just prior to them leaving the event. The intention was not to influence the choice spaces of the *WeValue InSitu* process itself, but rather the choice of the 'takeaway messages' that the participants might later reflect on the most, and, thus, influence the target learning outcome of new pro-environmental behaviours. For this, a group of 4–5 teachers at a high school in Nigeria had Nudge N5 applied to the *WeValue InSitu* method. The entire set up was repeated for five further, independent sets of such teachers for qualitative comparison. (We do not suggest that these groups are directly comparable to each other or to the Design #1 or 2 cases, but they are still useful for discussion. They are convenience samples, because we were not able to arrange otherwise.)

Nudge N7: Initiating a group discussion after the *WeValue InSitu* process, with the question, "What aspects of the ecosystem around you affects or benefits you or your community, in any way?"

2.4. Data Collection and Analysis

The data collection was designed to yield information not only on the target output—transformational learning to result in new environmental behaviours—but also on any transformational learning around other themes (e.g., worldviews and relationships), whether or not they culminated in any behaviour change. The data collection and analysis approaches used are the same as in other studies of transformative learning outcomes (TLOs) after *WeValue InSitu* events [10,17], described briefly below.

Individual interviews were undertaken with as many group participants as were available, up to three time points after the event (immediately afterwards, 3–4 days later, and 14–56 days later). In order to minimise bias towards the target outcome (environmental behaviours) but to provide room for information about it to emerge, indirect questions were used, and if participants mentioned any form of change, they were then probed to elaborate more, with questions such as, "How do you feel about the workshop you just participated in?"; "What do you think about when you remember the workshop you participated in? Or have any aspects of that workshop come up in conversation with other participants?"

The interviews were audio-recorded and transcribed, and then searched for any references to changes in perspectives and/or behaviours by two researchers independently. These references were extracted and coded as Environmental (or Not) and Behavioural (or Not).

3. Results

The direct results are presented concisely below. Their wider interpretation is given in Section 4.

In Table 2, the results from the post-event interviews are summarised for their evidence of reported transformative learning in the form of changed perspectives and/or behaviour. The examples give an indication of the topics involved, ranging from perspectives about relationships with other people to pro-environmental behaviour. The full data is in the Supplementary Materials (note that there is a separate and detailed methodology needed to formally establish whether transformative learning has occurred, and this is not carried out here, as it is highly involved and would constitute a paper on its own. However, that work has already been performed on similar *WeValue InSitu* cases, in detail [10,17], showing that

it is long-lasting. Therefore, in this work, we focus instead on linkages to the Nudging details, while accepting that further explanatory and specific studies would be needed for confirmation of the TL nature of the results).

Table 2. Examples of post-event interview data, extracted and coded for relevance to transformational learning outcomes (TLOs) reported, and their categorisation as environmental and/or behavioural. The full data is in the Supplementary Materials.

	Extracted Quotes Indicating TLOs	**Env Type Y/N**	**Beh Type Y/N**
	DESIGN #1: Case group A (international students)		
1	Ppt Da: . . .since that experience thing I now pay more attention to where I put my trash, I actually read the labels. . ..	Y	Y
2	Ppt Da: . . .my friend was at my place and she was washing her hands and she finished and didn't stop the water completely from flowing then I was like you need to do it. . .	Y	Y
3	Ppt O: . . . I would like off the lights, pay attention to where I put my trash and when I am like on social media and I see like a post related to global warming or pollution, I will share to people about it. . .	Y	Y
4	Ppt Da: . . .after the workshop that very same day when I went back to my room I did some research, . . .I pay more attention to the environment now I was careless before I'm not anymore. . .	Y	Y
5	Ppt Da: . . .I make sure that I off the lights if I'm not in the room I make sure that the lights are not on, I make sure that I stop the running water.	Y	Y
6	Ppt Da: . . . I know I felt bad. Even though I knew that there are some things I could do but I wasn't really doing much and I wasn't talking about it. . ..	Y	N
7	Ppt-Nj: . . .. I think that my behaviour when I go back . . . I have not been doing enough when it comes to waste management, so that that has triggered a change in my behaviour. . ..	Y	Y
8	Ppt-Nj: . . .before the workshop I really didn't care about the waste separation . . .after the workshop it actually realized this good part and pay attention on how to dispose.	Y	Y
	DESIGN #1: Case group B (international students)		
1	Ppt J: before I was like no people don't need to encourage each other because you encourage someone who doesn't want to get your opinion, . . .so after the discussions and after hearing from other people I realize that we can encourage each other even if someone is not in need of being encouraged. . ..	N	N
2	Ppt J: also issues of working together, working a group, my believe and idea was we can make a group where people have the same ideas and understanding but after the workshop I came to realize that a group can have people from different ethnicity different nationality...	N	N
3	Ppt S: . . .Another thing that I realized from the workshop its we need to appreciate someone opinions regardless he is educated or not educated. . .	N	N
4	Ppt Cr: . . . So, after the workshop I carefully throw box and I know and when I reflected on how that related to my values I separate because I knew it was part of my values. . .. I can switch off the lights when leaving places because they have become part of my values	Y	Y
5	Ppt-Cr: . . . so now when I go to the canteen, not only I do not take the chop sticks away but I take along my own pan. I do these because they are my values. . .	Y	Y
	DESIGN #2: Case group A (international students)		
1	Ppt-Bo: . . .it also made me to realize that (the workshop) it's not only people who learn about the environment should be responsible for the environment. . .	Y	N
2	Ppt-Bo:. . . .what I really get from the workshop. . .it's about respecting people's differences. . ..	N	N
3	Ppt-AL: . . .yeah. I got to think differently about the environment . . . the workshop made me to think about the fact that I am not doing enough. . ..	Y	N
4	P-AL: . . .it made me aware that people are different. So, whatever we think or say, we might come to the same conclusion but with different ideas. . .	N	N
	DESIGN #2: Case group B (international students)		
1	Ppt-F: But you know discussions from the workshop really made me to think about that people can actually do something if they collectively come together and then begin to demand.	Y	N
2	Ppt-F: . . .. from the workshop . . ..so the discussions really like opened my thinking and my eyes to many of these other angles	Y	N
3	Ppt-P: . . .initially I was like its ok to ride bike etc. . . .. but we are now seeing from the perspective that there is need for that collective demand that will make huge impact.	Y	N

Table 2. *Cont.*

	Extracted Quotes Indicating TLOs	Env Type Y/N	Beh Type Y/N
4	Ppt P: . . . the others were pretty critical of some companies, which really pollute the environment heavily right exactly and so I think there's something I want to also keep in mind and maybe hopefully also do additionally. . .	Y	N
	DESIGN #3: Case group A (teachers)		
1	Ppt. A: . . ., I began to understand it . . .. So, the way I talk to them just like a mother, even though I may caution that person, but no longer talk with that harsh tone. So, it made me to, you know, have some changes in my approach to issues.	N	N
2	Ppt B: . . .. Well, since after the workshop, it changed my method of looking after those children that I am forming . . .	N	N
3	Ppt. G: . . .. . .Seeing that picture, after that encounter that day, it made me to have a deeper understanding of that work. . ..	N	N
4	Ppt. G: . . .one of the quotes we got was teaching as a service. . . And I said that day that it got me thinking because I never really thought of teaching as a form of service . . .I try to do extra knowing that this is like my way of contributing to the society. . .	N	N
5	Ppt. D: . . .We discussed something about the environmental. . . because the environmental challenge that we have in that school. . . just as we discussed to begin to now see it as a problem that we need to sensitize our students. . ..	Y	N

The results for Design #1, for both case groups, show that the participants described their changed perceptions/behaviours in quite specific terms, e.g., about "where I put my trash" and "stop the water from flowing". They also mostly concern pro-environmental behaviours and mirror those mentioned within the N2 Nudging Questionnaire. This is interesting, because the TLOs for the other Designs #2 and 3 are not so specific, e.g., ". . .respecting people's differences. . .", ". . .I got to think differently about the environment. . .", and ". . .it changed my method of looking after those children. . .". These more general descriptions are more typical of those found in standard *WeValue InSitu* results, where no Nudging has been used. Also, the TLO topics mentioned here are closely related to the shared values crystallised by the participants as individuals—they concern their life as a student or as a teacher.

In Table 3, the results are summarised in terms of the indicative number of transformative learning items reported in each category by each case group in each Design #1, 2, and 3. As this is an exploratory study which focuses on uncovering theoretical concepts and not statistical representation, the numbers are intended to be indicative, not conclusive. They suggest that Design #3 did not influence transformative learning (either perspectives or behaviour) towards the target of pro-environmental behaviour. This Design involved the nudging of the post-event discussions, N7. This suggests that the choices of the participants about which topics they took away for reflection were not influenced by the facilitator-led emphasis of certain topics at the very end of the event.

Table 3. Summary of the relative number of transformative learning outcomes reported in each Design#1, 2, 3 involving Nudging Contextualisation, Nudging Several Stages, or Nudging Take-away Reflections, respectively. These are compared indicatively to the pre-study Design #0 with no Nudging data from [5], which we have analysed here and represented in the first line of Table 3.

Design#	Country	Group Type	No. of (ENV) Themed	No. of (BEH)	Both (ENV + BEH)
Design 0:	No Nudging [5]				
Aggregated	Various	Various group types	1 of 24	5 of 24	0 of 24
Design 1:	Nudging Contextualisation (N1 and N2)				
Case 1A	China	International students	21 of 21	11 of 21	11 of 21
Case 1B	China	International students	9 of 14	6 of 14	6 of 14

Table 3. *Cont.*

Design#	Country	Group Type	No. of (ENV) Themed	No. of (BEH)	Both (ENV + BEH)
Design 2:	Nudging Several Stages (N1, N3, and N4)				
Case 2A	China	International students	2 of 5	0 of 5	0 of 5
Case 2B	China	International students	6 of 6	1 of 6	1 of 6
Design 3:	Nudging Take-away Reflections (N7)				
Case 3a–f	Nigeria	Teachers	2 of 9	8 of 9	2 of 9

On the other hand, both other Designs, #1 and 2, were linked to an increase in the relative number of changes in pro-environmental perspectives. Of these, only Design #1 appeared to influence behaviours—the strongest of all types of changes—and it is notable that all of these were towards pro-environmental changes. This type of result is highly desired by researchers in sustainability.

4. Discussion

To understand the significance of the new results, some contextual information on related research is first provided. (At this point, the authors would like to point out that, although 35+ papers have been written in 8 disciplinary fields about *WeValue InSitu*, the approach is not yet codified for general use by other research groups and requires specialist training over 3 weeks (although a training course and manual are in preparation for an open-access book due in spring 2025). For this reason, we declare that 10 papers have been cited, since they are affiliated with most of the foundational papers.)

Research on interventions that can produce (any kind of) transformative learning outcomes and pro-environmental behaviours in individuals is widely called for [2,3,29]. The results summarised in Table 3 reflect that such an intervention has been identified (labelled as Design #0, summarised from [10]), but also that very few of the Transformative Learning Outcomes (TLOs) produced had any environmental dimension (specifically, 0 or 1 of the 1–12 TLOs produced per group of 3–5 people). The important point here is, what proportion were related to the environment? The answer is, very few. There were many other types of learning outcomes besides environmental, such as outcomes related to increased self-respect or changes in how team members viewed each other. The studies listed in [10] (Tables 1 and 2) which followed the same data collection and analysis methods (i.e., without any Nudging) reported 13 TLOs, but none of them were environmental.

The reference data from Design #0 also provide the typical proportion of TLOs which are behaviour changes (5 out of 24) compared to those which are changes in perspective only (16 out of 24). In many research fields (such as sustainability science and sustainable development), a behaviour change outcome is highly prized, and they are rare. So, the results of studies producing 5 pro-environmental behaviour changes from 24 TLOs in Design #0 are of great interest simply for producing TLOs, even without environmental themes.

However, the results from Design #1 are much more relevant to researchers in sustainability. They represent what was found from the recent exploratory study [13] mentioned in the Introduction, i.e., that 'some' environmental Nudging does indeed appear to lead to outputs biased towards environmental behaviour change—almost half of the reported Transformative Learning Outcomes were classified as both Environmental and Behavioural (Table 3). These results indicate a great usefulness for sustainability practice, but were unexpected and not understood. That exploratory study could not suggest which effects the Nudging had on which learning processes or learning environments, as it was simply designed to be pragmatically 'bolted on' to a standard *WeValue In Situ* process. In our work here, we analysed it to show that it included two types of nudges, N1 and N2, on the choice spaces in Stage 1, and relate those to the other Nudging designs we applied to allow for a better overall understanding of the results.

The above results from Designs #0 and #1 provide the context to understand how noteworthy our new results from Design #2 are, because it incorporated not only part

of the same Nudging (N1), but also incorporated additional Nudging (N3 and N4) for a total of three different stages—yet it was not associated with any additional TLOs for targeted Environmental Behaviours. The expectation had been that more Nudging at more stages would likely produce more, but these results do not support this. This suggests two things—that the N2 Nudge (the Questionnaire) was probably responsible for the success in Design #1—not N1. (Although the combination of N1 and N2 might be key, further studies would be needed to establish this. The result also suggests that the other Nudges N3 and N4 were not linked to the desired effects.

One possible interpretation is that any N1 nudged change in the group's self-assumed identity in terms of how pro-environmental they were was either very weak or did not endure into the subsequent activities. whereas the N2 Nudge, the Questionnaire, involving very specific questions for the individuals to consider concerning their own current environmental actions such as turning off lights or recycling, possibly involved individuals considering deeply tacit and personal knowledge, and perhaps they then embedded the new realisation, such as that they were personally perhaps not recycling enough, in a constructivist manner. It has already been established in separate detailed studies that the Stage 3 *WeValue* process encourages participants into explorations of shared tacit knowledge, where the group undertakes shared meaning making of specific topics, one at a time [17,19]. If such a new realisation from N2 was deeply linked to internal tacit knowledge of personal actions, it is possible the effect endured, certainly for the rest of the *WeValue* session, where other active learning about self-awareness was taking place. In other words, the N2 Questionnaire between Stages 1 and 2 might have caused the participants to begin questioning the environmental aspects of their tacit actions (e.g., their recycling), and they could have taken this emphasis with them to Stage 3, creating a preference to focus on this.

The results from Design #3 yield further useful information in the context of the other Design results. Contrary to the other Designs, this one used a Nudge N7 applied just before the participants left the group at the end of the event. The expectation was that this might influence the 'Take-away' thoughts that the participants would continue to reflect on in the subsequent days and weeks before they were interviewed about outcomes. On the contrary, no effect was seen when Nudge N7 was applied. This seems to suggest, instead, that the strongest active learning occurred during the event, probably because of the interactions taking place in the group between individuals. This interactive individual-group learning has already been well documented in the *WeValue InSitu* process [19], similar to that of a 'learning community', as described by researchers such as [30] and [31], where a strong sense of community enhances knowledge exchange, learning, and attachment to group goals and improves cooperation and satisfaction with group efforts. This raises interesting questions about the interplay of learning while in a 'community' versus related continued learning individually afterwards—how are the two connected and how do they influence each other?

Thus, our results raise new, ancillary questions about learning mechanisms. These participants were effectively a learning community (defined as individuals who share a common interest, engage in joint activities, have shared values [32]), and active learning is known to be enhanced in learning communities [33]. However, the reason for this is not established in the literature. Some have suggested that the enhancement of active learning is due to better communication [34], which is often presented as 'more frequent' communication. On the other hand, social constructivist learning is known to be an important element, because members of a learning community might collectively build on their interactions—and this is known to be what occurs in *WeValue InSitu* [19]. Further studies similar to the one presented here could investigate these through capturing and analysing conversations occurring throughout the *WeValue* activities in different stages and following the development of the different topics in terms of frequency, links to learning community history, and collective interactions.

The overall practical implications of our findings are as follows: *one type* of Nudging does indeed seem to influence the direction of transformative learning taking place via

shared values crystallisation. Its relevant characteristics seem to be that it occurred early on, involved specific questions, and required personal reflection on the target behaviour (e.g., recycling). However, many other types of Nudging did not have this effect, including the placement of extra items referring to the environment into the choice spaces or nudging participants towards certain topics just before they left. These aspects can now be tested and used in practical work in environmental education.

Finally, there are ethical considerations to consider from our results. Some work has been conducted on cultivated spaces for active learning [35], where designers can cultivate learning environments in terms of their perceived, conceived, and lived spaces (as described by [36]). Since our study shows that Nudges can influence active learning outcomes, then the designers need to take responsibility for any in the space they are cultivating. If it is known in advance that certain types of active learning (e.g., with Nudges) might lead to specific behaviour changes, so the need for prior informed consent from the participants about that outcome needs consideration. Where Nudges are purposely used to achieve behaviour changes, e.g., in pro-environmental behaviour, then there may be an ethical need to actively declare this rather than present the activity as otherwise focused. Such questions should be put before a local ethics board for consideration.

5. Conclusions

This study contributes to a better understanding about the influence of Nudging on a shared values crystallisation process which reliably produces transformative learning outcomes. The findings suggest that only certain types of Nudging seem to influence its meaning-making sub-processes to facilitate a targeted type of behaviour change to be produced (pro-environmental action, in this case). This result is significant for environmental sustainability practitioners, because learning processes which can trigger transformational learning outcomes for targeted behaviours are rare, and knowing any generalisations regarding its optimisation is useful. These results clarify that the use of the environmental behaviour Nudging questionnaire prior to the shared values crystallisation process is linked to the desired results of more pro-environmental behaviour outcomes, and the other Nudging types are not (i.e., those emphasising the environmental aspects of the materials used).

This result is also significant for researchers in active learning and reflective and critical thinking, in that it demonstrates that, despite the learning (in this case, in shared values crystallisation processes) being active, there exists some Nudging types which can greatly influence the direction of the learning. This raises questions about the ethics of using Nudging without informed consent (if its results are not anticipated and might be unwanted). It also raises questions about the mechanisms involved in active and reflective and critical thinking and learning—how is it that some Nudging can influence them, but others cannot?

Further research would be useful to test these results in explanatory studies and to study the interactions of different Nudging types with the learning mechanisms in more detail to provide contributions to both types of theories.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su16229773/s1, File S1: Full data set.

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