

Applying pedagogical theories to understand learning in participatory scenario planning

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ABSTRACT

Participatory scenario planning (PSP) is widely used by researchers and practitioners working towards social-ecological resilience with the expectation that it can encourage learning. However, thus far there is a lack of theoretically informed analysis regarding how PSP may support learning in this context. In this paper we present a novel conceptual framework, based on the Zone of Proximal Development, which highlights how learning can arise through interactions between people with different fields of expertise, and add the concepts of ‘boundary objects,’ and ‘scaffolding.’ We applied this framework to an empirical study of learning in PSP processes that focus on social-ecological resilience. We found that PSP purposively brings different participants into dialogue with each other, and through the process of developing and analysing narratives of possible futures, encourages their exposure to different knowledges. If carefully designed and facilitated, PSP can also stimulate structured, creative thinking about possible futures. This can be usefully understood as enabling participants to ‘enter’ their Zone of Proximal Development and to explore ideas and ways of thinking in which they would not normally engage. This highlights the importance of studying interactions between different participants in PSP, and of actively facilitating the process of imagining and exploring scenarios.

KEYWORDS: Participatory scenario planning; learning; zone of proximal development; boundary objects

36 1. Introduction

37 Futures tools are often used by researchers, policymakers, and practitioners to help address
38 the complex, uncertain and destructive challenges that characterise social-ecological systems.
39 Participatory Scenario Planning (PSP), especially, has been widely used as a tool to help
40 tackle these challenges, commonly motivated by an assumption that it can help people learn
41 about and identify responses to them (Oteros-Rozas et al., 2015). Indeed, one of the founders
42 of scenario planning, Wack (1985), explains that it can help people to structure future
43 possibilities into coherent narratives. In this way, he explains, scenario planning enables
44 groups of people who are working towards a common goal to articulate and reflect upon their
45 assumptions about the world, consider alternative perspectives, and thus learn through
46 developing a broader understanding of whatever system they are operating within. Similarly,
47 two other influential scenario planning scholars, Schoemaker (1993) and Van der Heijden
48 (1996), both argue that it can help people to develop an expanded understanding of the world
49 by structuring highly uncertain futures into sets of manageable narratives.

50 More recently, Ramirez and Wilkinson (2016; p.5) build on this earlier work to describe how
51 scenario planning can enable learning through ‘reframing’ (a process of exploring alternative
52 future contexts, which leads to an exchange of different perspectives, and thus the creation of
53 new knowledge and shared perspectives, as well as consideration of different options for
54 action) ‘reperception’ (identification of new courses of action to be taken for achieving
55 change). In this way, scenario planning can help groups and individuals to develop a more
56 holistic understanding of the system in which they are working, and then to identify ways to
57 approach a specific situation. Similarly, Ehresmann, Tuomi, Miller, Bejean, and
58 Vanbremeersch (2018) describe PSP as a ‘Collective Intelligence Knowledge Creation’
59 process that enables participants to understand and appreciate how the way they imagine the
60 future influences their perceptions of and actions in the present. This can thus encourage
61 people to ask new questions and ‘think outside the box.’

62 This scholarship creates expectations that scenario planning can be useful for learning and
63 provides some insights into how this learning can occur. However, there has thus far been
64 limited theoretically informed explanation of how participatory scenario planning (PSP)
65 enables such learning, especially as used in the context of tackling complex challenges in
66 social-ecological systems. Developing such an understanding could help futurists, researchers
67 and practitioners to assess how it should be used and what benefits it may be expected to have
68 when applied in different contexts. In this paper, we have two aims: Firstly, we review
69 theoretical literature on learning to build a conceptual framework that can help futurists and
70 other researchers and practitioners of PSP to study, understand and evaluate learning in PSP
71 processes. We base this on a specific pedagogical theory - Vygotsky’s (1978) Zone of Proximal
72 Development (ZPD) – then build on it using other influential concepts related to learning,
73 namely ‘boundary objects,’ (S. L. Star & Griesemer, 1989) and ‘scaffolding,’ (Wood, Bruner,
74 & Ross, 1976). Secondly, we apply this framework to a study of learning in PSP processes that
75 focus on addressing complex challenges in social-ecological systems. The study comprised i)
76 an analysis of 30 cases of PSP described in the academic literature, ii) interviews with 16
77 practitioners of PSP, and iii) two empirical case studies of PSP processes. We do this to
78 identify the processes through which PSP can support learning, and to assess the usefulness of

79 our conceptual framework. We begin with the review of theoretical literature on learning,
80 below.

81

82

83 2. Using Pedagogical theories to build a conceptual framework for 84 explaining learning in PSP

85

86 2.1 Literature Review of Pedagogical theories that can explain learning in PSP

87 *Defining Learning.* To begin, it is important to clarify what we mean by learning. There are
88 many ways in which learning scholars have defined learning, but they are often linked by the
89 theme of change (cognitively or physically) on the part of the learner, as a result of
90 interpreting experience (Illeris, 2009; Jarvis, Holford, & Griffin, 2003; Parker, 2005). In this
91 paper, we therefore consider learning to be a change in a person’s cognitive or physical
92 capacity that results from that person interpreting their experiences of external stimuli. For
93 example, not just learning new facts and information, but identifying new priorities and
94 solutions to problems, understanding alternative perspectives, reframing specific issues, and
95 developing a more holistic understanding of possible future conditions. We focus on
96 cognitive traditions of learning theory because of their emphasis on cognitive processing of
97 experience as the driver of learning. In particular, we look at the Zone of Proximal
98 Development, proposed by Vygotsky (1978).

99 *The Zone of Proximal Development.* In this influential learning theory, Vygotsky
100 distinguishes between a person’s current development (their independent capacity for
101 learning), and their proximal development (the potential learning capacity they have when
102 assisted by others). Vygotsky thus assumes that an individual’s capacity for learning
103 increases when they receive assistance from others. When such assistance is provided, he
104 refers to this as ‘entering’ the ZPD. In a more recent description of the ZPD, Wals and Dillon
105 (2013) explain the ZPD as the potential learning that can occur through interactions with
106 other people, their work and their thoughts and ideas. They indicate that such interactions can
107 help people understand things they would have been unable to without being encouraged or
108 challenged by one another.

109 However, as Chaiklin (2003) warns, Vygotsky specifically states that learning occurs through
110 interactions between learners and people who are more capable in a given field, or who have
111 a more advanced level of cognitive development. In PSP, the participants and facilitators may
112 have similar levels of cognitive development. However, it may create opportunities for
113 participants to encounter others who are more capable in different fields or contexts to their
114 own. For example, a smallholder farmer may have more expertise about localised rainfall
115 patterns in a village than a climate scientist. Conversely, the climate scientist may have more
116 expertise in global atmospheric processes than a smallholder farmer. If both apply their
117 knowledge to exploring scenarios about the possible effects of changing rainfall patterns,
118 they could each benefit from interactions with the other in learning about certain aspects of
119 the problem. The Zone of Proximal Development thus provides a useful theoretical basis for
120 explaining how learning occurs in PSP – indicating that it occurs through interactions

121 between people with different expertise. However, it is not sufficient for understanding the
122 specific attributes of PSP that enable such interactions, or indeed why these interactions help
123 participants to ‘enter’ their ZPDs.

124 *Boundary Objects.* One useful way to explain how PSP enables interactions and why these
125 interactions encourage learning is through using the concept of ‘boundary objects.’ These
126 were first conceptualised by S. L. Star and Griesemer (1989) as material or abstract objects
127 that occupy several interacting, intellectual worlds and remain relevant and outwardly
128 acceptable to all of them. They explain that boundary objects can facilitate effective
129 communication between diverse actors, which helps them to cooperate despite their
130 disciplinary and other differences. White et al. (2010) reason that this can enable negotiation
131 and exchange of knowledge between different groups. As Susan Leigh Star (2010) clarifies, a
132 ‘boundary’ in this context is not the physical edge of something. Instead, she states that it is a
133 physical or conceptual space that is shared by actors from different social worlds. Star also
134 emphasises that an ‘object’ is not necessarily a material thing but can be a concept that people
135 work towards and with.

136 The inclusion of different knowledges in PSP means the scenarios that are imagined can
137 become spaces that are shared by participants from different social worlds. They can thus
138 encourage interactions between people with diverse knowledge through creating opportunity
139 for interaction on a shared concern. Scenarios are also conceptual objects that participants
140 work towards and with, which can encourage them to share their knowledge and thus learn
141 from one another. We therefore follow Chaudhury, Vervoort, Kristjanson, Ericksen, and
142 Ainslie (2012) in proposing that the process of imagining plausible futures in PSP fits
143 particularly well with the concept of a boundary object. Viewing PSP processes as boundary
144 objects thus helps to understand how PSP can encourage interactions between participants
145 with different knowledge. This builds on the idea of the ZPD, in that these interactions
146 between different participants encourage them to enter their ZPD, and thus to learn. This is
147 illustrated in Figure 2, below.

148 *Scaffolding.* When Vygotsky (1978) proposed the ZPD, he argued that learners require
149 assistance, not just interaction, for them to enter the ZPD and for learning to occur. Hence,
150 we also draw on the related pedagogical concept of ‘scaffolding,’ Wood et al. (1976). Wood
151 et al. describe this as someone with more expertise than the learner gradually introducing
152 them to and helping them complete tasks that they would not have been able to complete
153 alone. A more recent description of scaffolding is provided by Van der Pol, Volman, and
154 Beishuizen (2010), who argue that scaffolding involves: contingency (tailoring support
155 provided to a learner’s existing ability), fading (decreasing the level of assistance as the
156 learner becomes more proficient), and transferring the responsibility for learning from the
157 expert to the non-expert.

158 Van der Pol et al. (2010) critique Wood’s view of scaffolding because it assumes that what is
159 learned is predefined by the expert. Instead, they argue that learners should be viewed as
160 active participants, rather than recipients of knowledge, and scaffolding should be viewed as
161 an interactive process, in which learners and experts create new knowledge together. This
162 reflects an argument made by other learning scholars, Fernández, Wegerif, Mercer, and
163 Rojas-Drummond (2001), who contend that scaffolding can and does occur in peer-to-peer
164 interactions as well as interactions with experts. Specifically, they indicate that peer-to-peer

165 scaffolding occurs when people engage in what they call ‘exploratory talk.’ They describe
166 this as a process of people engaging critically and constructively with others’ ideas by
167 proposing new ideas, and then giving and receiving critical but constructive feedback to and
168 from others. This enables learners to develop new understandings and drive the learning
169 process forward.

170 The concepts of both expert-learner and peer-to-peer scaffolding are valuable for
171 understanding learning in PSP since they highlight the role of facilitation in PSP. Typically,
172 PSP processes are designed and led by one or more facilitators. However, the role of
173 facilitators is something that appears to have received scant attention in PSP literature.
174 Facilitators may have an important role in enabling or constraining learning in PSP processes
175 since they arguably provide scaffolding that helps participants engage in, as well as learn
176 through, PSP. This can influence how participants interact with each other, as well as the
177 extent to which these interactions result in learning. Peer-to-peer scaffolding may also occur
178 between different participants in PSP when they interact in a way that encourages exploratory
179 talk. This could also help to explain why such interactions can encourage learning. This is
180 illustrated in Figure 3, below.

181 It is important to recognise that scenarios may be imagined for different purposes, ranging
182 from identifying what is probable by projecting trends in the past and present, through
183 exploring what is possible through constructive narratives of the future, to creating the future
184 by expanding what people consider possible (Tuomi, 2019). PSP processes can thus include
185 different methods, as well as different approaches to facilitation, depending on their purpose.
186 The ‘Futures Literacy Framework’ outlined by Miller (2018) lays out five stages of learning
187 with regards to anticipating the future, which represents a scaffolding process, in that
188 participants start with one stage and then become more proficient as they progress through
189 the different stages. In the early stages participants develop experience and awareness of how
190 their perceptions of the future influence how they think and act in the present, then in the
191 latter stages participants reassess their perceptions of the past and present, as well as their
192 aspirations for the future, and ultimately, through collaboration with others, choose why and
193 how to anticipate the future. The methods and facilitation style of individual PSP processes
194 will depend on the stage of the learning that participants are intended to reach through the
195 process, and the stage they are at already.

196

197 2.2. A conceptual framework for understanding learning in PSP

198 The conceptual framework is presented in three parts, reflecting the three learning theories
199 (the Zone of Proximal Development, boundary objects and scaffolding) reviewed above.
200 Firstly, we argue that PSP can support learning by creating opportunities for interactions
201 between people from different social and disciplinary backgrounds, and with different kinds
202 of knowledge and experience. This is illustrated in Figure 1, below.

203 *(Figure 1 here)*

204 Secondly, PSP can act as a boundary object that can facilitate exchange of knowledge, ideas
205 and experience between different people. By doing this, PSP can help those who participate
206 in it to enter their ZPDs and thus to learn. This is shown in Figure 2, below.

207 *(Figure 2 here)*

208 Thirdly, the above theories also suggest that facilitation plays a key role in enabling and
209 supporting learning. This is shown in Figure 3, below.

210 *(Figure 3 here)*

211 To further our understanding of how learning can occur in PSP, we conducted an empirical
212 study to understand whether and how the above characteristics of PSP can encourage
213 learning. Specifically, we explored real-world examples of PSP with a particular focus on the
214 interactions between participants, the processes that encouraged and hindered these
215 interactions, and the roles played by facilitators. We focused on PSP processes that aimed to
216 tackle complex challenges in socio-ecological systems, as this has become a popular
217 application of PSP (I. Brown, Martin-Ortega, Waylen, & Blackstock, 2016; Johnson et al.,
218 2012; Oteros-Rozas et al., 2015; Varum & Melo, 2010). As with the wider literature on PSP,
219 enthusiasm for PSP in this context often seems linked to implicit or explicit expectations that
220 PSP can support learning, specifically through the incorporation of knowledges of different
221 stakeholders in deliberations on how to tackle these problems. However, none of these
222 reviews or case descriptions have employed a theoretically informed explanation of how
223 learning occurs, particularly how PSP can encourage interactions, why these interactions can
224 promote learning and what role facilitation can play in this. We explored these issues through
225 the methodology described in Section 3, below.

226

227 3. Methods

228 To apply the conceptual framework in Section 2 to real-world applications of PSP we
229 conducted an empirical study into how learning occurs in PSP. We used a qualitative mixed
230 method approach as this is appropriate to explore a hitherto poorly-understood topic
231 (Creswell, 2003). This involved three different sources of data, gathered over 16 months
232 between August 2015 and December 2016. These were: i) a review of 30 PSP cases described
233 in the academic literature, ii) interviews with 16 practitioners of PSP, and iii) two empirical
234 case studies of PSP processes. These are described in more detail below. In accordance with
235 our use of the ZPD as the basis for the conceptual framework, we focused specifically on
236 exploring the interactions between different participants in PSP processes, the exchange of
237 knowledge between them, and the learning (if any) that resulted from this.

238 This research was conducted with ethical clearance from the Research Ethics Committee at
239 the School of Agriculture, Policy and Development, University of Reading. Participants in
240 the practitioner interviews and case studies were thus provided with, and asked to sign an
241 information sheet, clearly explaining the purpose, intent and process of the research, as well
242 as their right to request that any of their responses be excluded from recording and analysis,
243 and to withdraw from the research at any point. We ensured the confidentiality of
244 participants' responses by attributing quotes to pseudonyms, rather than participants' real
245 names, and replacing the names of the two case study workshops with pseudonyms. Data was
246 stored and managed in accordance with the University of Reading's Data Protection Policy
247 and the UK Data Protection Act.

248

249 3.1. Review of cases of PSP described in the academic literature

250 PSP is frequently used by sustainability researchers as part of wider research projects that aim
251 to inform responses to challenges in social-ecological systems. There is, therefore, a substantial
252 body of peer-reviewed, academic literature reporting on individual cases of PSP being used.
253 However, cross-cutting analyses of these cases are rare. We therefore interrogated and analysed
254 30 such cases to develop an understanding of how learning was discussed and theorised (if at
255 all), as well as how learning may have occurred in them. As Haddaway, Woodcock, Macura,
256 and Collins (2015) suggest, we ensured that the selection of cases was rigorous by selecting
257 literature from multiple databases, selecting literature based on a consistent set of criteria, and
258 critically appraising the literature before selection. The literature was identified using the
259 databases: ‘Web of Science’, ‘Google Scholar’ and the University of Reading’s online
260 literature catalogue. In line with our focus on PSP in social-ecological contexts as a case study,
261 we searched for: ‘scenario planning social-ecological systems,’ ‘scenario planning sustainable
262 development,’ and ‘scenario planning environmental management’. We then selected
263 individual pieces of literature by studying the titles of papers that were found through these
264 searches. We selected titles that matched the search terms exactly, and also those that used
265 words and phrases related to the search terms. For example, a title such as ‘identifying
266 strategies for poverty reduction under climate change using future scenarios,’ would be
267 included. Finally, we narrowed the sample down from 53 cases to a set of 30 information-rich
268 cases that provided enough information for a justifiable analysis of learning and other benefits
269 that occurred in these examples.

270 However, although this provided a set of detailed cases for analysis, we acknowledge that the
271 sample is biased towards well-reported and information-rich analyses of PSP processes.
272 Equally, our sample focuses solely and deliberately on academic literature, as we did not seek
273 to conduct a thorough analysis of grey, and other forms of literature in this research. We also
274 recognise that the papers that described these cases were written by academics, many of whom
275 had been directly involved in the cases they reported on, thereby introducing a second source
276 of bias. It was therefore important to triangulate this with other sources of data.

277 3.2. Practitioner Interviews

278 As stated by Yeo et al. (2016), in-depth interviews can be a powerful way of exploring detailed
279 interactions with people. In-depth, interviews were therefore conducted with 16 practitioners
280 of PSP (researchers and professional facilitators) globally to explore how interactions between
281 participants in PSP processes may have resulted in learning. These practitioners included 14
282 researchers from: ecology and ecosystem services (n=5), geography (n=2), sustainable energy
283 (n=1), interdisciplinary studies (n=1), sustainable development (n=1), food systems (n=3),
284 climate change adaptation (n=1). The remaining two practitioners were both professional
285 facilitators. Nine practitioners were from the cases in the academic literature that were
286 reviewed as part of this research, one was from a case that was excluded from the review for
287 lack of detailed information about learning (to investigate if the detail was understood by those
288 involved, but excluded from published material), three were prominent figures in PSP
289 discourse, and three were from the case studies detailed below.

290 Most of the interviews took place by Skype or telephone. However, four of the interviews took
291 place face-to-face, as the practitioners were available locally and suggested we meet in person.
292 All of the interviewed practitioners interviewed appeared happy to talk, were open to being
293 questioned, and provided detailed and eloquent responses. The practitioner interviews were

294 semi-structured and used mainly open-ended questions to achieve both breadth of coverage
295 and depth of information regarding the key topics of interest in the research (Yeo et al., 2016).
296 These questions focused on practitioners' experiences of PSP, including why they thought it
297 was beneficial, or not, in the contexts in which it was used, as well as specifically exploring
298 cases in which they thought learning had occurred and how they explained this. The full topic
299 guide can be found in Appendix A. Pseudonyms were given to each of the interviewed
300 practitioners and used in the analysis below to protect the identity of individual informants.

301 3.3. Case Studies of specific PSP processes

302 The review of cases of PSP in the academic literature and the practitioner interviews provided
303 useful information, but they still relied on post-rationalised accounts of PSP processes by the
304 people who facilitated or had been directly involved in them. For the purposes of triangulation,
305 it was also important to elicit the experiences of participants and to observe, first-hand, the
306 interactions that took place in specific PSP processes, how these interactions were encouraged,
307 and how assistance provided by facilitators, and between participants, enabled learning to
308 occur.

309 We collected observations from two case studies. These were selected based on the criteria that
310 they: 1) developed alternative narratives of plausible future events, conditions and trajectories;
311 2) were participatory and included a range of different participants; 3) encouraged knowledge
312 exchange between different participants; and 4) focused on tackling global challenges. Of the
313 processes that met these criteria, we selected the two that were easiest to access, because of
314 existing contacts held by the research team. Both processes were part of wider research
315 projects. The first was part of the 'Food Security Futures' (FSF) project, which explored threats
316 and opportunities for achieving food security under climate change in Tanzania. The second
317 was part of 'Positive Futures for Southern Africa' (PFSA), an initiative that aimed to develop
318 hopeful and innovative, but also realistic, ways of thinking about future relationships between
319 human and environmental systems.

320 We chose two case studies for comparison, but as Lewis (2003) observes, some degree of
321 difference between cases is always inevitable and may be illuminating. The two case studies
322 used different approaches but followed essentially the same logic for developing scenarios –
323 using present signals, trends and drivers to develop storylines of alternative futures. Both
324 processes were participatory to the extent that they included participants (purposively selected)
325 with a range of different worldviews, social-economic backgrounds, and disciplinary
326 perspectives, and they actively encouraged them to share knowledge through imagining and
327 exploring scenarios together. Table 1, below, provides an overview of both case study
328 workshops, whilst Tables 2 and 3 provide detailed descriptions of the structure and activities
329 undertaken in each one. The case studies have been anonymised to protect the identity of the
330 participants, facilitators and organisations involved. Pseudonyms were given to each of the
331 workshop participants and facilitators, and used in the below analysis to protect their identities.

332 *(Table 1 here)*

333 *(Table 2 here)*

334 *(Table 3 here)*

335 Our research into the case studies involved three aspects: i) administering a pre-workshop
336 questionnaire by email to the participants of each PSP workshop; ii) observation of the

337 workshops; and iii) semi-structured interviews with the workshop participants and facilitators.
338 The pre-workshop questionnaires consisted of five open-ended questions, concerning:
339 participants' occupations, motivations for attending the workshop, and the benefits they
340 expected it to have, and were administered the week before each workshop occurred. The
341 observations involved: meetings with the workshop facilitators before, during and after the
342 workshops to explore their preparations and expectations, watching, listening and speaking to
343 participants and facilitators during the workshops themselves, and asking participants and
344 facilitators to reflect on their experiences during breaks and meal times. Detailed written notes
345 were made throughout these observations using an observation guide (see Appendix C), based
346 on the conceptual framework outlined in Section 2, which included the extent and type of
347 interactions that occurred during the workshops, the role that developing and analysing the
348 scenarios played in encouraging and shaping interactions between the participants, and how
349 participants were encouraged to engage effectively in PSP through assistance from facilitators.

350 The interviews with participants (n=13 from each case study) from the case studies focused
351 firstly on ascertaining whether learning, taken as a change in understanding as a result of
352 some external stimuli, had occurred through the workshops. Participants were asked directly
353 if their understanding of the subject of each workshop had changed through the PSP process.
354 Furthermore, most participants alluded to learning, unprompted, when asked about other
355 aspects of the workshops, including what they found most interesting and challenging, and
356 about their interactions with others. The second focus was to explore the interactions between
357 different participants, the role (if any) that these interactions played in enabling learning, and
358 the specific activities that stimulated these interactions. We thus asked participants about
359 which aspects of the workshops, and which specific activities, they attributed learning to.

360

361 4. Results

362 4.1. Learning through interactions

363 Our research confirmed that learning is commonly reported as a benefit of PSP. Indeed, 23 of
364 the 30 reviewed cases in the academic literature reported learning as a benefit (Poskitt, 2017).
365 This supports previous assumptions that PSP can result in learning. A total of 14 of these
366 cases alluded to interactions between diverse participants contributing to learning,
367 particularly interactions that involved 'discussion,' 'deliberation,' 'dialogue,' and 'knowledge
368 exchange' as highlighted in bold in Table 4. In each of these 14 cases, the authors
369 subsequently reported that learning occurred. We thus infer from this that learning is linked
370 to interactions that involved 'discussion,' 'deliberation,' 'dialogue,' and 'knowledge
371 exchange' between different participants. Although there are nuanced differences between
372 the terms 'discussion,' 'deliberation,' 'dialogue,' and 'knowledge exchange,' this study
373 focused more on exploring the attributes of PSP that can encourage these kinds of
374 interactions, rather than defining the differences between them. We therefore refer to these
375 kinds of interactions as 'discussions between different participants.'

376

377 (Table 4 here)

378

379 The attribution of learning to interactions was also a recurrent theme in the practitioner
380 interviews, in which respondents referred to learning occurring through interactions between
381 indigenous and scientific communities, local and national level stakeholders, smallholder and
382 commercial farmers, and many more. This was summed up eloquently by two practitioners,
383 Gavin and Gordon, with substantial experience of using PSP in high-profile global processes:
384

385 *“The learning potential lies in interactions across disciplines, where people’s*
386 *assumptions are questioned in a respectful way... This leads to learning about*
387 *different drivers and learning about different people’s visions and desires for the*
388 *future.” (Gordon, 2016)*

389

390 *“It is the interactions between stakeholders that are brought together. They are*
391 *brought together with people they don’t normally interact with, across those*
392 *different scales or across sectors, or areas of government, or industry.” (Gavin,*
393 *2016)*

394

395 This evidence shows that practitioners, and the authors of papers reporting on specific PSP
396 processes regarded that learning occurs through interactions between different participants in
397 PSP. This theme was also evident in the interviews with participants in the case studies,
398 especially from the PFSA workshop, in which all 13 of the interviewees indicated they had
399 learned through interactions with other participants. For example, one participant, Geoffrey
400 gave a detailed example of how discussions with another participant about the role that artificial
401 intelligence (AI) could play in creating just and sustainable futures, led to him learning about
402 a specific topic:

403 *“I sat in that group with a totally different understanding of what artificial intelligence*
404 *meant. [To me it meant] we’re going to be taken over by aliens, but through Penelope’s*
405 *explanations, I thought ‘oh, this is what it actually means, okay!’ It’s not necessarily just a*
406 *computer; it’s also the digital learning and all these different dynamics.” (Geoffrey, 2016)*

407

408 In the interviews with participants from the FSF workshop, 6 of the 13 interviewees stated that
409 interactions with other participants had resulted in them learning. The lower number of
410 responses reflecting this may be because many of the interviewees in this case study found it
411 difficult to articulate how they had learned in English. One participant, Sally, an academic
412 researcher, described how she had learned from interacting with participants who had different
413 expertise:

414 *“I met with people’s different expertise, nutrition specialists, policy makers, one*
415 *person from the pressure group, from NGOs. Those participants shared their*
416 *skills, their knowledge, their experience accordingly.” (Sally, 2016)*

417 Our data thus demonstrates that learning in PSP does indeed occur through interactions
418 between different people, and infers that discussions between participants are aspects of these
419 interactions that encourage learning. However, this could arguably be said of any participatory

420 or educational process that brings different people into discussion. We therefore move on to
421 explore any specific attributes of PSP processes that encourage discussions between
422 participants and any specific attributes of these discussions that promote learning.

423
424

425 4.2. Providing a point of focus for discussions between participants

426 As shown in Table 5, 21 of the 30 reviewed papers mentioned specific aspects or activities that
427 encouraged learning in PSP by acting as a point of focus for discussions between different
428 participants. These aspects or activities are highlighted in bold in Table 5, below.

429

430 (Table 5 here)

431

432 The evidence in the table above indicates that discussing different aspects of social-ecological
433 systems through developing structured narratives of the future provides a point of focus for
434 discussions between different participants. In one typical case, extracted from Table 5, Van
435 Berkel, Carvalho-Ribeiro, Verburg, and Lovett (2011) state that *'The scenarios acted as prompts*
436 *in the workshop discussions,' (p.135)*. In their paper, the authors explain that deliberating on the
437 effects of specific future trajectories in participants' local area stimulated discussion about local
438 development issues. They report that this led to a *'richer understanding of rural development*
439 *issues,' (p.136)* including the interests of different stakeholders. It thus appears that developing
440 and exploring specific narratives of the future prompted discussion between the participants,
441 which led to learning.

442

443 This was also reflected, strongly, in the practitioner interviews. We asked 10 of the 16
444 respondents about what specific aspects of PSP they thought enabled learning. All 10 of them
445 indicated that the narratives of the future provided a point of focus for discussions about SEPs.
446 This was encapsulated by one practitioner, Belinda, who had a wealth of experience conducting
447 PSPs in global projects. She stated:

448 *"Everyone has expectations, aspirations and anxieties with regards to the future,*
449 *which they are forced to make explicit when they imagine scenarios."* (Belinda,
450 2016)

451 Another practitioner, Rick, provided more detail regarding how he thought learning had
452 resulted from a specific PSP process in which he was involved. He explained that the PSP
453 process encouraged learning:

454 *"through focusing people's minds on what they think are the most important*
455 *developments and trends... People know it, but people don't necessarily have a*
456 *chance to focus on it and pull it together."* (Rick, 2016)

457 This shows that the participants learned, specifically, through focused discussions on
458 potential future developments, which encouraged them to reflect on their existing
459 assumptions.

460 In the FSF case study too, the process of exploring specific narratives of the future acted as a
461 focal point for discussions. Of the ten interviewees who stated they had learned from the

462 workshop, eight of them described how this learning had been stimulated by the process of
463 exploring structured narratives of the future together with others. For example, one
464 interviewee, Alan, who indicated that he had learned about different aspects of food and
465 nutrition security, explained that thinking about future narratives in a step-by-step way had
466 helped him to learn:

467 *“The methodology of using scenarios, and the planning by using the backcasting,*
468 *that was the most interesting part because really it was new to me... It facilitates*
469 *somebody to go step-by-step... It is difficult to miss something, to overlook*
470 *something.” (Alan, 2016)*

471 The above evidence thus indicates that PSP can engage participants in processes of exploring
472 narratives of the future together in a structured and focused way. This is a specific aspect of
473 PSP that encourages discussions between participants, and specifically acts as a focal point
474 for these discussions, which encourages them to share and reflect upon their existing
475 knowledge and assumptions about the future. However, as discussed in the next section, it is
476 not just structure and focus, but also the opportunity to be creative in exploring narratives of
477 the future that stimulates learning.

478

479 4.3. Creativity and learning in PSP

480 In the PFSA case study there was also evidence that exploring structured narratives of the
481 future resulted in learning through promoting discussion between different participants.
482 However, this went further than just structure to emphasise the importance of creativity. In
483 our interviews with the workshop participants, 9 of the 13 interviewees attributed learning in
484 PSP to structured thinking *combined* with creative thinking. For example, one participant,
485 Penelope, stated fluently:

486 *“I think imagining different futures, or different realities, is really powerful,*
487 *because you’re starting from a place of possibilities. When you are thinking of*
488 *different futures like that, when you’re doing scenarios, you’re provided an*
489 *opportunity to be creative... scenario planning provides an opportunity to be*
490 *strategic, to be creative, and to start from a place of possibilities.” (Penelope,*
491 *2016)*

492 Similarly, another participant, Gareth emphasised creative thinking, but within a structure
493 provided by PSP:

494 *“It helped people to ‘think outside of their boxes,’ but within some particular*
495 *parameters.” (Gareth, 2016)*

496 In other words, the PSP process in the PFSA workshop provided some structure to focus the
497 participants’ thinking about the future but gave freedom within this structure to explore
498 possibilities they would not normally think about.

499 In the PFSA workshop, this ‘focused, creative thinking’ appeared to be especially encouraged
500 by two specific activities: ‘Futures Wheels’ (Bengston, 2016) and connecting small-scale
501 initiatives in the future. As explained in Table 3, above, the PFSA workshop began with
502 creating ‘Futures Wheels,’ whereby participants imagined the impacts of small-scale
503 initiatives if they were mainstream ways of doing things. This activity provided the initial

504 stimulus for participants to think creatively. For example, one group of participants imagined
505 a future in which the division between rural and urban spaces became increasingly blurred. In
506 another group, the participants imagined how the effects of gene technology on human health
507 could lead to much longer human life. The ideas and creative thinking generated in the
508 Futures Wheels were subsequently expanded on and developed in the later activities. The
509 subsequent activity of exploring the effects these small-scale initiatives could have on each
510 other also helped participants to think creatively. For example, one discussion group
511 connected an initiative involving artificial intelligence (AI) with another promoting more
512 equitable and inclusive access in urban spaces. This led to them imagining ‘fluid
513 infrastructure,’ in which urban infrastructure could physically change shape to meet different
514 purposes and, thus, encourage more equitable and sustainable use of space.

515 These observations were reinforced by the responses given by participants in the interviews.
516 For example, Penelope spoke about how imagining the future using the ‘Futures Wheels’ had
517 provided a stimulus for focused, creative thinking:

518 “It gave people a structure to push beyond where their thinking would normally
519 take them... we did, in some ways, get beyond the standard ways of thinking
520 about how things will evolve. It was a genuine shift in my understanding of what
521 is possible.” (Penelope, 2016)

522 This provides a clear example of how focused, creative thinking in PSP resulted in a strong
523 learning experience for this participant.

524

525 The observations of the FSF case study also showed that creativity combined with structure
526 helped to encourage learning. During the workshop, we observed that the activity of thinking
527 about how to overcome specific future challenges that were presented in the scenarios
528 encouraged this structured creative thinking. A key objective of the FSF workshop was to
529 explore plausible future conditions and identify challenges and opportunities for food security
530 in Tanzania. We observed that this aspect of the workshop prompted participants to think
531 creatively together about challenges and opportunities for FNS, as well as responses to them.
532 For example, one discussion group came up with the idea of a ‘taskforce’ to help foster
533 cooperation across different sectors dealing with food and nutrition issues.

534 This observation was encapsulated by two interviewees, Sally and Fiona, who described how
535 encountering a challenging lack of communication in their scenario had prompted them to
536 think creatively about how to overcome it.

537 “We were in a scenario whereby there was no cooperation, so we had to design a
538 committee, which would be responsible to create that cooperation... There are
539 challenges, but with ideas given by others then you get through.” (Fiona, 2016)

540 “We said we need the task force to include different people with different
541 backgrounds, from different sectors, because the issue of food security and
542 nutrition is a cross-cutting issue.” (Sally, 2016)

543 The above evidence shows that PSP can stimulate learning through: 1) bringing different
544 participants into discussion, thus exposing them to new or unfamiliar perspectives and
545 approaches, 2) the development and exploration of future narratives providing a point of

546 focus and a structure to aid these discussions, and 3) providing opportunities through
547 structured activities to think creatively about new ideas and solutions, but in a focused way.
548 However, although these characteristics may be present in many PSP processes, as we
549 explain below, the way in which PSP processes are designed and delivered by facilitators can
550 also enable or constrain learning.

551

552 4.4. Facilitation as a constraint and enabler of learning in PSP

553 In the reviewed cases of PSP in the academic literature, although the authors of the 30
554 analysed cases typically paid scant attention to the role of facilitation in PSP, five of them did
555 emphasise the importance of carefully designing PSP workshops to provide a structure for
556 participants' discussions and thinking. For example, Plieninger et al. (2013) state that: *'the*
557 *workshops were pre-structured regarding their form and central aims, but remained*
558 *completely open for the participants regarding content,' (p.44)*. Hence, the facilitators appear
559 to have provided a structure to support participants' discussions by providing a template for
560 them to fill in.

561 This overall lack of attention given to facilitation and design in these papers is especially
562 surprising when compared to the practitioner interviews. In these, 13 of the 16 interviewed
563 practitioners acknowledged the importance of facilitation for helping participants engage in
564 PSP processes. One practitioner, Vera, who was interviewed as part of these interviews, and
565 was a highly experienced professional facilitator of PSP and other futures-thinking methods,
566 emphasised that facilitation is a key condition for learning in PSP. She acknowledged that
567 participants can find it difficult to think about the future, in the way that PSP proposes, which
568 means facilitators need to help ease them into it:

569 *"The challenge is to get people to engage with these scenarios... The important*
570 *thing is to get participants to at least entertain the idea [of thinking about possible*
571 *futures] and play with it. The role of the facilitator must be to pick up on what*
572 *incremental changes people are willing to consider in the future and build on*
573 *those."* (Vera, 2016)

574 Arguably, since the interviewed practitioners all had experience of facilitating PSP processes,
575 they might have emphasised their own roles in enabling learning. However, the importance of
576 facilitation was also strongly evident in the two case studies. In PFSA, we observed that the
577 role of the facilitators in designing and facilitating the workshop encouraged participants to
578 engage in the structured creative thinking, described in Sections 4.2 and 4.3, which stimulated
579 their learning. The facilitators designed the workshop to include specific activities, including
580 the Futures Wheels mentioned in Section 4.3, that provided a structure within which
581 participants could think 'outside the box' with regards to innovative solutions to the challenge
582 of thinking about just and sustainable futures. Furthermore, the lead facilitator, Anne, took time
583 to explain and demonstrate each activity to ensure that the participants understood them and
584 how each activity fed into the process and eventual goals of the workshop. For instance, she
585 demonstrated the Futures Wheels activity, described in Table 5, using an example of how the
586 primary, secondary and tertiary impacts of a specific small-scale initiative could develop in the
587 future.

588

589 Anne then moved between the discussion groups to provide clarification and advice on the
590 activities. This allowed the four supporting facilitators to concentrate solely on encouraging
591 and guiding discussions between the participants. They did this by asking questions and
592 prompting participants to discuss specific points. For example, one facilitator, Pamela, asked
593 participants to think about where people would live, and how, in the world described by her
594 group’s scenario. This helped the participants to imagine future conditions in greater detail.
595 Another facilitator, Danielle, encouraged participants in her discussion group to consider the
596 divide between rural and urban spaces, and how it might change in their scenario. This was
597 appreciated by participants in the interviews. For example, one informant, Miriam highlighted
598 how the facilitator in her group had prompted discussions by asking questions about how the
599 small-scale initiatives could develop:

600 *“She was just bringing questions in, like: ‘okay what’s next, and what’s next, and*
601 *what’s next?’ ‘What are the limits of this?’ ‘Do you think this is bad?’” (Miriam,*
602 *2016)*

603 Anne’s explanations and the supporting facilitators’ prompting questions therefore seem to
604 have encouraged participants to engage in structured, creative thinking that helped them to
605 learn.

606
607 In the FSF case study, by contrast, the participants’ ability to engage in the workshop was
608 limited by the fact that the facilitators were fewer in number, had less time, and limited
609 resources. The lead facilitator, Mike, was an expert in PSP, having facilitated many PSP
610 processes, as well as publishing academic papers on PSP, and had been recruited to lead the
611 FSF workshop. However, he had to play multiple roles, including explaining the activities,
612 moving between the groups to provide clarification, and prompting discussion in one specific
613 group. At the end of the workshop, he reflected that this had limited his ability to ensure all
614 the participants were engaging with the activities. This was especially problematic since one
615 of the two sub-facilitators lacked previous experience in facilitating PSP and would thus have
616 benefited from more support. This was picked up on by one of the interviewed participants,
617 who stated:

618
619 *“I think facilitator matters. I know the other facilitator (Mike), he is very much*
620 *experienced, so he knows how to ‘pick’ things from out of people, but in this*
621 *group, you could see, he is not much experienced of scenario-creating things.”*
622 *(Keith, 2016)*

623 This shows that the constrained facilitation in FSF limited the potential opportunities for
624 structured, creative thinking, and thus for learning. Hence, although PSP can be a useful tool
625 for learning, through creating a focal point for discussions between different participants, and
626 encouraging structured creativity, it requires skilled and well-resourced facilitation to fully
627 realise this potential.

628

629 5. Discussion & Conclusion

630 In this paper we aimed to: 1) present a conceptual framework that could help to understand,
631 study and evaluate learning in PSP processes; and 2) use an empirical study of PSP processes
632 (specifically focused on tackling complex problems in social-ecological systems), to test this
633 framework and identify the processes by which PSP can support learning. In this paper, we
634 have laid out the conceptual framework, and presented empirical evidence regarding the
635 processes through which learning occurs in PSP. We now draw these two strands together to
636 assess how useful our conceptual framework is for explaining learning in PSP, and what
637 implications this has for PSP researchers and practitioners. We begin by looking at the
638 connections between the evidence presented in Section 4, and the learning theories
639 introduced in Section 3.

640 The evidence from our study of PSP processes connects closely to our conceptual framework.
641 It shows that PSP encourages people to learn through fostering interactions between people
642 who have different expertise and ways of understanding. Specifically, these interactions can
643 encourage discussions between different participants, which promotes learning. This fits well
644 with the elaboration of Vygotsky's ZPD (Vygotsky, 1978), which posits that learning is
645 encouraged by interactions between people with different kinds of expertise. This also
646 reflects commonly held arguments that bringing different stakeholders into dialogue through
647 PSP can encourage them to engage with each other's knowledge, which can thus foster
648 learning (Johnson et al., 2012; Oteros-Rozas et al., 2015). This evidence indicates that the
649 ZPD is a useful basis for understanding learning in PSP processes, and research that aims to
650 assess and understand learning-related outcomes of PSP should therefore focus on studying
651 interactions between different participants.

652 However, the idea that learning can be encouraged through creating opportunities for
653 interactions between diverse participants does not apply exclusively to PSP. Indeed, it is
654 widely believed by researchers and practitioners of participatory methods that such
655 approaches can, generally, create conducive conditions for learning to occur (Mark S Reed,
656 2008; Stringer et al., 2006). In this paper, we thus identified specific aspects of PSP that can
657 encourage learning. We found that through exploring narratives of the future in a structured
658 and focused way, PSP processes can provide a focal point and structure for discussions
659 between different participants. This encourages them to make explicit their knowledge,
660 assumptions, anxieties and aspirations about the future, as well as to reflect critically on them
661 and those of other people. Our research also highlights how this can be especially effective
662 when PSP processes are designed to include specific, structured activities, such as 'Futures
663 Wheels' and testing proposed responses to future challenges. These activities not only create
664 a focal point but provide opportunities for participants to think creatively about ideas and
665 solutions they would not normally think about, within a structured set of parameters. This
666 encourages participants to enter their ZPDs, and therefore to learn.

667 PSP processes thus fit well with the concept of 'boundary objects,' as outlined in our
668 conceptual framework (S. L. Star & Griesemer, 1989). The process of creating and exploring
669 scenarios can become a boundary object through providing a focal point and structure for
670 discussions between different participants. This corresponds with previous work on PSP by
671 Chaudhury et al. (2012) who state that PSP is useful as a boundary object. However,
672 Chaudhury et al. specifically consider the outputs of PSP (scenarios themselves) as boundary

673 objects that can be used to negotiate the exchange of knowledge between different
674 stakeholders after the scenarios have been developed. In this paper, we argue that the *process*
675 of creating, imagining and exploring scenarios can also act as a boundary object. This reflects
676 findings by Bowman (2016) which indicate that the process of creating and exploring
677 scenarios is more meaningful as a boundary object, than the scenario narratives themselves.
678 Our findings also emphasise the importance of carefully designing PSP processes to include
679 specific, structured activities that can stimulate structured creative thinking. Conceptualising
680 PSP as a type of boundary object therefore helps to explain how it can enable interactions and
681 encourage learning through creating opportunities for discussions on a shared concern.

682 Our findings resemble the arguments put forward by the influential scenario planning
683 scholars we referred to at the start of this paper. The arguments put forward by Wack (1985),
684 Schoemaker (1993) and Van der Heijden (1996) that scenario planning can provide a
685 structure that helps people to understand complex and uncertain problems, are reflected in our
686 finding that PSP supports learning through creating a focal point, which enables people to
687 imagine uncertain futures in a structured way. Equally, the argument of Ramirez and
688 Wilkinson (2016), that scenario planning can lead to an exchange of knowledge and
689 development of new understandings and courses of action, is reflected in our findings that
690 PSP processes can act as boundary objects that encourage interactions between different
691 people, and stimulate the exchange of different knowledge. Our research adds to this
692 knowledge by providing a conceptual framework, based on an established pedagogical
693 theory, that helps to explain how learning occurs in PSP, and connects this with empirical
694 evidence of how PSP processes can support learning.

695 However, although PSP processes can themselves be powerful tools for learning, as explained
696 in Section 4.4, we also found that they may be enhanced or constrained by the ways in which
697 they are facilitated. As shown in the PFSA case study, skilled and well-resourced facilitation
698 can help participants to engage in PSP processes and to achieve the sort of structured creative
699 thinking described in this paper. This speaks to the concept of ‘scaffolding’ (Wood et al., 1976)
700 described in our conceptual framework and shows how such support can provide the assistance
701 Vygotsky claims is necessary for people to enter and subsequently extend their ZPDs. The
702 design and explanation of specific activities to assist participants to engage in PSP processes
703 also reflects the specific stages of scaffolding (contingency, fading, and transfer of
704 responsibility), as outlined by Van der Pol et al. (2010). Equally, the prompting questions
705 observed in our two case studies encourage the ‘exploratory talk,’ (proposing new ideas and
706 then receiving critical and constructive feedback from others) described by Fernández et al.
707 (2001). In contrast, the FSF case study showed that facilitation can constrain learning if the
708 facilitators are under-prepared and under-resourced, thus limiting the support they can provide
709 for participants.

710

711 It is also important to consider that the different case studies had different aims and scope, and
712 could thus be described as aiming for different stages of learning. The PFSA workshop aimed
713 to broadly explore how positive futures might look, and how they may be reached, thus
714 expanding participants’ perceptions of what is possible and their capacity for ‘creating’ the
715 future (Tuomi, 2019). This required methods and facilitation that pushed participants to be
716 creative, to ask new questions and to think ‘outside the box’ (Ehresmann et al., 2018), as per

717 the more advanced levels of Miller’s (2018) framework. In contrast the FSF workshop had a
718 more specific focus and aimed to inform decision-making on a specific policy. There was
719 therefore less emphasis on creativity, and more on encouraging participants to use anticipation
720 to think about how imagining the future could influence their decisions and actions in the
721 present, as per the early stages of Miller’s (2018) framework.

722
723 We conclude that our conceptual framework based on the ZPD is a useful way of studying
724 learning in PSP. This highlights the importance for futurists, as well as other researchers and
725 practitioners of PSP, of studying interactions between different participants in PSP. Our
726 research also emphasises the importance, not just of creating opportunities for interactions, but
727 of actively enabling the process of imagining and exploring scenarios, since this is what pushes
728 people, through discussion, to engage critically and constructively with their own and others’
729 assumptions about the future. It is therefore vitally important to consider the specific activities
730 that are included in the design of PSP processes, as well as the role of facilitation to help PSP
731 participants engage in this process. This paper is the first of our knowledge to highlight the
732 importance of learning as an outcome of PSP and to offer a theoretical framework that helps to
733 understand this. We acknowledge there is scope for further refinement of theory about how and
734 why PSP can support learning, especially regarding the role of facilitation in supporting and
735 promoting learning through interactions in PSP. We note this as an area for further research.

736

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752

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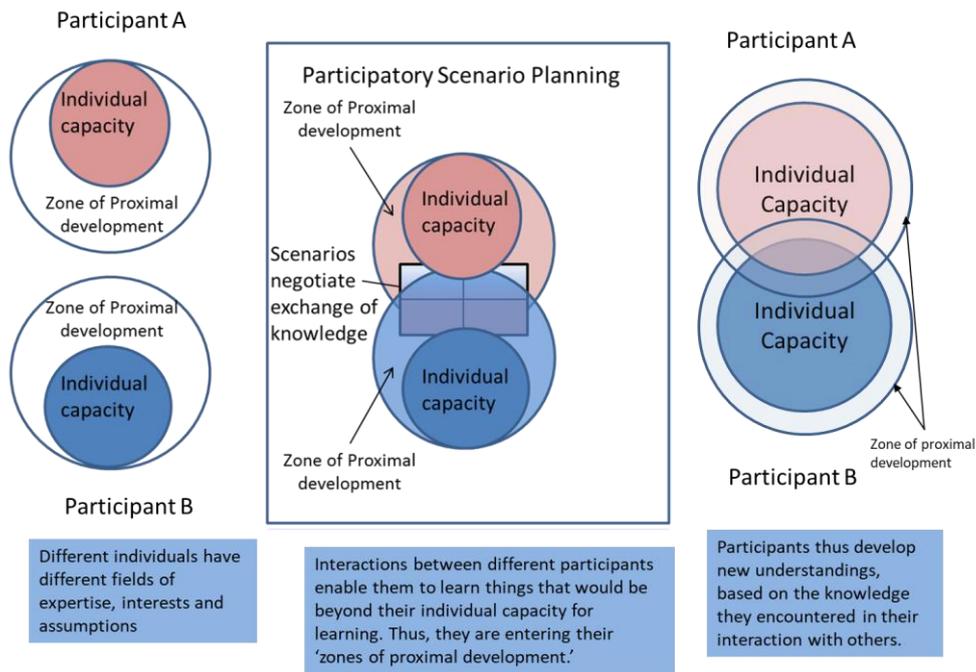
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938 **Figures and tables**

939 **Figure 1: Explanation of how PSP enables learning through interactions with others,**
940 **using the Zone of Proximal Development. *Publish in colour***



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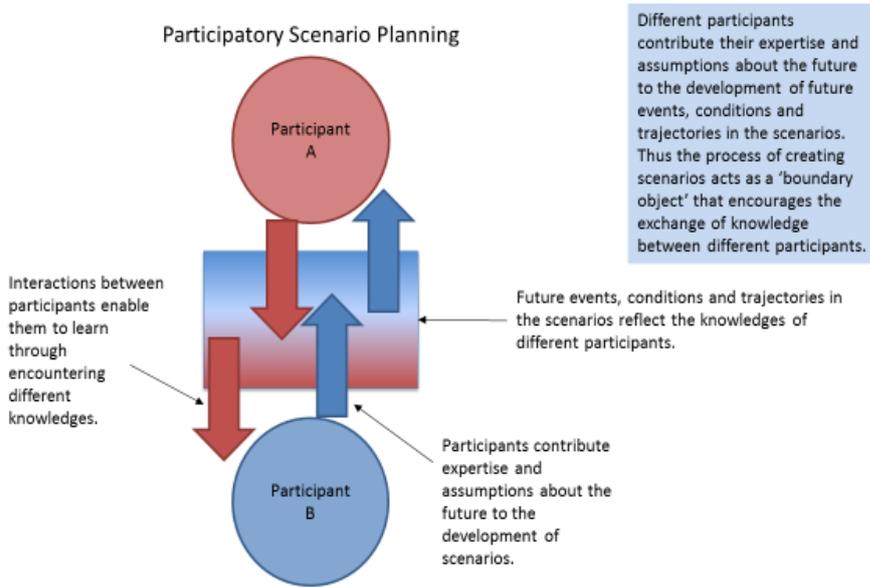
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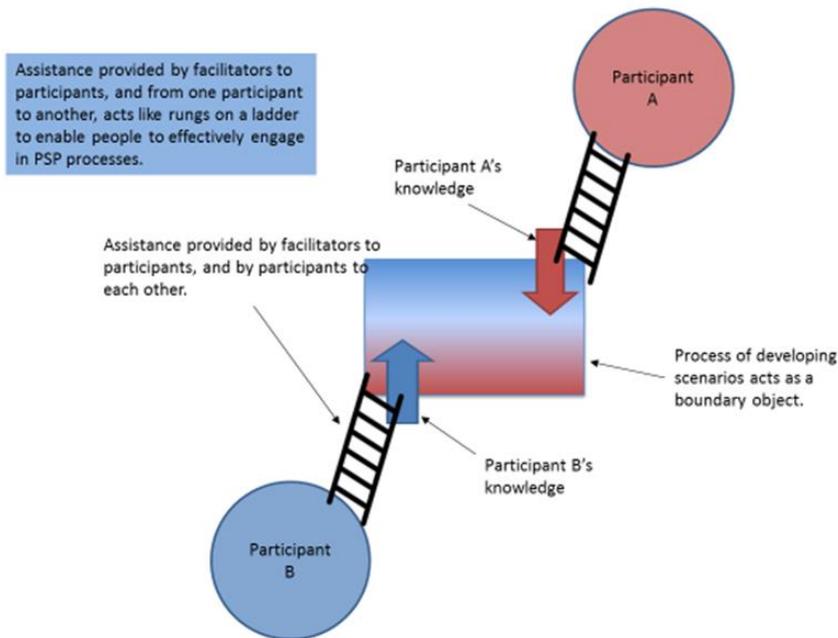
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950 **Figure 2: The process of creating scenarios in PSP can be viewed as a boundary object, by**
 951 **including the knowledges of participants from different social worlds. *Publish in colour***



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 953 **Figure 3: Assistance provided by facilitators to participants, and through interactions between**
 954 **participants, helps participants to engage effectively in PSP. *Publish in colour***



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Table 1 Overview of the case studies

	Case Study 1 – Food Security Futures (FSF)	Case Study 2 – Positive Futures for Southern Africa (PFSA)
Topic and scale of Focus	Specific focus on food and nutrition security for urban dwellers in Tanzania.	Broad focus on exploring possible just and sustainable future conditions for the Southern African region.
Location and length of the PSP process	Took place in a seminar room at the University of Dar es Salaam over 1.5 days.	Took place in a conference suite at a hotel in Cape Town over 3.5 days.
Aims of the PSP process	Aimed to use downscaled versions of pre-developed ‘East Africa scenarios’ (Vervoort et al. 2013) to inform the Tanzanian government’s food and nutrition policy for their new ‘Five-Year Development Plan.’	Aimed at exploring how positive futures might look, and how they may be reached, in order to guide the sorts of small-scale initiatives that the specific development organisation who funded the project should be directing funding towards.
Funding and organisation	Modest funding from a research institution. Seemingly haphazard organisation of the process.	Generous funding from a development organisation. Organised strategically, well in advance.
Approach to PSP	Exploratory approach to assess the implications of plausible futures on food and nutrition security in Tanzania.	Normative approach to explore what participants’ preferred futures would look like and how they might be realised.
Specific activities used in the PSP process	Developing a scenarios matrix of downscaled versions of pre-developed regional scenarios. Used ‘visioning,’ ‘backcasting’ and testing potential strategies under different scenarios.	Used the ‘Manoa method’ to create original scenarios based on ‘weak signals’ of the future in the present. Included use of ‘Futures Wheels’ and ‘3 Horizons.’
Participants	20 participants from a mixture of government institutions, NGOs, education, academia, and the private sector, all of whom were Tanzanian and worked and lived in Dar es Salaam	23 participants, including a mixture of academics, practitioners and Artists from several countries across Southern Africa.
Facilitators	3 academics with a range of facilitation experience, led by a PSP expert with experience facilitating PSP processes.	4 academics with a range of facilitation experience, led by one experienced professional facilitator.

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962 **Table 2 – Structure of the Food Security Futures case study PSP workshop**

Activities (Food Security Futures)	Description
Introduction	Presentation of workshop objectives and process. Participants split into 3 groups. Each group explored one of 3 themes: 1) issues directly affecting food security, 2) capacity-building for food security, and 3) cross-cutting themes.
‘Visioning’	Participants constructed a ‘vision’ of an ideal future in which specific objectives from a new government food security policy were realised. Each participant noted ideas for how this vision would look, and then presented their ideas to their group. The groups then discussed these ideas and combined them into a collective vision.
‘Backcasting’	Participants considered what steps would need to be taken to achieve the visions they created in the previous step. They constructed a timeline of these steps, working backwards from the visions to the present day.
Imagining scenarios for Tanzania	Participants imagined scenarios for Tanzania, based on scenarios for the East Africa region scenario, which had been previously developed by another researcher programme. Each group imagined what events, conditions and trajectories would be like in Tanzania in one of the pre-built scenarios for East Africa.
Identifying challenges and solutions	Each group considered the timeline of steps developed in the ‘backcasting’ stage and imagined how they could successfully implement them in the scenario they had developed for Tanzania. This included identifying challenges and exploring solutions to them. Each group then developed a set of recommendations that could help decision-makers to achieve food security objectives in different scenarios in Tanzania.

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964 **Table 3 - Structure of the Positive Futures for Southern Africa case study PSP workshop**

Activities (Positive Futures for Southern Africa)	Description
Introduction	Introduction of the topic and objectives for the workshop. Explanation of the workshop process and the activities involved. Participants were split into 4 groups and given 3 diverse, small scale initiatives that promote sustainability and social justice in Southern Africa and globally.
‘Futures Wheels’ (Bengston, 2016)	Each group imagined what these small-scale initiatives would look like if they were or mainstream ways of doing things in the future, including their primary, secondary and tertiary impacts. Participants noted their ideas and then presented them on paper as a series of concentric circles, the inner circle representing primary impacts, the second representing secondary impacts, the outermost representing tertiary impacts.
Connecting the small-scale initiatives	Each group explored how the small-scale initiatives would affect each other if they were mainstream ways of doing things in the future. Participants plotted these connections on a table and with lines drawn between the initiatives to represent connections between them.
Imagining scenarios	Each group imagined and explored a scenario based upon the Futures Wheels and the connections between the small-scale initiatives. This included exploring the events, conditions, and narratives that would exist in their scenario. Each group presented their scenarios in the form of a headline statement, three imaginary statistics and an artistic expression that represented their scenario.
‘3 Horizons’ (Sharpe, Hodgson, Leicester, Lyon, & Fazey, 2016)	Each group imagined three trajectories, or ‘horizons’ for how the future could develop in their scenario. ‘Horizon 1’ represented the dominant way things are in the present, ‘Horizon 2’ represented the way things will be during the transition from Horizon 1 to Horizon 3 and ‘Horizon 3’ represented the way things would be the future in the group’s scenario. The groups each identified ways to encourage a transition from Horizon 1 to Horizon 3, and then presented this to the other groups.
Plenary discussion	After each group had presented their scenario, the participants and facilitators reconvened in plenary to discuss commonalities between the scenarios, insights for how a ‘positive’ future might look in southern Africa and what steps could be taken to achieve this.

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Table 4 – Evidence from the review of 30 cases of PSP described in the academic literature that learning occurred through interactions between different participants (this is our synthesis of evidence in the sources, not verbatim excerpts except where quotation marks are used).

Case of PSP	Evidence of interactions
E. L. Bohensky, Reyers, and Van Jaarsveld (2006) - ecosystem services in South Africa	Creating links between different aspects of the scenarios encouraged discussion between participants at different spatial levels.
Brand, Seidl, Le, Brandle, and Scholz (2013) - ecosystem services in the Swiss Alps.	Discussions around consistency and surprise in potential futures occurred between participants from different disciplines and spatial levels.
Fisher et al. (2011); and Swetnam et al. (2011) - ecosystem services in Tanzania.	‘Diverse’ participants collectively deliberated on the development of trends and drivers in alternative futures.
Malinga, Gordon, Lindborg, and Jewitt (2013) - ecosystem service assessment in South Africa.	Interactive workshops were held with stakeholders from different spatial levels.
Mistry et al. (2014) - ecosystem management in Guyana.	PSP created a ‘platform for dialogue’ (p.131) between participants with different worldviews.
Palacios-Agundez, Casado-Arzuaga, Madariaga, and Onaindia (2013) - ecosystem management in Spain.	PSP encouraged interactions between participants with local, and specialised scientific knowledge.
Plieninger et al. (2013) - managing ecosystem services provided by cultural landscapes in Germany.	PSP encouraged discussion between scientists and local actors.
Ravera, Hubacek, Reed, and Tarrason (2011); and M. S. Reed et al. (2013) - environmental management and adaptation in UK uplands.	Interactions occurred between participants with different knowledges.
Shaw et al. (2009) - adaptive action for climate change.	Inclusion of participants from different stakeholder groups expanded the amount of local-level information that was included and facilitated knowledge exchange .
Van Berkel et al. (2011) - rural development in Portugal.	Carefully selected stakeholders from different professional roles deliberated on challenges and opportunities for the future.
Vermeulen et al. (2013); and Vervoort et al. (2013) - climate change and food security in East Africa.	Different stakeholders explored uncertainties and considered how to overcome potential future challenges.
Schulz, Ioris, Martin-Ortega, and Glenk (2015) - Payments for Ecosystem Services in Brazil.	Carefully selected participants, with different worldviews, deliberated on future threats and how they may be overcome.

K. Brown et al. (2001) - marine protected area (MPA) management in Tobago.	Different stakeholders deliberated on trade-offs in the future.
Wollenberg, Edmunds, and Buck (2000) - use scenario planning in adaptive co-management of community forests.	PSP encouraged knowledge exchange between different stakeholders.

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Table 5 - Evidence from the review of 30 cases of PSP described in the academic literature that PSP supported learning by creating a point of focus for discussions between different participants (this is our synthesis of evidence in the sources, not verbatim excerpts except where quotation marks are used).

Case of PSP	Evidence of PSP creating a point of focus for discussions
Rivard and Reay (2012) - exploring the future of Malawi's energy sector.	Discussions encouraged by exploring 'structural uncertainties.'
E. L. Bohensky et al. (2006) - ecosystem services in South Africa.	Discussions prompted by creating links between different components of the scenarios.
Brand et al. (2013) - understanding ecosystem services in the Swiss Alps.	Discussions arose from exploring issues of consistency and surprise in potential future states.
Fisher et al. (2011); and Swetnam et al. (2011) - ecosystem service analysis in Tanzania.	Collectively thinking about the development of trends and drivers in alternative futures encouraged discussions.
Mistry et al. (2014) - ecosystem management in Guyana.	Creating a 'platform for dialogue' stimulated discussions between participants from different perspectives.
Palacios-Agundez et al. (2013) - ecosystem management in Spain.	Discussions arose from exploring plausible futures and thinking about how to avoid challenges.
Plieninger et al. (2013) – managing ecosystem services provided by cultural landscapes in Germany.	Discussion occurred through participants being provided with a structure , with which to explore future possibilities and responses to challenges.
Henly-Shepard, Gray, and Cox (2015) - improving adaptive capacity to hazards in Hawaii.	Discussions prompted by considering responses to challenges.
Pearson, Park, Harman, and Heyenga (2010) - sustainability planning in Australia.	Discussions triggered through developing and testing responses to problems.
Ravera, Hubacek, et al. (2011); and Ravera, Tarrason, and Simelton (2011) - climate change adaptation in Nicaragua.	Discussions encouraged by considering adaptation options in different scenarios.
Tschakert et al. (2014) - climate change adaptation in Ghana and Tanzania.	Discussions arose from combining experiences of everyday life with climate projections and anticipatory views of the future.

Wesche and Armitage (2014) - understand environmental change in northern Canada.	Structured discussions occurred regarding the implications of different drivers, on livelihoods, in alternative scenarios.
Sheppard et al. (2011) - climate change action and awareness.	Visual methods helped stimulate discussions by making potential climate impacts seem real.
Van Berkel et al. (2011) - rural development in Portugal.	Scenarios ‘prompted’ discussions about rural development issues.
Vermeulen et al. (2013); and Vervoort et al. (2013) climate change and food security in East Africa.	Discussions encouraged by exploring how to overcome potential future challenges.
E. B. Bohensky, Butler, and Mitchell (2009) - ecotourism in Papua New Guinea.	Considering what would influence the outcomes of ‘guiding questions’ stimulated discussions between participants.
Schulz et al. (2015) - Payments for Ecosystem Services in Brazil.	Discussions arose through deliberating on challenges and responses to them.
K. Brown et al. (2001) - marine protected area management in Tobago.	Discussions stimulated by deliberating on trade-offs of different options in the future.
Palomo, Martin-Lopez, Lopez-Santiago, and Montes (2011) - protected area management in Spain.	Discussions encouraged through exploring trade-offs between different options.
Jessel and Jacobs (2005) - planning for the European Water Framework Directive	Considering the effects of different policy options in different scenarios encouraged discussions between participants.

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Appendix A – Interview guide for practitioner interviews

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Discussion topics

1. Experiences of using scenario planning.
2. Disciplinary background
3. The approach taken to using scenario planning.
4. Motivations/rationales for using scenario planning. The intended benefits of using scenario planning for the management of wicked problems.
 - a. The theory underlying these intentions and rationales.
 - b. The objectives for using scenario planning.
5. The reported outcomes of using scenario planning for the management of wicked problems.
 - a. The learning outcomes of scenario planning processes.
 - b. The relationship (if any) between the learning outcomes and the management of wicked problems in practice?
6. The evidence they used to justify the reported outcomes of SPPs.
7. The challenges they experienced in using scenario planning.
8. Discussion on the results of my case review, including the specific projects they were involved with, where appropriate.

Questions to discuss

Informal, factual, ice-breakers

1. Approximately how many scenario planning processes have you been involved in?
 - a. What role(s) did you take in each of them?
2. Can you tell me any interesting anecdotes? For example, are there any particular scenario narratives, or scenario planning processes that have really stuck in your mind?
3. Tell me a bit about your disciplinary background. How did you end up practicing scenario planning?
4. Did you receive any formal or informal training in how to facilitate scenario planning processes?

- 1014 a. Could you describe what this entailed?
1015 b. How did this inform the way you facilitated scenario planning?

1016 *Lead into more granular questions on the core research*

- 1017 5. How do think your disciplinary background has influenced your role in facilitating scenario
1018 planning?
1019 6. Can you describe your rationale for using scenario planning?
1020 a. What were your expectations regarding the benefits scenario planning could achieve?
1021 b. Why was scenario planning selected over other methods?
1022 c. How did you come to form these expectations? Where did you get the idea that
1023 scenario planning might be beneficial?
1024 7. Thinking specifically about the processes you have been involved in, what would you say
1025 were the benefits achieved by using scenario planning?
1026 a. To what extent did scenario planning processes influence participants' understandings
1027 of the wicked problem(s) being addressed? If so, how?
1028 b. Was there any variation between different participants in terms of the outcomes
1029 scenario planning had for them?
1030 i. Could you describe this variation?
1031 ii. Why do you think this was?
1032 c. How would you describe the roles played by different participants in the scenario
1033 planning process?
1034 i. Could you describe the relationships that developed between different
1035 participants over the course of the process?
1036 ii. What do you think influenced the development of these relationships?
1037 d. What tangible impacts have scenario planning processes achieved in practice?
1038 i. What were the mechanisms by which these impacts resulted from the
1039 scenario planning process?

- 1040 ii. What was the relationship between the tangible impacts and the internal
1041 dynamics of the scenario planning process itself?
- 1042 8. Can you justify these claims?
- 1043 a. What concrete evidence do you have for these outcomes?
- 1044 b. What methods and criteria have you used to assess the outcomes of scenario planning
1045 processes?
- 1046 9. Could you tell me about any challenges you have faced in the use of scenario planning?
- 1047 a. Why do you think these challenges came about?
- 1048 b. How do you think these challenges could have been avoided, and could be avoided in
1049 the future?

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Appendix B – Interview guide used in the case studies

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- 1064 1. Icebreaker – questions to ask me? Did my presence as an observer affect their experience of
- 1065 the workshop? If so, how?
- 1066 2. Participant’s expectations of the workshop.
- 1067 a. A little bit about participant’s background and reasons for attending the workshop.
- 1068 b. What they expected the benefits of the workshop to be.
- 1069 3. Participants’ experiences of the workshop
- 1070 a. How well participants understood the objectives of the workshop.
- 1071 b. How easily participants were able to carry out the tasks set for them by the
- 1072 facilitators
- 1073 c. What participants found interesting, challenging, easy, difficult about the process?
- 1074 d. What participants thought about the location and layout of the workshop space? –
- 1075 How comfortable did they feel, how did the space affect their participation?
- 1076 e. What participants felt they, and others contributed to discussions in the workshop
- 1077 and to what conditions, events and trajectories were eventually included in the
- 1078 storylines.
- 1079 f. Participants’ interactions with other participants. – Who they spoke with most, the
- 1080 extent to which they felt included in group discussions, who they thought was most
- 1081 vocal and who was more of an active listener, what they thought about the
- 1082 characteristics of their group (argumentative, cooperative, friendly, relaxed, hostile,
- 1083 imaginative, pragmatic, analytical).
- 1084 g. Participants interactions with facilitators – how they helped participants carry out
- 1085 the tasks to engage with the process, how well the time was managed, how well
- 1086 they managed the group discussions and the interactions between different
- 1087 participants.
- 1088 h. Observations as prompts – “I noticed you seemed to be having an interesting
- 1089 discussion with *x*, could you tell me some more about that?”
- 1090 4. What participant’s think were the benefits of imagining future conditions of human-
- 1091 environmental systems.
- 1092 a. What do they think were the benefits of imagining alternative futures of social-
- 1093 ecological conditions?
- 1094 b. Has the way they imagine alternative futures of social-ecological systems changed?
- 1095 If so, how? – What topics, problems, opportunities, relationships has the workshop
- 1096 flagged up for them?
- 1097 c. What aspects of the workshop encouraged learning to occur? – What sorts of
- 1098 processes do they feel help them to learn?

- 1099 d. What participants felt were the most important outcomes for them – what they
1100 learnt, how they think the workshop will affect them in their everyday activities,
1101 any opportunities for new actions, roles and relationships to help encourage more
1102 sustainable and socially equitable future conditions in social-ecological systems.
- 1103 e. Anything they thought could have been better about the process. – What else would
1104 they have liked to learn about? What else do they think it would have been
1105 important for others to learn about? What would have helped further encourage
1106 learning?
- 1107 f. Would they take part in a participatory scenario planning exercise again in future?
1108 What are their reasons for this?

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1124 Appendix C – Observation Guide used for observations during the 1125 case studies

1126 In this research, I assume that learning in PSP occurs through interactions between people
1127 from different fields. Specifically, I assume that scenarios act as boundary objects, in that deliberating
1128 over their creation, and then using them to analyse aspects of the future stimulates the exchange of
1129 knowledge across different perspectives. I also suggest that participants are enabled to engage in the
1130 process of developing and analysing scenarios through assistance from facilitators of PSP processes.

1131 To test these assumptions and understand the process of learning in PSP, it is important to
1132 understand the extent and nature of interactions that occur during the process, the role that developing
1133 and analysing the scenarios plays in encouraging them, and how facilitators enable people to
1134 effectively engage in PSP. These aspects may be indicated by interactions leading to changes in
1135 understanding, the extent and nature of interactions across different fields being stimulated by
1136 development and discussion of scenarios, and the ways in which facilitation enables this process to
1137 occur.

1138 Observation of the Seeds GA workshop in Stellenbosch will therefore involve looking at:

- 1139 • Facilitation: how facilitators prepare themselves for the workshop – their aims, expectations,
1140 understanding of the topic (the Anthropocene), awareness of the different types/levels of
1141 assistance different participants might need; the materials they prepare to help facilitate the
1142 workshop; the ways they introduce scenario planning to participants and then help them to
1143 carry out specific tasks - including tailoring them to participants' existing abilities,
1144 decreasing the level of assistance as participants becomes more competent, and transferring
1145 the responsibility for carrying out tasks to participants; the way the workshop is structured,
1146 including the method used for scenario planning, time management, and the way the
1147 workshop space is laid out; and how quickly participants are able to confidently carry out the
1148 tasks necessary for scenario planning.
- 1149 • Interactions between people and how they may be stimulated by thinking about scenarios:
1150 who speaks to whom at different points in the workshop, and in the informal spaces outside it;
1151 what is the content of different discussions – what knowledge is exchanged during
1152 discussions, is it related to the tasks being undertaken or is it irrelevant; the content of the
1153 scenarios and how this relates to the perspectives of different participants; at what points do
1154 discussions appear most lively – when does most conversation occur, when do people seem
1155 most stimulated based on their level of contribution, body language, facial expressions, vocal
1156 expressions, and actions.

1157 As well as exploring *how* learning may occur in PSP, observations in the workshop will also
1158 be used to help understand *what* is learned by whom and under what *conditions* learning occurs. In
1159 this research, I assume that learning ranges from identification of boundaries with different
1160 perspectives, through communication across boundaries, to expansion of understanding about wicked
1161 problems and transformation of roles and actions to confront them. I also suggest that learning is
1162 shaped by the extent to which participants find information to be credible, salient and legitimate,
1163 which is itself influenced by the social context that learning occurs in, including the roles and
1164 relationships between different participants, and between participants and facilitators.

1165 Observation will thus include looking at:

- 1166 • Present and historical context: the present and historical condition of social and ecological
1167 systems in southern Africa – challenges faced and how they came about, positive aspects
1168 and how they came about, historical and current relationships between different groups of
1169 people.
- 1170 • Facilitation: social groups that facilitators are a part of; institutions they are associated
1171 with; their prior knowledge of participants – the groups they belong to, the relationships
1172 between them; how they introduce, explain and help participants to engage with scenario
1173 planning – and how they tailor these aspects to the needs of different people; how they
1174 manage discussions, conflicts, power imbalances, domination, subordination, different
1175 abilities, sensitive issues; who they interact with, and how, in informal spaces outside the
1176 workshop.
- 1177 • Interactions between participants: who participants are – the social groups they belong to,
1178 the relationships between them, their interests in attending the workshop, their roles in
1179 society, their prior experience of workshop settings; who contributes most and least
1180 frequently in group discussions; who is heeded and who overruled; who appears to take
1181 interest in the contributions of which others, indicated by eye contact, vocal
1182 encouragement, non-verbal signals, distractions, interruptions; content of discussions –
1183 what is discussed and what ignored, what seems relevant and irrelevant, what people
1184 agree and disagree on; how different people speak – tone, pitch, speed, clarity, body
1185 language, volume, length of speech; who interacts in informal spaces outside the
1186 workshop – what is the nature and content of these conversations; how people position

1187 themselves, physically, around other people – body language, distance, peripheral or
1188 central, who groups together.

1189 In practice, the approach to observing these aspects of the Seeds GA workshop began with
1190 communicating with the workshop organisers, via email and Skype. This will continue through face-
1191 to-face meetings in the period building up to the workshop, throughout the workshop itself and after it
1192 has finished. During these meetings I have been, and will continue to ask questions and make notes
1193 about their preparations for the workshops, their plans for how it will be organised, what the aims and
1194 objectives will be, how the scenarios will be created and used, and who the participants will be. I will
1195 also spend time, during and after the workshop, discussing the ways they facilitated the workshop and
1196 their rationale for the decisions and actions they made.

1197 Prior to the workshop, I will also familiarise myself with the context in which it takes place.
1198 This involves using the list of attendees to find out about each participant, their background and their
1199 role in society. Equally, it will involve developing a working understanding of current, and historical,
1200 social and environmental conditions, challenges and opportunities in southern Africa. Importantly, I
1201 will also need to become familiar with the ‘seeds,’ or initiatives that represent socially and
1202 ecologically just and sustainable conditions in the Anthropocene, since they will make up the
1203 foundations of the scenarios.

1204 In the workshop itself, I will introduce myself, my research, and my intention to observe the
1205 workshop to participants at the start. I will also ask them to fill in my information and consent sheet,
1206 to ensure they are aware of the purpose of my research and consent to it. Thereafter, I will move
1207 around the workshop space, watching, listening and making notes on the structure, facilitation and
1208 interactions that occur in the workshop. Since I am interested in who learns what from whom, I am
1209 reluctant for learning to be influenced by my own contributions. For this reason, I will not be directly
1210 participating in the workshop myself. It will also be important for me to move around and observe
1211 discussions in different groups. Participating in the process would limit me to staying in just one
1212 group for the duration.

1213 Considering that the expected number of participants is 33, and these will be divided into
1214 multiple groups, it will be impossible to observe every single participant and every single group at all
1215 times. Equally, since the interactions that occur in any group will be of equal interest, it would be
1216 inappropriate to prioritise one over another. In order to concentrate on each group to a similar extent, I
1217 will aim to observe each group evenly during each stage of the workshop. This will involve consulting
1218 the workshop programme and dividing up the time for each section between the different groups. In
1219 the follow-up interviews, I will also ensure I speak to people from all of the different groups to
1220 explore the interactions and learning that went on in them.

1221 I will position myself such that I can hear participants’ discussions as they occur, but avoid
1222 becoming obtrusive (for example, distracting participants, diverting participants’ attention away from
1223 the workshop tasks). If it does not interrupt the flow of conversation, or concentration on a particular
1224 task, I may ask participants to tell me a little about what they are discussing, at what stage they are at
1225 in the process, and what they are finding easy/hard, interesting/boring etc. I will also aim to speak to
1226 as many people as possible during breaks, mealtimes, and informal settings outside the workshop
1227 space.