1 Climate change projects and youth engagement:
2 Empowerment and contested knowledge.

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14 Abstract

15 This study investigated youths' empowerment through EU-funded climate change projects

16 (CCPs) and the role that social research and public engagement have in that process. The

17 importance of considering youth empowerment in a time of climate change is increasingly

18 recognised. Youths are exposed to interrelated health, social, economic, and political

19 vulnerabilities caused by climate change, but they often have limited resources to address and

20 navigate these changes. To help address these issues youth empowerment holds the potential

21 to give youth a greater influence over their life in the context of evolving climate change.

22 EU-funded CCPs plays a crucial role in EU's climate mitigation and adaption policies and the

23 implementation of these projects can have widespread implications for youth across the EU.

24 However, despite this, there is little research that explores the local youth implications of EU-

25 funded CCPs. In this paper we want to start addressing this knowledge gap by exploring how

26 youth empowerment was facilitated, shaped, and restrained over a year-long collaboration

27 with students from a Greek school as part of an EU Horizon 2020 project on social

28 acceptance of Carbon Capture and Utilisation (CCUS) technologies.

29 The findings indicate that the activities provided the students with opportunities to explore

30 and express different types of concerns, knowledges and perspectives on issues related to

31   climate change, social acceptance and CCUS. However, the empowering potential of these

32   activities were also shaped by power differentials and contestations around what types of

33   knowledge should matter and the source of that knowledge. Although the capacity to engage

34   with youth through Horizon 2020 resources is feasible, more longitudinal and meaningful

35   participation is needed.

Introduction:

37   Climate change is one of the most prominent and multidimensional challenges that humanity

38   is currently facing. As a result, climate change impacts give rise to social inequalities with

39   disproportional impacts to different groups of people (1, 2). Thomas, Hardy (2) refers to that

40   disproportion as "differential vulnerability", with social and economic factors being the key

41   factors determining the vulnerability spectrum. Pertinent literature, suggests that the youth's

42   differential vulnerability is evidenced in their mental and physical health while interlinking

43   with other social, economic and political inequalities (3-5), with the youth of the Global

44   South being more exposed to climate change vulnerabilities (6). In this study we adopt UN's

45   definition of "youth" as the population aged between 15 and 24 years old (7). To further

46   aggravate these differential vulnerabilities, youths' political disengagement and lack of

47   participation (8) may result in limited capabilities to influence the political, economic, and

48   social dynamics that create the conditions for climate change and that inform how climate

49   mitigation and adaptation initiatives are carried out.

50   The notion of youth empowerment is one approach that is increasingly being used to try and

51   address the differential climate change vulnerabilities that the youth are currently

52   experiencing . Youth empowerment has the potential to enable youths to gain greater

53   influence over their own education, personal growth and wellbeing, as well as giving greater

54   opportunities for youth to instigate social and political transformations (9). The importance of

55   youth empowerment in relation to climate change is also recognised by the EU with a number

56   of EU policies and initiatives having been initiated to support youth empowerment for

57   climate change (10). Furthermore the E.U. emphasizes the role that young people should play

58   in shaping democracy through political participation and active engagement in the commons,

59   however, a recent study conducted by the European Union Agency for Fundamental Rights,

60   found that there is a lack of active participation from the youth in the political scene (11).

61   Whilst youth empowerment for climate change is thus promoted by the EU, we still have

62   very little knowledge about how the EU's own climate change projects such its flagship

63   Horizon 2020 Research and Innovation programme impact on youth empowerment issues.

64   To start address this knowledge gap, this paper will examine the impacts on youth

65   empowerment of an EU-funded Horizon 2020 funded project. The purpose of this

66   international E.U. funded project is to develop innovative and sustainable solutions for

67   carbon capture, utilisation, and storage, while exploring their societal dimensions including

68   social acceptance and awareness of CCUS technologies. Drawing on a year-long school

69   collaboration, we will explore how the EU-project activities enabled the students to express

70   and be exposed to a variety of different ways of making sense of climate change, but we will

71   also discuss the implications and manifestations rising from the unequal power imbalance

72   between the students, the institutional educational settings and the researchers. In the

73   following sections we will first review the literature on how youth are exposed to particular

74   patterns of differential vulnerability. Then we will explore the importance of youth

75   empowerment in instigating change that can address the differential vulnerabilities that the

76   youth is experiencing in relation to climate change. Finally, we will examine how the

77   relationship between knowledge, power and education can inform our understandings of

78   empowerment in relation to climate change initiatives.

79   ## Background:
80

Climate change and differential vulnerabilities of the youth

Despite everyone having an environmental impact through their actions (12), the youth are

often disproportionally affected by environmental degradation due to their lower contribution

to environmental issues (13, 14). Several scholars and organizations have highlighted the

vulnerabilities that the youth are currently facing due to climate change and how they differ

from older populations. The impacts of climate change on the mental health of the youth has

been reported as a global phenomenon with one study indicating that 45% of the study's

respondents (aged between 16-25 years old), reporting that their feelings towards climate

change have negative effects on their daily lives (15). There is also relevant research

indicating that climate change has a disproportionally negative impact on the mental and

physical health of the youth (3, 16-18).The environmental, economic, social damages caused

by climate change can also exacerbate and interlink with gendered, social, economic and

political vulnerabilities that youths are already experiencing. The complex and interlinked

factors can have a range of consequences for youths including increased levels of forced

migration, decreased school attendance, increasing levels of domestic violence, as well as the

decreased desire of having children (5, 18-20).

Climate change and youth empowerment:

Youth empowerment can be seen as an important tool to help address the differential

vulnerabilities that the youth experience in connection to climate change. Youths across the

globe have themselves sought to change the politics around climate change by increasingly

initiated climate related actions, protests and initiatives (21, 22).

Within a European context, the "Fridays for Future" movement has been initiated by school

students as an attempt for the younger generations to be part of the public discussion

regarding climate change, with the current support of "Scientists for Future" (3, 23, 24).

Fridays for Future is one of the avenues that the youth are using to express their disapproval

of current climate change policies by questioning pertinent political decisions (25).

4

108   From an institutional perspective, international organizations such as the UN and the EU,

109   have established initiatives to support youth engagement and empowerment in climate

110   change. The United Nations have established the Action for Climate Empowerment (ACE)

111   initiative. The focus of ACE is on climate change education and public awareness, training,

112   public participation, public access to information, and international cooperation (26). The EU

113   from their side, have initiated the Youth for Climate Action program to involve the youth in

114   climate change decision making (27).

115   To facilitate youth empowerment, it is important that the youth are politically active, are

116   partners in the co-construction of knowledge as well as being active in civic engagement (28-

117   30). Despite the existence of initiatives such as youth councils, those initiatives have been

118   critiqued for trying to prepare the youth for adult like institutions, and they have primarily

119   designed for socializing the youth and being elitist by excluding some of them (31-34).

120   Despite the diversity in youth empowerment approaches, there is a common focus on how

121   people and social groups can better control and gain power over their lives (9).What

122   empowerment looks like is inherently contextually situated and cannot be easily measured

123   across different social contexts (35). We can therefore have different dimensions of youth

124   empowerment that depending on the social context can take different levels of importance.

125   According to Úcar Martínez, Jiménez-Morales (9) those dimensions can be summarised as 1)

126   personal growth and wellbeing, 2) relational, 3) educational, 4) political, 5) transformative

127   and 6) emancipative.

128   As the students' engagement activities that were conducted took place in an educational

129   setting in this study we focus on the educational dimension although we also recognise that

130   this at particular times can interlink with other dimensions of empowerment.

131   **Education and Empowerment:**
132   Academically and politically, it has been recognised that education can enable empowerment.

133   Education for empowerment has been promoted on a policy level by institutions such as the

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134   United Nations, as a tool to enable more inclusive and equitable quality education for all (36).

135   There is a range of initiatives that seek to use education as a tool to empower different groups

136   of people, including women, the youth, refugees, as well as prisoners (37-40) .

137   Academically, Dewey, Teixeira and Freire were some of the pioneers of exploring the

138   empowering potentials of education by considering how to democratize education by being

139   free, inclusive and critically provoking (41-43). Dewey argued that teachers and students

140   should be on an equal level, and their relationship should be reciprocal and not a one-way

141   relation where the teacher possesses all the knowledge and just transfer it to their students

142   (44). Based on Dewey's educational philosophy, it is important that students are exposed to

143   hands on environmental education activities allowing them to learn the local context through

144   community engagement while being part of a political and economic culture (45). In his

145   book *Pedagogy of the oppressed* Freire (46), discusses the importance of education as an

146   instrument of critical thinking by providing students' knowledge, skills and social relations to

147   become critical citizens. For Freire, pedagogy was not a political indoctrination but rather a

148   political practice that facilitated critical thinking (42, 47).

149   Education for empowerment approaches have also been used in education on sustainability

150   issues like climate change. In his paper, Reigota (48) discusses how Freire's ideas on a

151   participatory and politically based education have impacted environmental education around

152   the globe, while Spínola (49) argues for liberation from environmental oppressions (i.e.,

153   norms, beliefs and values) through cultural transformations. In the context of education for

154   sustainability one of the main concerns is to empower students to become critical and

155   informed citizens and act upon those socioecological intersections through sometimes

156   alternative education formats (50-52). Empowerment approaches to sustainable education

157   can thus enable transformative learning experiences that gives students the necessary space

158   for constructive discussions and developing their critical thinking skills (38). Furthermore,

159   studies have shown how empowerment approaches to sustainable education can improve

160   students' awareness of the socio-scientific dimensions of climate change while improving the

161   student's argumentation skills (53).

162   Whilst empowerment approaches to sustainable education have the potential to develop

163   students' critical citizenship skills, research has highlighted the complex role that knowledge

164   and power can play in these initiatives (54, 55). Knowledge is deeply entangled with issues of

165   power, i.e., who produces, uses, and has agency over knowledge. In his book Veyne, (2013)

166   discusses Foucault's views on knowledge and power, and his criticism on the paradigm that

167   knowledge must conform to the limitations institutionalized by university research, or else it

168   risks misrepresenting the truth. Influenced by Freire's ideas on pedagogy, Bingham (56)

169   discusses the role of authority amongst teachers and students, and how authority should not

170   be treated as a possession, but rather as a relation where two or more parties have different

171   roles. In his article Nieminen (57), suggests the use of self-assessments in education not as a

172   way to bolster students' performance in education, but to rather use it as a form of students'

173   empowerment to resist power imbalances in assessments.

174   However, knowledge can also be used to enable marginalised groups to challenge powerful

175   social groups and institutions. Knowledge can be a means for public participation in public

176   debates and facilitates influence in decision making processes (Gaventa & Cornwall, 2008).

177   In relation to knowledge authority, Gaventa & Cornwall, (2008) have suggested that

178   empowerment through knowledge creation can provide the necessary authority for the lay

179   people to challenge the expert's paradigm and provide an inclusive and diverse voice in the

180   knowledge production process.

181   These complexities around the intersection of power and knowledge are furthermore

182   complicated when it comes to complex and multidimensional environmental issues like

183   climate change. Some scholars argue that it is important to empower people by equipping

184 them with the knowledge that can address misconceptions and alternative conceptions about

185 climate change. They consider alternative conceptions to refer to understandings of a concept

186 that is not aligned with scientific evidence or scientific ideas (58, 59). In an educational

187 setting these alternative conceptions can be found amongst students, their teachers and in the

188 scientific textbooks they are using (60, 61). However, some scholars point out that scientific

189 evidence and ideas are just one form of knowledge, and that other knowledge systems and

190 perspectives are necessary to address climate change. For example, increasingly scholars

191 have been advocating for the incorporation of traditional ecological knowledge (TEK) in

192 environmental research (62, 63). According to Stori, Peres (64) "*TEK refers to a cumulative*

193 *body of knowledge, practices, institutions, and beliefs, evolving by adaptive processes and*

194 *handed down through generations by cultural transmission (tradition)*" p.2. Such cultural

195 transmissions include cultural festivals and oral traditions that allow the transfer of

196 knowledge from one generation to another while often socially empowering the local

197 communities on natural resource management (65). Thus, it is necessary that more diverse

198 voices are included in decision making for climate change issues.

199
200 Drawing on these insights we wanted to explore whether it was possible to utilise resources

201 from a E.U. funded climate change project to enable educational activities aiming to

202 empower students in relation to climate change and CCUS. To explore that, we initiated a

203 collaboration with school students in Greece. In the methods section below we describe the

204 methods we used to try plan and facilitate these activities.

205

Methods:

Context:

206 To develop methods that could empower youths an emergent approach was taken. Research

209 has pointed out the complexity of developing youth empowerment initiatives within

210 particular cultural and institutional educational settings that can be characterised by power

211 differentials between students and teachers, institutional regulations, cultural norms and

212 limited flexibility to change the curriculum (66-68). The methods that were deployed were

213 therefore dependent on our ongoing interaction and negotiation with the school and the

214 students. As one of the industrial partners of the project and host of a CCUS pilot project is

215 located in an area in northern Greece, one of the researchers spent an extended amount of

216 time in the area for his fieldwork. During his stay in the area, he contacted the local middle

217 school principal suggesting a collaboration between the school and the project.

218 The purpose of the collaboration and the research study was bifold. First was to understand

219 what school students knew about CCUS and what they thought their role was in

220 decarbonising societies, and secondly, to expose students to educational activities that could

221 bolster their critical thinking skills and empowering them to build capabilities to address the

222 technological developments in their area.

223 After receiving the necessary ethical approvals from the university and the school principal's

224 consent, the researcher had an initial meeting with a group of students at the school grounds

225 to inform them about the overall project and the research study. The researchers also received

226 assent forms from the students and consent forms from their parents that wanted to be part of

227 this research study. In addition, to safeguard participants, the researchers of the project are

228 members of the Protection of Vulnerable Group (PVG) scheme in Scotland.

229 Due to the focus of the project funding this research being on CCUS technologies and

230 perceptions, the emphasis of this school collaboration to begin with was about CCUS, climate

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231   change, and students' perceptions. Due to the particularities of the project such as working

232   with school students in an area that we did not have access before and the time constraints,

233   we followed an emergent approach allowing us for fluidity and flexibility to the development

234   of this project's methods (69).

235   During the evolution of this collaboration, it became evident that students were not familiar

236   with CCUS technologies, so asking any questions about their beliefs and perceptions about

237   these technologies would not have been appropriate. Instead, the activities were designed in

238   such a way to expand students' knowledge on climate change and CCUS , while

239   understanding their perceptions on climate change and strategies of addressing it. The

240   culmination of the engagement activities included discussions on CCUS, as well as posters

241   prepared by the students. On a later stage, we wanted to explore the potential of students'

242   empowerment through those activities and the role that different knowledge systems have on

243   their CCUS and climate change perceptions.

244   The school we collaborated with is in a semi-rural area of Greece, and the region is very

245   active in both the agricultural and tourism sector, both of which are seasonal activities. It has

246   a total population of approximately 10,000 people and the town where the school is placed is

247   the hub for the civil services of the region. Due to the semi-rural characteristics of the region,

248   the school serves students not just from the town where it is located, but from nearby villages

249   as well.

250   The students formed a study group of 15 students aged 15-16 years old, all of whom were in

251   the same school year. The school principal together with the lead teacher made the selection

252   of the students. The researchers, other than deciding the number of students that would form

253   the group, had no influence on the selection of the students. From a school perspective,

254   students were selected based on their interest in the topic and their year-long commitment to

255   the study group.

256   Below is a description of the different types of engagement we had with the students together

257   with the objectives of those engagements. All engagement activities were attended by the

258   same group of students. A fourth and final engagement activity with the already involved

259   students was planned but due to limitations discussed in the "limitations" section below, that

260   was not feasible. That fourth engagement activity was specifically about CCUS and students'

261   opinions about them.

262   Engagement process:
263   PowerPoint presentation:
264   The first interaction with the students was through a PowerPoint presentation that one of the

265   researchers shared with the students in the school's assembly hall. The purpose of this

266   presentation was to inform the students on the EU project and discuss with them the idea of

267   collaborating in a research study. Despite going with an open agenda on how to collaborate

268   with the students, the lack of time in combination with the rigidity of the Greek education

269   system, it was up to the researchers to suggest the activities that students could engage with.

270   Both the principal of the school and the teacher leading this potential collaboration were

271   present throughout this presentation. The project's CCUS video was also presented in this

272   session. This presentation was attended by a cohort of approximately 40 students. No data

273   were collected in that instance.

274   PlayDecide card game:
275   Once the study group was formed, few days after the PowerPoint presentation one of the

276   researchers met again with the students to participate in a PlayDecide conversation game.

277   PlayDecide is an open access serious game that promotes discussion while sharing

278   information for controversial issues in a simple and effective way (70, 71). The PlayDecide

279   conversation game has been used by several researchers and educators in different disciplines

280   to both provide information on a topic as well as elicit discussions amongst participants (72-

281   74). The PlayDecide conversation game we used for this study is titled "Climate Change" and

282   it is an open source educational resource through the EU PlayDecide portal (75). A sample of

283   the students' card choices can be seen in Appendix 1. The PlayDecide game lasted for 90

284   minutes and the discussions throughout the game were audio-recorded after receiving

285   participants' consent. The objective of this engagement activity was to establish a baseline of

286   what climate change is amongst the students, while discussing their perspectives, and

287   identifying potential gaps in their current knowledge on climate change. The game was

288   played in the English language and not in the students' native language, as they all felt

289   comfortable with their level of English and the principal wanted to use it as an activity for

290   their English language course as well.

291   **Science museum educational visit:**

292   After discussions with the students, the teacher leading this activity and the principal of the

293   school, it was decided that students would benefit from a visit to a regional science museum

294   to learn more about CCUS technologies and climate change. Initially the researchers

295   requested from the science museum a tailored made programme on CCUS technologies for

296   the students to attend, but such a program was not available at the science museum, as the

297   education team of the museum were not aware of those technologies. Instead, the education

298   director suggested an activity called "Gone with the Wind". The purpose of this activity is for

299   students to be exposed to a role-playing game (RPG) focusing on the social acceptance

300   dimension of renewable energy and more specifically the development of a windfarm in a

301   fictitious rural area of Greece. This RPG was facilitated by the education team of the science

302   museum. Several studies using RPGs in school settings, suggest that students participating in

303   such activities can benefit from developing their critical thinking skills, encouraging

304   collaboration, whole increasing their learning motivation (76-79).

305   Students were organised in teams of three and each team was given a role that they had to

306   impersonate e.g., a farmer, local resident, a shop owner etc. Each team was provided with an

307   electronic tablet that contained all the information they needed about their specific role;

308   Based on that information they were asked to contribute to the discussion. At a later stage

309   more information was provided by the facilitator through the tablet to enhance the discussion.

310   The information provided to the students included a publication by the environmental

311   organisation "*Greenpeace*" that supported the use of wind energy, a report by the "*European*

312   *Platform Against Windfarms*" that highlighted the negative impacts of windfarms and thus

313   opposed to the development of the windfarms, as well as an Environmental Impact

314   Assessment from a consultancy company. Appendix 2 demonstrates some of the documents

315   used in this RPG. Similarly, to the PlayDecide card game, the RPG conversation was audio

316   recorded.

317   Online workshops and poster presentations:
318
319   The purpose of the online workshops was to discuss with the students the development of the

320   project, as well as give them the opportunity to ask specific questions on the work they were

321   doing. Two online workshops were conducted, but due to technical issues the objectives of

322   the workshops were not met. Instead, it was decided with the students and the teacher, that

323   students would form 4 separate working groups to each explore a separate topic suggested by

324   the researcher and create a presentation. Questions such as " What is carbon storage" and

325   "What is the role of forests in decarbonisation" were used as discussion and anchoring points,

326   to instigate students' engagement in the posters. In addition, examples of sources were

327   provided for students to collect information from with the expectation that more sources

328   would be consulted.

329   The four topics were:

330   • What are CCUS technologies and what is their role in addressing climate change?

331   • What are nature-based solutions and what is their role in addressing climate change?

332   • What is climate change and how can it be addressed?

333   •   What are the social dimensions of both nature-based solutions and technological

334   innovations in addressing climate change?

335 Ethics Statement:

336 This study has received ethical approval from the Research and Ethics Committee at Robert

337 Gordon University, Aberdeen Business School.

338 Data analysis:

339 Data were collected in three separate but interlinked engagement activities, 1) PlayDecide

340 game and, 2) Science Museum educational visit, and 3) Poster presentation.

341 Data from the PlayDecide game and the Science Museum educational visit include the

342 students' conversations that were audio-recorded, and their notes during the activities. The

343 audio-recording was initially transcribed in the Greek language, and the Greek text was then

344 subsequently translated into the English language. The English text was then imported in

345 NVivo, a qualitative analysis software, and thematic analysis followed (80). The discussions

346 amongst the facilitator and the students were transcribed verbatim, whereas the discussions

347 amongst the students when they were reading the information provided were not transcribed

348 and were not considered for the purpose of this study. Throughout the analysis of the three

349 separate education activities, we looked for evidence that provoked critical thinking in

350 relation to climate change and their perceptions of CCUS. We also looked at how the

351 structure of the activities promoted or demoted different types of knowledge and the role of

352 the facilitators in that exercise.

353 Posters were analysed in relation to the guidance given to the students by the researcher, e.g.,

354 suggested questions, as well as sources consulted. Examples of the posters can be seen in

355 Appendix 3.

356

357

Results:

359 Below, we present the results of the three engagement activities that the researchers collected

360 data on. Each one of three engagement activities will be presented separately in this section

361 and will be merged in the discussion section below.

PlayDecide card game:

363 The thematic analysis of the discussions during the card game gave rise to three themes that

364 are relevant to the analysis of this paper. Those themes are 1) Uncertainties and Alternative

365 conceptions 2) Complexities, and 3) Concerns. There were several interlinks amongst these

366 three themes as described below and each theme cannot be considered exclusive.

Uncertainties and Alternative conceptions:

368 Despite the students having a good understanding of what climate change is, there were still

369 some uncertainties and misconceptions discussed during the activity. One of the students was

370 hesitant on whether she was describing climate change or global warming:

371 [S5] "*Where we create …global warming…climate change*".

372 This followed a discussion about the existence of greenhouse gases in the atmosphere during

373 the past 200 years. The same student had the belief that the greenhouse gases are the ones that

374 are found within the agriculture greenhouses, and those gases are the problem,

375 [S5] "*Which means that the gases that exist in greenhouses are present in the atmosphere*".

376 In matters of energy production, one of the students mentioned a new discovery by the

377 Chinese who discovered a new mineral on the moon:

378 [S3] "*Well, I read, I saw a video somewhere anyway, some people from China went to the*

379 *moon, and they dug inside the moon, and they found a fuel that is much smaller, covers much*

380 *more energy, produces energy and if they bring it, they intend to bring this to earth and use*

381 *it*".

382 There were several unknowns in relation that above statement including the following:

383 [S3] "*One gram I think they said covers New York* (energy needs); *I think for two months*".

384 Complexities:

385 Students recognized that solving climate change is not an easy task. They are aware of

386 several complexities associated with addressing climate change. Below is an excerpt of the

387 students' discussion concerning the installation of photovoltaics in the Sahara Desert:

388 [S1] *"The biggest desert is the Sahara. So, this is barren land, no one steps on it right? The*
389 *sun shines there 24/7, if you fill this with photovoltaics won't you power all of Greece?"*
390 [S2] *"You will extract (the energy) but the grid will not be able to pick up all that energy*
391 *from a certain point".*
392 [S4] *"The only problem is who has the cash".*

393 [S2] *"Also, if the Sahara is filled with photovoltaics, the life that exists in the Sahara will also*

394 *decrease".*

395 Another complexity was identified in relation to the mineral discovered by the Chinese.

396 Despite the other students not being familiar with that mineral, they were sceptical and

397 critical on its application:

398 [S1] *"I believe that this moon is not such a good idea, because sending rockets into space is*
399 *not the most ecological (sustainable) thing. By the time the rockets arrive, come out of the*
400 *atmosphere, the carbon dioxide they release is very large amounts, so imagine one rocket*
401 *going off every month".*
402 [S7] *"Hey people, it is how we consume first and then look at the moon and the rest".*

403 Complexities were also identified in relation to energy production:

404 [S9] *"I believe that the industry cannot be easily weaned off from non-renewable energy*
405 *sources, because non-renewable energy sources, such as coal and natural gas, oil, can*
406 *produce larger amounts of energy than renewable ones, and are difficult to replace let's say*
407 *with photovoltaics and wind turbines; is not so easy to replace them and to depend the*
408 *industry on them".*
409 [S2] *"They shut down the lignite and suddenly the electricity bill went up. My pocket money*
410 *was cut"* (the children laugh).

411 Concerns:

412 Students were concerned about their role in the society, while also recognizing that they need

413 to be the agents of change that they seek. One of the students in a joking manner was

414 concerned about his life expectancy when discussing carbon dioxide emission targets:

415 [S1] *"The fact that we have already adapted to climate change and, of course, the damage*
416 *has been done, it is very difficult to completely remove carbon dioxide from our lives. I mean,*
417 *I had seen somewhere, I had read that by 2050 we have to reduce carbon dioxide emissions*
418 *to zero to stop climate change, which is not going to happen, so adapting is the best thing".*
419 [S5] *"Will we reach fifty years of age"?*

16

420　There were concerns that politicians do not necessarily have the public's interests as a

421　priority, but they are more concerned about their own benefits:

422　[S8] "*Most politicians look out for their own interests*".

423　[S3] "They *are not going to do anything to improve the situation, I would say that we have to*

424　*do*".

425　[S5] *"… no matter how many photovoltaics we put in, no matter how much money we give,*
426　*no matter what we do, they (politicians) will find another way to spend money again and be*
427　*in their own interest. So, I think the best thing would be to discuss with a large group of*
428　*people who have a lot of influence, if we are a very large group of people, we can make a*
429　*change*".
430

431　Science Museum Educational Visit:
432　The RPG data were analysed as a resource and tool for the empowerment of students in

433　decision making. The thematic analysis gave rise to three separate themes, 1) Instruction

434　dynamics, 2) Expertise, and 3) Public participation. The "Concerns" theme was also present

435　in the Play decide card game.

436　Facilitation dynamics:
437　During the role-playing game, the instructor impersonated the role of the local mayor in the

438　game, but they would often break character when they wanted to make a point on a topic,

439　they had strong opinions in as a real person rather than as an RPG player. Below is an excerpt

440　where the facilitator defended nuclear energy as the safest option for energy production:

441　[F] "*Nuclear is the safest, most reliable, clean and cheap source from which we can get*
442　*electricity and energy in general… Nuclear is the most ecological source of energy, but we*
443　*don't use it. Wind turbines are a very safe source of energy, not so efficient and take up a lot*
444　*of space. Hydroelectric is a lousy source of energy"*.
445

446　It was also evident that the power dynamics in the discussion were in favour of the facilitator,

447　as they often interrupted the students and suggested what they wanted to say; they had control

448　of the conversation flow:

449　[S] "I *want to ask, because the house we live in and the plot will be expropriated, with the fee*
450　*we will get…*
451　[F] *…will the expropriation be fair? Isn't that what you want to say*?
452　[S] *Other than that, will there be other land available that is not affected by the wind farm?*"
453

17

Expertise:

454 Part of the RPG was to discuss the role that different stakeholders might have in the

455 suggested scenario of a wind turbine project development. In matters of expertise the

456 facilitator both in their role as a mayor, but also in real life held the opinion that expertise is

457 directly linked to scientists and engineers, and that only experts; opinions should be

458 considered when deciding on issues such as societal and environmental impacts of wind

460 turbines:

461 [F] "The *engineer's study will tell you that if is managed correctly, because Greenpeace is*
462 *Kostas, Giannis, Lefteris, Eleonora and Dimitra, this is Greenpeace. It (Greenpeace) has*
463 *some people who have a scientific background, but it is not a scientific position, like the other*
464 *weird Belgians who are against wind. Okay? It's Mr. Giannis, Mrs. Tasoula and Eleni or the*
465 *mayor. It's not some scientists who say it, it's groups of citizens.*"
466 [F] "*So the study of an engineer is the only scientific one. Ok? They may be thorough, they*
467 *may not be, you may trust them, you may not trust them, but the most reliable of the three*
468 *(NGOs, residents, engineer) is the study.*"
469 The participants raised an issue concerning the trust they had on the engineer, as they were

470 appointed by the company, and wanted to have a more independent expert in assessing the

471 potential impacts of the wind turbines:

472 [S]: "*How do we know that they are telling the truth and they are not part of you?* (We want)
473 *an engineer of our own.*"
474
475 Public participation:
476 Throughout the RPG process the facilitator emphasized the importance of public participation

477 towards a just and sustainable society:

478 [F] "*Obviously as active citizens you have to go and position yourself, regardless of whether*
479 *you are an expert on the subject, you have an obligation to have an opinion, you don't have to*
480 *be right, okay?*"
481 [F] "*In essence, this discussion is not for you to decide to be in favour. This discussion is to*
482 *convince you to be in favour. And that's what it's always for.*"
483 [F] "Every *active citizen must have an opinion. You have to be active. Yes, it's not a luxury to*
484 *be active, it's your obligation. Every active citizen and having an opinion on something is*
485 *your obligation. Being right is not your obligation, you don't have to know everything*
486 *obviously.*"
487 Participants were asked to declare their position (for or against the wind farm) in two separate

488 occasions. Each occasion was followed by a set of information the students received in their

18

489 tablets as part of their scripts. The facilitator discussed how opinions can change in light of

490 new information, and that everyone is entitled into changing their opinions:

491 [F] "*Guys, democracy means that when there are new arguments, we change our opinion… I*
492 *was wrong and now I believe something else*".
493 [F] " *…we will discuss what changed your ideas and how you were affected.*"

494 There were also discussions on the ethics of changing one's mind, and what constitutes moral

495 vs immoral decision making:

496 [F] "That *is, if, say, we hold a competition for the recruitment of new employees for the new*
497 *positions that are to be opened, and we reward the locals in points, so that they can be*
498 *appointed more easily, will you change your vote*?
499 [S] "*Maybe yes*"

500 [F] "*Maybe yes, very nice. This negotiation is not unethical. The other thing the guys were*
501 *saying before, "what will they give us to change the vote" is unethical. Do we understand the*
502 *difference between immoral and moral? It may look the same, it's not. Because the argument*
503 *is my wife will lose her job, we are here and you are breaking us up, there is the counter*
504 *argument, if we help hire local people first. He has an argument that makes more sense*."
505
506 Poster presentations:
507
508 Poster presentations were thematically analysed based on the above themes and the theme of

509 "Facilitations dynamics" was identified. The analysis of the posters suggest that students did

510 not engage with the activity in a meaningful manner, as on some occasions the text was

511 copied and pasted from the original source that was suggested by the researcher.

512 Facilitation dynamics:

513 An example of facilitation dynamics can be seen at the "What are CCUS technologies" group

514 poster picture 3b where the below text was lifted directly from a media website without any

515 citation or acknowledgment of the original source.

516 "*Ένας _αποτελεσματικός _τρόπος _διαχωρισμού είναι _με _την _επιλεκτική _χημική*
517 *_απορρόφηση _του CO2 από _μίγμα _χημικών _ενώσεων _(διαλύτες) που επιλεκτικά*
518 *_αντιδρούν _χημικά _με _το _CO2 και _δεν το _αφήνουν _να _εκλυθεί _στην _ατμόσφαιρα*".
519 English translation: "An efficient way of separation is by selective chemisorption of CO2 by
520 a mixture of chemical compounds (solvents) that selectively react chemically with CO2 and
521 do not allow it to be released into the atmosphere".
522

523   As well in another case as seen below in picture 3a, the information on the texts was very

524   basic and the students cited themselves as sources of information.

525   " ΠΛΗΡΟΦΟΡΙΕΣ _ΑΝΤΛΙΘΗΚΑΝ _ΑΠΟ _ΤΗΝ ΕΡΓΑΣΙΑ _ΤΩΝ _ΜΙΧΑΛΗ, ΘΟΔΩΡΗ
526   _ΝΙΚΟ". English translation: "Information was retrieved by Mixalis, Theodoros and Nikos
527   work".
528
529

Discussion and conclusion:

531   Young adults are important members of our societies and drivers of political, societal, and

532   environmental changes. Youth empowerment is imperative for the above changes to happen,

533   and that can be bolstered through knowledge construction and meaningful public engagement

534   (81, 82). This study sought to explore students' knowledge on climate change and

535   decarbonisation, while examining how Horizon 2020 projects could shape youth

536   empowerment.

537   During the PlayDecide activity it was evident that students had a fair understanding of

538   climate change and its environmental and societal consequences. Despite that, there were

539   evidence of alternative conceptions and uncertainties amongst the students when issues were

540   discussed in more detail. As an example, Sahara was discussed as the biggest desert, but that

541   is a common misconception. Such alternative conceptions have been reported in other studies

542   of similar age students in different countries (83-86). These common alternative conceptions

543   amongst individuals in different countries could be because of the power that the mass media

544   have in dispersing information (87, 88). Amongst others, for youth empowerment to be

545   possible, it is important that the youth are able to identify and challenge those alternative

546   conceptions by developing better understandings of a topic (89).

547   Both during the PlayDecide activity as well as the RPG, students expressed their concerns

548   regarding both the impacts of climate change to themselves and their families, but they were

549   also vocal about their disbelief and lack of trust to the politicians and adults in general, as

550   well as the political system to address climate change. Those viewpoints have also been

551   reported by studies on adults' beliefs on the same matter (88, 90, 91). Several students held

552   the opinion that it was up to them to organise as groups to fix things, rather than wait for

553   political initiatives from the politicians. Such cohort organization and mobilization has also

554   been evidenced in the Italian youth activism realm for environmental matters (92), as well the

555   Fridays for Future movement (22, 93). According to Kitanova (8), the youth in the EU choose

556   to abstain from political engagement. That disengagement with the traditional political world

557   could have an impact on how environmental issues such as climate change will be addressed,

558   as Weiss (94) suggests that the youth are part of new political participation forms, i.e. non-

559   institutionalized political participation. Those concerns and uncertainties around the inactions

560   of adults and politicians, have empowered the youth to take actions towards climate change

561   to promote the wellbeing of their future (55, 88, 95).

562   Additionally, the education activities showcased the complexities of addressing climate

563   change and the students were aware of these complexities, especially socio-ecological

564   complexities. The complexities span from whose opinion is more "*valid*" and should be

565   trusted, to potential consequences of energy production in the wildlife of the Sahara Desert.

566   Part of the overall project was to explore peoples' perceptions and acceptance of CCUS

567   technologies. As mentioned above, when we requested a CCUS based activity at the Science

568   Museum, the answer was that they had never heard of these technologies before, so we would

569   have to do something different. The option of developing something custom made for the

570   students of this study was discussed, but due to the lack of time and funding that was not

571   possible. That brings to the question of what level of acceptance and perceptions are we

572   seeking to elicit from communities, when experts such as science educators are not familiar

573   with those technologies. EU funded CPPs can empower communities by ensuring that social

574   acceptance or rejection are long term processes and enabling community members to develop

575   the required capacity to increase their content knowledge as well as consider previous

576   experiences.

577   In any education activity the role of the facilitator is vital as it can shape students'

578   engagement and involvement in the activity (96). As researchers we also facilitated some of

579   the engagement activities, e.g., poster presentation and it was evident that we dictated to the

580   students what to do, and the end result indicates that this engagement was not impactful as

581   students did not engage meaningfully in the activity. Similarly, and as presented in the results

582   section, the facilitator at the Science Museum had strong opinions around some issues, e.g.,

583   nuclear energy, and they broke their RPG character to emphasize their opinions, while in

584   some cases the students were cut off from sharing their thoughts. At that point, it is important

585   as researchers to reflect to our own positionalities when we analyse the data. Each of us

586   prescribes to a certain understating of reality and how knowledge is constructed, and that has

587   implications on how the data is analysed and discussed.

588   Throughout the educational activities we noticed a lack of neutrality in teaching, and that can

589   influence students' opinions and create biases on matters that students are not necessarily

590   very familiar with. As an example, the science museum facilitator had a positivist approach to

591   science and knowledge, and that was contrasting to the students' opinions and beliefs on the

592   importance of forming social groups to achieve social changes. The impact of teachers'

593   beliefs in environmental matters has been discussed by Cotton (97), where the author argues

594   that personal beliefs do matter, and they should be considered when designing curricula.

595   Another example of bias was when matters of morality and public engagement were

596   discussed during the RPG at the Science Museum. It was apparent that the facilitator whether

597   it was on purpose or not, brought their own values and morals on the table and presented

598   them as the truth. As Veugelers (98) explains, based on Freire's work on morality, morals are

599   something contextual that depends on certain social, cultural and political elements present in

22

600   a society. Morality is a very important topic in public engagement and decision making, but

601   under what circumstances should students be exposed to it? Although it is essential to discuss

602   morality as a topic in the school curriculum alongside the implications they can have on

603   students' decisions on ethical dilemmas (99), we find it problematic when educators try to

604   instil their personal morals to students.

605   In addition to the above, the facilitator made some statements that could be debated, but

606   because of his position and the power he held as an educator, their positionality was not

607   argued or contested. In addition to the nuclear energy example, they also stated that NGOs

608   such as Greenpeace are just a group of people with no scientific background, so they should

609   not be considered as a valid source of information. In contrast the students did not have the

610   resources to make their beliefs more vocal. This could be due to the educational setting where

611   it is difficult to oppose the teacher as a figure of authority. It could also be due to limited

612   experiences of voicing their concerns in political and public spheres. In this particular

613   instance, the teaching approach therefore aligned more with hierarchical classroom structures

614   that obstructs constructive two-way dialogue amongst teachers and students (46, 100).

615   While the aim of the education engagement activities was to use education both as a resource

616   to empower the youth, and better understand their perceptions on climate change and

617   decarbonisation, we run the risk at using education initiatives as a resource for indoctrination

618   by dictating the students what to do and use our position to instil these opinions.

619   Several examples of misconceptions and uncertainties have been identified in this study.

620   Milovanovic, Shealy (101) have suggested that the presence of misconceptions towards

621   climate change in engineering students, could hinder their empowerment to make changes

622   and find ways to alter the human induced impacts on the planet. In addition Darnovsky and

623   Hasson (102) are calling for the active involvement of the public to reduce their

624   misconceptions on controversial issues that could hinder their decision-making process.

625 Horizon 2020 projects have been critiqued both for the lack of integration of social sciences

626 but also on the evaluation of their societal impact capacity (103, 104). In line with the above,

627 we suggest more direct community engagement from the Horizon 2020 projects, to

628 encourage empowerment and knowledge construction. We suggest that EU funded projects,

629 should conduct need assessments for the local communities where the projects are to be based

630 to empower the local communities with an emphasis on the youth. To conclude this paper, we

631 agree with Spínola (49) interpretation of Freire's pedagogy of the oppressed within the

632 environmental domain, suggesting that in order to have true societal transformations to

633 address environmental issues, environmental education should not be subjected to any

634 political, societal and economical boundaries, but it should be available to all without any

635 boundaries.

636

637 Limitations

638 This study was conducted with a group of students living in a rural area, and it would be

639 interesting to replicate this study with a cohort of students from an urban environment. One

640 limitation of the study was that although the research and the engagement activities were

641 conducted face to face, the researchers lived abroad and that limited the amount of time and

642 interactions they could have with the students. We acknowledge that not using the students'

643 native language could have prevented some students that are not comfortable with the

644 English language, from participating and that could result in a selection bias in our

645 recruitment strategy.

646 Although students participated in the RPG, their responses do not necessarily reflect their

647 own beliefs. Time permitting more relevant to the students' research should be conducted.

648 Due to a tragic train accident that took place in Greece killing 57 people, it was decided as a

649   sign of respect to not conduct the fourth and final engagement activity as it coincided with the

650   national mourning period.

666

Appendix 1

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Picture 1a

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Picture 1b

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Picture 1c

Appendix 2

670

671

Picture 2a

Picture 2b

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Picture 2c

673

Appendix 3

674

Picture 3a. Social dimensions of climate change   *Picture 3b. What is CCUS?*

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REFERENCES

1.   Islam N, Winkel J. Climate change and social inequality. 2017.
2.   Thomas K, Hardy RD, Lazrus H, Mendez M, Orlove B, Rivera-Collazo I, et al. Explaining differential vulnerability to climate change: A social science review. Wiley Interdisciplinary Reviews: Climate Change. 2019;10(2):e565.
3.   Clemens V, von Hirschhausen E, Fegert JM. Report of the intergovernmental panel on climate change: implications for the mental health policy of children and adolescents in Europe—a scoping review. European child & adolescent psychiatry. 2020:1-13.
4.   Sanson AV, Van Hoorn J, Burke SE. Responding to the impacts of the climate crisis on children and youth. Child Development Perspectives. 2019;13(4):201-7.
5.   Hayward G, Ayeb-Karlsson S. 'Seeing with Empty Eyes': a systems approach to understand climate change and mental health in Bangladesh. Climatic Change. 2021;165(1-2):29.
6.   Barford A, Mugeere A, Proefke R, Stocking B, editors. Young people and climate change2021: The British Academy.
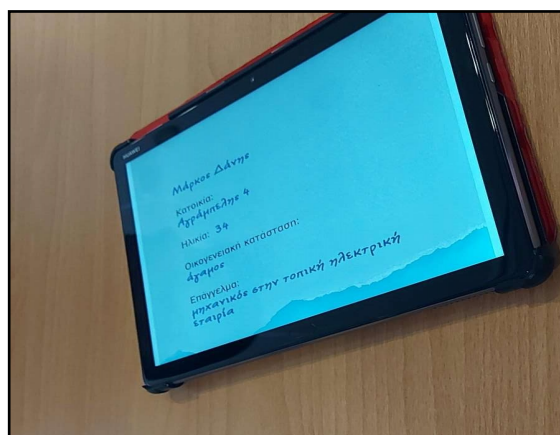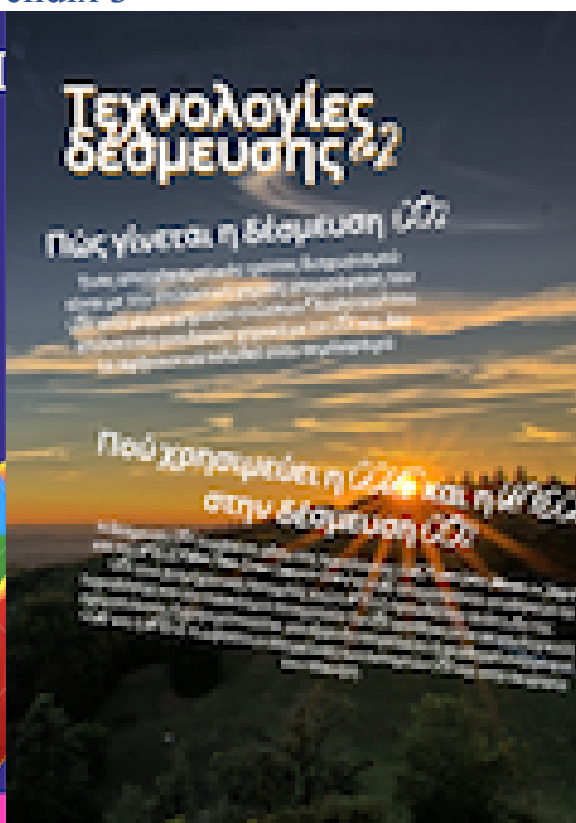7.   Evans R, Forte CL, Fraser EM. UNHCR's engagement with displaced youth. A Global Review Geneva: UNHCR Available online: https://www unhcr org/en-us/513f37bb9 pdf (accessed on 10 July 2021). 2013.
8.   Kitanova M. Youth political participation in the EU: evidence from a cross-national analysis. Journal of Youth Studies. 2020;23(7):819-36.
9.   Úcar Martínez X, Jiménez-Morales M, Soler Masó P, Trilla Bernet J. Exploring the conceptualization and research of empowerment in the field of youth. International journal of adolescence and youth. 2017;22(4):405-18.
10.   Commission E. EU launches the Youth Empowerment Fund: new partnership with the world's largest youth organisations to support young people contributing to the SDGs 2023 [Available from: https://international-partnerships.ec.europa.eu/news-and-events/news/eu-launches-youth-empowerment-fund-new-partnership-worlds-largest-youth-organisations-support-young-2023-10-04_en.
11.   O'Flaherty M. What do fundamental rights mean for people in the EU? Luxembourg: European Union Agency for Fundamental Rights; 2020.
12.   Klaniecki K, Leventon J, Abson DJ. Human–nature connectedness as a 'treatment'for pro-environmental behavior: making the case for spatial considerations. Sustainability Science. 2018;13:1375-88.
13.   Watts N, Amann M, Arnell N, Ayeb-Karlsson S, Belesova K, Berry H, et al. The 2018 report of the Lancet Countdown on health and climate change: shaping the health of nations for centuries to come. The Lancet. 2018;392(10163):2479-514.
14.   Guillemot J, Burgess J. Child rights at risk. 2019.
15.   Hickman C, Marks E, Pihkala P, Clayton S, Lewandowski RE, Mayall EE, et al. Climate anxiety in children and young people and their beliefs about government responses to climate change: a global survey. The Lancet Planetary Health. 2021;5(12):e863-e73.
16.   Clark H, Coll-Seck AM, Banerjee A, Peterson S, Dalglish SL, Ameratunga S, et al. A future for the world's children? A WHO–UNICEF–Lancet Commission. The Lancet. 2020;395(10224):605-58.
17.   Skeirytė A, Krikštolaitis R, Liobikienė G. The differences of climate change perception, responsibility and climate-friendly behavior among generations and the main determinants of youth's climate-friendly actions in the EU. Journal of environmental management. 2022;323:116277.
18.   Gibbons ED. Climate change, children's rights, and the pursuit of intergenerational climate justice. Health & Hum Rts J. 2014;16:19.
19.   Akresh R. Climate change, conflict, and children. The future of children. 2016:51-71.
20.   Helm S, Kemper JA, White SK. No future, no kids–no kids, no future? An exploration of motivations to remain childfree in times of climate change. Population and Environment. 2021;43:108-29.

21.   Prendergast K, Hayward B, Aoyagi M, Burningham K, Hasan MM, Jackson T, et al. Youth attitudes and participation in climate protest: An international cities comparison frontiers in political science special issue: Youth activism in environmental politics. Frontiers in Political Science. 2021;3:696105.

22.   Han H, Ahn SW. Youth mobilization to stop global climate change: Narratives and impact. Sustainability. 2020;12(10):4127.

23.   Kühne RW. Climate change: the science behind Greta Thunberg and Fridays for future. 2019.

24.   Wallis H, Loy LS. What drives pro-environmental activism of young people? A survey study on the Fridays For Future movement. Journal of Environmental Psychology. 2021;74:101581.

25.   Parth A-M, Weiss J, Firat R, Eberhardt M. "How dare you!"—the influence of Fridays for future on the political attitudes of young adults. Frontiers in Political Science. 2020;2:611139.

26.   Nations U. Action for Climate Empowerment 2024 [cited 2024. Available from: https://unfccc.int/topics/education-and-youth/big-picture/ACE.

27.   Commission E. European Youth for Climate Action. 2018 November 2018.

28.   To S-m, Chun-Sing Cheung J, Liu X, Lau CD, Zeng HJ, Chan AM-y. Youth empowerment in the community and young people's creative self-efficacy: The moderating role of youth–adult partnerships in youth service. Youth & Society. 2021;53(6):1021-43.

29.   Chapman J, Schott S. Knowledge coevolution: generating new understanding through bridging and strengthening distinct knowledge systems and empowering local knowledge holders. Sustainability Science. 2020;15(3):931-43.

30.   Brady B, Chaskin RJ, McGregor C. Promoting civic and political engagement among marginalized urban youth in three cities: Strategies and challenges. Children and Youth Services Review. 2020;116:105184.

31.   Turkie A. More than crumbs from the table: A critique of youth parliaments as models of representation for marginalised young people. A Handbook of Children and Young People's Participation: Routledge; 2009. p. 284-91.

32.   Milliken M. Enfranchising young people: The case for a youth parliament. Child Care in Practice. 2001;7(2):157-63.

33.   Wood BE. Crafted within liminal spaces: Young people's everyday politics. Political Geography. 2012;31(6):337-46.

34.   Shephard M, Patrikios S. Making democracy work by early formal engagement? A comparative exploration of youth parliaments in the EU. Parliamentary Affairs. 2013;66(4):752-71.

35.   Rappaport J. Studies in empowerment: Introduction to the issue. Prevention in human services. 1984;3(2-3):1-7.

36.   Chankseliani M, McCowan T. Higher education and the sustainable development goals. Higher Education. 2021;81(1):1-8.

37.   Le K, Nguyen M. How education empowers women in developing countries. The BE Journal of Economic Analysis & Policy. 2020;21(2):511-36.

38.   Bentz J, O'Brien K. ART FOR CHANGE: Transformative learning and youth empowerment in a changing climate. Elementa: Science of the Anthropocene. 2019;7.

39.   Ciptono WS, Anggadwita G, Indarti N. Examining prison entrepreneurship programs, self-efficacy and entrepreneurial resilience as drivers for prisoners' entrepreneurial intentions. International Journal of Entrepreneurial Behavior & Research. 2023;29(2):408-32.

40.   Kourtis-Kazoullis V, Gouvias D, Oikonomakou M, Skourtou E. The Creation of a Community of Language Learning, Empowerment, and Agency for Refugees in Rhodes, Greece. Handbook of Theory and Research in Cultural Studies and Education. 2019:1-21.

41.   Westbrook RB. John Dewey and american democracy: Cornell University Press; 2015.

42.   Giroux HA. Rethinking education as the practice of freedom: Paulo Freire and the promise of critical pedagogy. Policy Futures in Education. 2010;8(6):715-21.

43.   Warde MJ. John Dewey through the Brazilan Anísio Teixeira or reenchantment of the world: Springer; 2005.

44. Dewey J. Democracy and education: An introduction to the philosophy of education: Macmillan New York; 1930.

45. Ardoin NM. Toward an interdisciplinary understanding of place: Lessons for environmental education. Canadian Journal of Environmental Education (CJEE). 2006:112-26.

46. Freire P. Pedagogy of the oppressed (revised). New York: Continuum. 1996;356:357-8.

47. Schreiner C, Henriksen EK, Hansen PJK. Climate education: Empowering today's youth to meet tomorrow's challenges. Studies in Science Education. 2005;41(1/2):3.

48. Reigota M. Environmental education in Brazil and the influence of Paulo Freire. Oxford Research Encyclopedia of Education2020.

49. Spínola H. Environmental education in the light of Paulo Freire's pedagogy of the oppressed. PLOS Sustainability and Transformation. 2023;2(7):e0000074.

50. Hadjichambis AC, Reis P, Paraskeva-Hadjichambi D, Činčera J, Boeve-de Pauw J, Gericke N, et al. Conceptualizing environmental citizenship for 21st century education: Springer Nature; 2020.

51. Chawla L, Cushing DF. Education for strategic environmental behavior. Environmental education research. 2007;13(4):437-52.

52. Kopnina H. Education for the future? Critical evaluation of education for sustainable development goals. The Journal of Environmental Education. 2020;51(4):280-91.

53. Dawson V, Carson K. Introducing argumentation about climate change socioscientific issues in a disadvantaged school. Research in Science Education. 2020;50:863-83.

54. Khatibi FS, Dedekorkut-Howes A, Howes M, Torabi E. Can public awareness, knowledge and engagement improve climate change adaptation policies? Discover Sustainability. 2021;2:1-24.

55. Trott CD. Children's constructive climate change engagement: Empowering awareness, agency, and action. Environmental Education Research. 2020;26(4):532-54.

56. Bingham C. Authority is relational: Rethinking educational empowerment: State University of New York Press; 2009.

57. Nieminen JH. Beyond empowerment: student self-assessment as a form of resistance. British Journal of sociology of Education. 2021;42(8):1246-64.

58. Abimbola I. The problem of terminology in the study of student conceptions in science. Science education. 1988;72(2):175-84.

59. Osborne R, Freyberg P. Learning in Science. The Implications of Children's Science: ERIC; 1985.

60. Choi S, Niyogi D, Shepardson DP, Charusombat U. Do earth and environmental science textbooks promote middle and high school students' conceptual development about climate change? Textbooks' consideration of students' misconceptions. Bulletin of the American Meteorological Society. 2010;91(7):889-98.

61. Bozkurt F. Evaluation of geography textbooks in terms of misconceptions about climate topic. Review of International Geographical Education Online. 2019;9(1):149-70.

62. Ludwig D, Macnaghten P. Traditional ecological knowledge in innovation governance: a framework for responsible and just innovation. Journal of Responsible Innovation. 2020;7(1):26-44.

63. Hill R, Adem Ç, Alangui WV, Molnár Z, Aumeeruddy-Thomas Y, Bridgewater P, et al. Working with indigenous, local and scientific knowledge in assessments of nature and nature's linkages with people. Current Opinion in Environmental Sustainability. 2020;43:8-20.

64. Stori FT, Peres CM, Turra A, Pressey RL. Traditional ecological knowledge supports ecosystem-based management in disturbed coastal marine social-ecological systems. Frontiers in Marine Science. 2019;6:571.

65. Hosen N, Nakamura H, Hamzah A. Adaptation to climate change: Does traditional ecological knowledge hold the key? Sustainability. 2020;12(2):676.

66. enge LAF, Hodges C, Cutts W. Seen but seldom heard: Creative participatory methods in a study of youth and risk. International Journal of Qualitative Methods. 2011;10(4):418-30.

67. Mohajer N, Earnest J. Youth empowerment for the most vulnerable: A model based on the pedagogy of Freire and experiences in the field. Health education. 2009;109(5):424-38.

847   68.   Pereira T, Freire T. Positive youth development in the context of climate change: a
848   systematic review. Frontiers in psychology. 2021;12:786119.
849   69.   Hesse-Biber SN, Leavy P. Emergent methods in social research: Sage; 2006.
850   70.   Agell L, Soria V, Carrió M. Using role play to debate animal testing. Journal of Biological
851   Education. 2015;49(3):309-21.
852   71.   PlayDecide. About PlayDecide.: EU; 2004 [Available from: https://playdecide.eu/about.
853   72.   Ward M, Ní Shé É, De Brún A, Korpos C, Hamza M, Burke E, et al. The co-design,
854   implementation and evaluation of a serious board game 'PlayDecide patient safety'to educate junior
855   doctors about patient safety and the importance of reporting safety concerns. BMC medical
856   education. 2019;19(1):1-14.
857   73.   Macdonald SH-F, Egan K, Shé ÉN, O'Donnell D, McAuliffe E. The PlayDecide Patient Safety
858   game: A" serious game" to discuss medical professionalism in relation to patient safety. International
859   Journal of Integrated Care (IJIC). 2019;19.
860   74.   Sporea D, Sporea A. Europe of innovative science and mathematics education. Romanian
861   Reports in Physics. 2014;66(2):539-61.
862   75.   Bandelli A. Climate change Playdecide: European Union; 2010 [cited 2023 12/5/23].
863   Available from: https://playdecide.eu/node/628.
864   76.   Chen H-L, Wu C-T. A digital role-playing game for learning: Effects on critical thinking and
865   motivation. Interactive Learning Environments. 2023;31(5):3018-30.
866   77.   Schrier K. Designing role-playing video games for ethical thinking. Educational Technology
867   Research and Development. 2017;65(4):831-68.
868   78.   Mao W, Cui Y, Chiu MM, Lei H. Effects of game-based learning on students' critical thinking:
869   A meta-analysis. Journal of Educational Computing Research. 2022;59(8):1682-708.
870   79.   Daniau S. The transformative potential of role-playing games—: From play skills to human
871   skills. Simulation & Gaming. 2016;47(4):423-44.
872   80.   Tracy SJ. Qualitative research methods: collecting evidence, crafting analysis, communicating
873   impact. Second edition ed. Hoboken, NJ: Wiley-Blackwell; 2019 2019. 412 p.
874   81.   Pospieszna P, Galus A. Promoting active youth: evidence from Polish NGO's civic education
875   programme in Eastern Europe. Journal of International Relations and Development. 2020;23:210-36.
876   82.   Kaya A, Benevento A. Epistemic justice as a political capability of radicalised youth in Europe:
877   A case of knowledge production with local researchers. Journal of Human Development and
878   Capabilities. 2022;23(1):73-94.
879   83.   Chang C-H, Pascua L. Singapore students' misconceptions of climate change. International
880   Research in Geographical and Environmental Education. 2016;25(1):84-96.
881   84.   Kurup PM, Levinson R, Li X. Informed-decision regarding global warming and climate change
882   among high school students in the United Kingdom. Canadian Journal of Science, Mathematics and
883   Technology Education. 2021;21:166-85.
884   85.   Shepardson DP, Niyogi D, Choi S, Charusombat U. Seventh grade students' conceptions of
885   global warming and climate change. Environmental Education Research. 2009;15(5):549-70.
886   86.   Jordan RC, Sorensen AE, Gray SA. What undergraduate students know and what they want
887   to learn about in climate change education. PLOS Sustainability and Transformation.
888   2023;2(4):e0000055.
889   87.   Henriksen EK, Jorde D. High school students' understanding of radiation and the
890   environment: Can museums play a role? Science education. 2001;85(2):189-206.
891   88.   Bandura A, Cherry L. Enlisting the power of youth for climate change. American Psychologist.
892   2020;75(7):945.
893   89.   Jamatia PL. The Role of Youth in Combating Social Inequality: Empowering the Next
894   Generation. International Journal of Social Science, Educational, Economics, Agriculture Research
895   and Technology. 2023;2(8):229-38.

896   90.   Kitt S, Axsen J, Long Z, Rhodes E. The role of trust in citizen acceptance of climate policy:
897   Comparing perceptions of government competence, integrity and value similarity. Ecological
898   Economics. 2021;183:106958.
899   91.   Fairbrother M, Sevä IJ, Kulin J. Political trust and the relationship between climate change
900   beliefs and support for fossil fuel taxes: Evidence from a survey of 23 European countries. Global
901   Environmental Change. 2019;59:102003.
902   92.   Bertuzzi N. Political generations and the Italian environmental movement (s): innovative
903   youth activism and the permanence of collective actors. American behavioral scientist.
904   2019;63(11):1556-77.
905   93.   Belotti F, Donato S, Bussoletti A, Comunello F. Youth activism for climate on and beyond
906   social media: insights from FridaysForFuture-Rome. The International Journal of Press/Politics.
907   2022;27(3):718-37.
908   94.   Weiss J. What is youth political participation? Literature review on youth political
909   participation and political attitudes. Frontiers in Political Science. 2020;2:1.
910   95.   Marquardt J. Fridays for future's disruptive potential: an inconvenient youth between
911   moderate and radical ideas. Frontiers in Communication. 2020;5:48.
912   96.   Xu B, Chen N-S, Chen G. Effects of teacher role on student engagement in WeChat-Based
913   online discussion learning. Computers & Education. 2020;157:103956.
914   97.   Cotton DR. Implementing curriculum guidance on environmental education: The importance
915   of teachers' beliefs. Curriculum and Environmental Education: Routledge; 2019. p. 298-314.
916   98.   Veugelers W. The moral in Paulo Freire's educational work: What moral education can learn
917   from Paulo Freire. Journal of Moral Education. 2017;46(4):412-21.
918   99.   Walia N. Promoting ethics and morality in education for equality, diversity and inclusivity.
919   Journal of Multidisciplinary Cases (JMC) ISSN. 2022:2799-0990.
920   100.   Nebeker ML. The teacher and society: John Dewey and the experience of teachers.
921   Education and culture. 2002;18(2):14-20.
922   101.   Milovanovic J, Shealy T, Godwin A. Senior engineering students in the USA carry
923   misconceptions about climate change: Implications for engineering education. Journal of Cleaner
924   Production. 2022;345:131129.
925   102.   Darnovsky M, Hasson K. CRISPR's Twisted Tales: Clarifying Misconceptions about Heritable
926   Genome Editing. Perspectives in biology and medicine. 2020;63(1):155-76.
927   103.   Pedersen DB. Integrating social sciences and humanities in interdisciplinary research.
928   Palgrave Communications. 2016;2(1):1-7.
929   104.   de Jong SP, Muhonen R. Who benefits from ex ante societal impact evaluation in the
930   European funding arena? A cross-country comparison of societal impact capacity in the social
931   sciences and humanities. Research Evaluation. 2020;29(1):22-33.
932