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2 Promoting physical activity with a school-based dance mat exergaming intervention:
3 qualitative findings from a natural experiment

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18

19 Abstract

20 Background:

21 Physical activity is critical to improving health and well-being in children. Quantitative
22 studies have found a decline in activity in the transition from primary to secondary
23 education. Exergames (active video games) might increase physical activity in adolescents.
24 In January 2011 exergame dance mat systems were introduced in to all secondary schools
25 across two local authority districts in the UK. We performed a quasi-experimental evaluation
26 of a natural experiment using a mixed methods design. The quantitative findings from this
27 work have been previously published. The aim of this linked qualitative study was to explore
28 the implementation of the dance mat scheme and offer insights into its uptake as a physical
29 activity intervention.

30 Methods:

31 Embedded qualitative interviews at baseline and 12 month follow-up with purposively
32 selected physical education teachers (n=20) and 25 focus groups with a convenience sample
33 of pupils (n=120) from five intervention schools were conducted. Analysis was informed by
34 sociology of translation approach.

35 Results:

36 At baseline, participants (both teachers and pupils) reported different expectations about
37 the dance mats and how they could be employed. Variation in use was seen at follow-up. In
38 some settings they were frequently used to engage hard to reach groups of pupils. Overall,
39 the dance mats were not used routinely to increase physical activity. However there were
40 other unanticipated benefits to pupils such as improved reaction time, co-ordination and
41 mathematic skills. The use of dance mats was limited in routine physical education classes
42 because of contextual issues (school/government policy) technological failures
43 (batteries/updates) and because of expectations about how and where they could be used.

44 Conclusions:

45 Our linked quantitative study (previously published) suggested that the dance mats were
46 not particularly effective in increasing physical activity, but the qualitative results (reported

47 here) show that the dance mats were not used routinely enough to show a significant effect
48 on physical activity of the intervention. This research demonstrates the benefit of using
49 mixed methods to evaluate complex physical activity interventions. Those planning any
50 intervention for promoting physical activity in schools need to understand the distinction
51 between physical activity and physical education.

52

53 Keywords: physical activity; children; Sociology of translation; qualitative; exergaming

54

55 Word Count: 342 (Max 350)

56

57 *Background*

58 Adolescence, the years from puberty to adulthood, is important in the development of
59 lifelong behaviours including regular physical activity (PA)[1]. Increasing PA is a priority to
60 improve health and well-being, however there is a marked decline in activity in the
61 transition (around the age of 11 years) from primary to secondary school[2, 3]. Changes in
62 both social and physical environments during the transition from primary to secondary
63 school appear to be important determinants of the decline in PA seen at this time, with
64 reduced opportunities and social support to be physically active seen alongside increased
65 worry about competition and competence[4]. A systematic review of interventions to
66 promote PA in children and adolescents found that multi-component school-based activities
67 that were gender-sensitive and peer supported were the most promising[5]. However, the
68 highest quality studies in this review were mostly from the US and culturally appropriate
69 interventions elsewhere are under-explored. Another review identified that interventions
70 that were computer-tailored and empowered members of the school community were most
71 effective at engaging adolescents in physical activity[6].

72 One such multi-component activity that could be gender-sensitive, peer-supported and may
73 increase PA in adolescents is exergaming. Exergames are active video games which include
74 dancing, balance board simulators and virtual sports simulators. There is evidence to
75 support the role of exergames in promoting positive attitudes to PA and improving physical
76 activity self-efficacy in children[7]. Likewise, exergames show promise as a means to
77 increase PA levels[8, 9] including in inactive children during physical education (PE)
78 lessons[10]. However, the majority of studies have focused on short term PA outcomes[8,
79 11] with limited evidence on the long term effectiveness of exergames[12, 13]. Some
80 studies have specifically addressed gender concerns however there is little research
81 addressing the broader issues of culture[5].

82 In January 2011 exergame dance mat systems were introduced in to all secondary schools
83 (n=22) across two local authority districts in the UK. Dance mats are a combination of
84 computer game and PA in which dance steps are projected onto a wall or screen and players
85 follow them on foot-activated floor pads. The dance mat scheme was a regional initiative of
86 local National Health Service (NHS) and local authority partners. The secondary schools
87 were each provided with a 32 mat system that could be used independently by individual

88 schools or wirelessly linked to enable interschool and external competition. The dance mat
89 scheme was overseen by a multi-agency steering group of stakeholders, including school
90 sports leads and public health officials. This steering group aimed to encourage greater PA
91 amongst secondary school students; and facilitate wider use of the dance mats in local
92 primary schools, through intercollegiate competitions and during after school programmes.
93 Schools' agreement with the local authority involved a commitment to use the mats for an
94 initial 6 week pilot. Mats belonged to schools and there was encouragement from the
95 steering group to continue to use the dance mats beyond this pilot phase in scheduled PE
96 classes, breaks, lunchtime, and outside of school hours. The company that supplied the mats
97 were contracted to provide initial training on their use, and ongoing technical support and
98 updates (system, music).

99 As the dance mat scheme was limited to two local authority districts, we had the
100 opportunity to evaluate a 'natural experiment' of the effects of a large scale exergame
101 intervention over a long period, in a 'real-world' setting. By recruiting schools from
102 neighbouring local authority districts, that were not taking part in the scheme, we were able
103 to conduct a quasi-experimental evaluation of the effects of the intervention on quality of
104 life domains, body mass index (BMI) and PA in 11-13 year old children over 12 months. Our
105 quantitative findings, presented elsewhere[14] (Supplement 1), were that the intervention
106 was associated with improvement in the quality of life domains psychological well-being,
107 autonomy, parent relations, as well as a decrease in BMI[14]. However, there was a negative
108 effect on PA overall.

109 Alongside the quantitative evaluation of the dance mats scheme[14], we also conducted a
110 qualitative evaluation. Qualitative research can be useful in teasing out the contextual,
111 social and cultural aspects important to longer-term effectiveness of public health
112 interventions[15]. Indeed, it has been proposed that qualitative approaches are
113 fundamental to the development and evaluation of complex public health interventions[16].
114 However, qualitative methods are not commonly used to capture contextual information
115 about school-based PA promotion interventions. Some mixed methods studies use
116 qualitative methods to explore the acceptability of exergame interventions, others have
117 considered the broader contextual issues in relation to PA for non-exergame related
118 interventions[17, 18], but we are not aware of any studies that have used qualitative

119 methods to explore the broader cultural and social context of exergame interventions in
120 schools.

121 The aim of this qualitative study was to explore and understand the successful and
122 unsuccessful elements of the dance mats scheme in order to help explain and interpret the
123 findings from the quantitative evaluation[14]. In order to provide a strong theoretical
124 framework[16] we drew on elements of a sociology of translation (see below) to take into
125 account expectations of users, and ways in which the technologies were integrated (or not)
126 in the already complex settings in which they were placed[19, 20].

127

128 *Methods*

129 We conducted a qualitative study with PE teachers and pupils from the five intervention
130 schools that participated in our quantitative evaluation[14]. Teachers took part in individual
131 interviews and pupils in focus groups. Data was collected at both baseline, before
132 intervention implementation, and at 12 month follow up.

133 Participants

134 A total of 20 teachers based at intervention schools participated in in-depth interviews with
135 the lead qualitative researcher (Duika Burges Watson PhD) at baseline, before intervention
136 implementation. Included teachers were aware of the dance mat scheme and its evaluation
137 and were available for interview. Teachers were purposively selected for inclusion by their
138 managers based on meeting the criteria listed above.

139 Twelve months after implementation, eight of the original 20 teachers were no longer in
140 employment with the same schools (most had originally been employed under a
141 government scheme that was subject to substantial cuts during the evaluation period).
142 Therefore 12 month follow up interviews were undertaken with the remaining 12 teachers.

143 Pupils were invited by their PE teacher to volunteer for focus group sessions during their
144 regular PE sessions. We conducted focus groups at baseline, before intervention
145 implementation and at 12 months follow up. This convenience sample of pupils was
146 therefore not necessarily the same at baseline and follow-up. In total, 25 focus groups were
147 undertaken with mixed gender pupils (n=120) aged 11-14 years.

148 Data collection

149 All interviews with teachers took place at the convenience of participants within school
150 time, normally on a one to one basis in staff rooms. Interviews were guided by a topic guide
151 (available from the lead author) based on the objectives of the study and existing literature,
152 and focused on questions that explored perceptions of the benefits and barriers to
153 engagement with the intervention over time, and the potential effect of this engagement on
154 physical, emotional, school and social functioning. Interviews lasted between 10 and 30
155 minutes. Given saturation of thematic findings across interviews, we have used extracts

156 from the 12 teachers who participated in both baseline and follow up to illustrate key
157 themes in the results section.

158 Focus groups with pupils were undertaken in convenient quiet locations near to regular PE
159 classes, alongside the collection of quantitative data, by experienced researchers (Duika
160 Burges Watson (PhD), Jean Adams (PhD), Liane Azevedo (PhD), and Catherine Haighton
161 (PhD), at baseline and at 12 month follow up. Focus groups, consisting of 3-6 pupils, were
162 led by a topic guide (available from the lead author) that were based on the objectives of
163 the study and existing literature, and focused on questions that explored pupils
164 expectations of the dance mats, experience and access to exergames outside school and at
165 follow up their reflections of, and use of dance mats in school. Focus groups lasted between
166 10-15 minutes.

167 Data analysis

168 All interviews and focus groups were audio recorded and transcribed verbatim. Analysis
169 involved listening to recordings and checking against transcripts for accuracy and to develop
170 high level themes in NVivo by the lead qualitative researcher (DBW). A framework approach
171 [21] was employed to map sub themes within the meta-framework informed by studies of
172 science and technology (STS)[22, 23]. As dance mats are a technological and social
173 intervention, transcripts were analysed using a sociology of translation approach – making
174 no a priori distinction between the technology and the social context. This involved more
175 than a focus on context but also consideration of the ‘problematization’ of how
176 stakeholders are brought into the process and how they use the technologies. A more
177 detailed explanation of the steps involved - inter-definition of actors, inter-assessment,
178 enrolment, obligatory passage points and mobilization – can be found elsewhere[22, 23].

179

180 *Results*

181 Anonymised profiles of the twelve teachers who took part in both baseline and follow up
182 interviews are shown in Table 1.

183 Table 1: Profiles of the 12 teachers with data at both time points.

ID	Gender	Role
S1a	Male	Faculty lead on sport
S1b; S2b; S5a; S5b; S3a	Female	PE teachers
S1c; S3a; S3b;	Female	Dance teachers
S1 d; S2a;	Male	PE teachers
S4a	Male	School sports lead

184 S(no.) = school

185 The headings and sub-headings listed below reflect the themes and sub-themes derived
186 from our data, quotes are used to illustrate key themes.

187 **Expectations of use: teachers**

188 At baseline, teachers reported very different expectations about the mats and how they
189 could best be employed. Decisions about use involved a trade-off between perceived
190 appropriateness as an activity for PE classes and other school based PA opportunities, and
191 meeting the skill needs and requirements of the curriculum and sport. Views on the
192 appropriateness of the dance mats as an activity were initially split on the basis of ideas
193 about the mats as play, game, sport or exercise. For most respondents, the mats were not
194 considered 'sport' but rather as a game or playful activity. One of the teachers had the
195 following view:

196 *"No computer games would ever take the place of sport, not my idea of proper sport,*
197 *but at least it is some form of physical activity. They have some potential, but I prefer*
198 *the old fashioned face to face confrontation, competition and participation, but*
199 *that's a personal preference, not whether they are effective or not". S2a*

200 One teacher described looking beyond ‘tradition’, suggesting some pupils were unlikely, and
201 unwilling, to engage in sports such as football, and that dance mats could be employed as an
202 alternative ‘game’ with inter-collegiate competition.

203 *“[We have to] look beyond the traditional sports of rugby, football, hockey,*
204 *netball...most [professional] people with their eyes open can see that that works for*
205 *quite a lot of kids, but it doesn’t work for every kid”*. S1d

206

207 At the same time, another teacher felt that dance mats were more about engaging those
208 disengaged from physical activity in any form.

209 *“I thought it would be a good way to sort of engage some of the students who*
210 *wouldn’t engage quite so readily in kind of traditional sports”*. S1 b

211 The dance mats were, at least in expectation, considered as likely to produce engagement
212 as they were similar to technologies such as *Wii Fit* and *Play Station* that pupils were familiar
213 with. Several teachers noted the high use of video games in the region, with two teachers
214 suggesting a relationship between deprivation and higher than national average video game
215 play.

216 *“In this neighbourhood they may not have carpet on the floor but they’ll have every*
217 *console”*. S1a

218 The dance mats were thus viewed less as *sport*, compared to activities such as football and
219 cricket, and more as a video game or means to encourage PA where no ‘skills’ could be
220 taught other than as some suggested, an introduction to dance or means of engagement in
221 physical activity. At best, dance mats were viewed as a non-traditional game that could
222 increase activity levels for those for whom sport ‘doesn’t work’, particularly for girls who it
223 was generally assumed would enjoy them the most.

224 *“Yeah they are good, they serve as an alternative and they get not so active people*
225 *involved. They have some great benefits. But they are just one of the pieces of*
226 *equipment and I think they’ll only appeal to the girls that enjoy dancing”*. S3a

227 A key concern for teachers was whether the dance mats would be ‘effective’ in encouraging
228 skills development, and if they would be of pedagogic value in the time limited constraints
229 of the curriculum. It was anticipated that beyond the 6 week pilot in PE sessions, they were
230 most likely to be used in after school and lunch time activities, particularly during
231 ‘enrichment programmes’ (after-school programmes based on a topic that will lead to new
232 in-depth learning).

233

234 *“My only concern is quite how you use it in a lesson and progress and what they’re*
235 *getting from it. Say you had it as a unit of work, what are they going to get from that*
236 *unit of work? ...we’re going to experiment and try and use them in curriculum time as*
237 *well as after school and evaluate it, see how it goes...” S5b*

238

239 While teachers expressed concerns about high obesity rates and low levels of PA amongst
240 pupils, most argued that increasing PA was not the responsibility of the school, and
241 therefore had few expectations about the value of the dance mats for PA, other than as
242 ‘incidental’ to the curriculum.

243 *“It’s just not feasible for us to be responsible for their overall physical activity with 2*
244 *½ hours a week available to us. We are of course concerned about obesity rates and*
245 *so on, but we also have to deliver a sports curriculum. We can introduce kids to sport*
246 *to some extent, but parents just have to take the lead on keeping their kids active”*

247 S2a

248 Teachers felt that school PE concentrated on skills training and the introduction of a range
249 of new sporting activities from which pupils could develop independently and beyond the
250 confines of the curriculum. Moreover, they emphasised the limited time and space available
251 for PA within PE classes and other scheduled activities such as dance, in school time.

252 *“It’s difficult, because as a PE teacher I would want the children to be active as much*
253 *as possible in an hour’s lesson; however, if they’re teaching skills, the activity level*
254 *becomes less. But until they have the skills they can’t keep the activity going. So you*
255 *have to forgo some activity to get the skill level up” S5a*

256

257 **Expectations of use: pupils**

258 Feedback from pupils revealed a high level of frustration at the lack of time and suitable
259 spaces available for PA, particularly during lunch hours.

260 *“Lunch times! I want to be active but you don’t have time. If you don’t eat your*
261 *dinner in a certain time there is no time to go outside”.* Girl S1

262 Pupils talked about long queue times for lunch, the lack of space for play relative to their
263 previous (primary) schools and the poor facilities. Follow up questions about what they
264 meant by facilities was often expressed in terms of embarrassment at public exercise; and
265 for girls, the personal sense of exposure involved in getting changed for, or being seen
266 ‘doing’, exercise in school.

267 *“Yeah, it was easier at primary school because there was more space and time, and*
268 *you could get changed without people looking at you”.* Girl S2

269

270 For pupils across all of the focus groups there was frequent discussion and comparison of
271 the technological sophistication of the dance mats and comparison with exergames they
272 had at home, particularly *Wii Fit* and *Playstation*. Almost all the pupils reported having at
273 least one movement based exergame at home, and many had experienced arcade based
274 dance mats - they anticipated the school systems would be commensurate. One described it
275 as replacing ‘thumbs’ with ‘feet’ – suggesting that dance mats were more video game than
276 dance activity. Both boys and girls expressed excitement at the prospect of the mats being
277 used in the school.

278 *“You just use your feet instead of your thumbs”.* Boy S3

279 *“I guess they’ll be like the arcade dance mats? Yeah!”.* Girl S4

280

281 At the same time some boys did regard the mats as a dance activity most suitable for girls,
282 but more frequently, the mats were read as a computer game that they would happily
283 engage with on those terms.

284 *“It’s mainly the lasses who do it but some of the lads will do it too. You just do it, like, for the*
285 *fun. Like no one’s going to take the mick, it’s valid, like it’s a computer game and better than*
286 *just standing around and just talking to your mates or something”*. Boy S2

287 **Use and non-use of mats at follow-up**

288 A year on, the use of the mats was highly variable between and schools, and between pupils
289 even within the same school. All schools maintained records of the use of the mats by the
290 individuals in the linked quantitative study[14]. Use across the schools varied from only
291 being used for enrichment activities after school, to full incorporation into 6 week ‘blocks’ of
292 PE lessons. The highest use school (S3), had pupils who had never used the mats through to
293 some who had used them more than 20 times. Another school (S1) was singled out by
294 teachers in several of the others as an ‘exemplar’ of good practice. This school had
295 organised an after school inter-collegiate dance mat based competition and had attempted
296 to establish inter-school competition until, under a separate programme, the transport
297 needed to move the mats was no longer available. Some teachers had successfully
298 integrated the use of the mats within specific programmes, when the weather was not
299 suitable for traditional outdoor activities, for dance and boxing classes, and for key ‘harder
300 to reach groups’ - most notably amongst older girls. While isolated examples suggest the
301 mats were used frequently in some settings, the majority of respondents felt the use of
302 mats was limited in routine PE classes because of other contextual issues, curriculum
303 pressures, and because of technological and human failures. Each of these elements is
304 considered below.

305 **Contextual issues**

306 The School Sports Partnership (SSP) was a government scheme introduced in 2000 to
307 increase participation amongst 5-16 year old school children to at least 2 hours of ‘high
308 quality PE and school sport’ per week[24]. For teachers, the target of 2 hours of high quality
309 PE was frequently spoken about as unrealistic in curriculum time. However part-way
310 through our evaluation (March 2011) there was a decline in funding to the SSP associated
311 with a change in government (May 2010). This decline was considered by participants as a
312 major ‘loss’, resulting in decreased opportunities for activities that engage the ‘non-football
313 types’ and for after school and enrichment activities to improve PA. Moreover, the focus of

314 policy on particular sports was noted as a feature of the then incumbent government's push
315 for an 'Olympic legacy'[25].

316

317 *"We used them[dance mats] more initially than we do now because we have the*
318 *national curriculum to follow and all the Olympic legacy stuff ... so um ... what we try*
319 *to do now is fit them in to lunch times and what's left of the after school enrichment*
320 *programme". S3b*

321

322 Most schools had, until the change of government, timetabled extensive 'enrichment'
323 programmes that provided students with time for optional activities both within non-class
324 time and after school. Dance mats were used as one of many options, and in most settings
325 students were encouraged to try as many activities as possible to improve their skill levels.
326 When the dance mats were used however, they were very popular and teachers were
327 frequently surprised at their success, even with sometimes 'apprehensive' boys.

328

329 *"Originally the girls were much better, and er, the lads were a little bit more*
330 *apprehensive...but you do notice the improvement in foot work co-ordination" S1a*

331

332 Teachers noted the increased reaction times, and multi-sensory skills employed by pupils
333 using the mats as well as being surprised by how girls appeared to lose their normal
334 inhibitions about being seen exercising, even if others looked on. Unfortunately many of
335 these enrichment initiatives were cut midway through the evaluation period.

336

337 *"It's like they've got 5 sets of eyeballs...well how can you do that and watch the*
338 *arrows at the same time?" S3*

339

340 *"It's like they are in a bubble; when they are on the mats they just don't notice whose*
341 *looking on and they go for it". S1*

342

343 **Curriculum pressures**

344

345 Given the priorities within the PE curriculum to include both skills and exercise; most
346 teachers felt the balance of these priorities precluded the use of the mats beyond
347 occasional sessions. Moreover, pressures on the curriculum were also seen to have
348 increased with a change in government. The views of teachers were that, particularly in the
349 first two years of secondary school, effort should be directed towards encouraging pupils to
350 try as many new activities as possible and to increase skill levels. In general, teachers
351 continued to argue that PA was only possible outside PE lessons not within.

352

353 *“...to be honest we’ve not put it [dance mats] on the curriculum, because I felt that*
354 *there’s only so much you can do in terms of learning”*. S2b

355

356 **Technological/human failures**

357 All teachers reported problems with using the dance mat technology and most felt they
358 were not using the mats to their full potential. Not all had received the initial training and
359 many found updating the systems and adding new music difficult.

360

361 *“They are not always easy, for example one day one of the mats seemed to have reset itself,*
362 *and I couldn’t get the mats to work, both mats had the same ID no. or something. There*
363 *hasn’t been as much support in how to use them as I thought there was going to be”*. S5b

364

365 Noted also in focus groups with pupils, the technology lost its interest if they became
366 ‘bored’ by the repetition of particular songs and having the latest ‘hit’ tracks was for some, a
367 key motivation.

368

369 *“You can do different songs and its great when you get Lady Gaga and stuff, just...it’s*
370 *better not doing the same old songs all the time”*. Girl S2

371

372 While ongoing access to technical support from the dance mats manufacturers had been
373 part of the initial purchase agreement negotiated by the local authority, teachers either did
374 not access it, or found it hard to access. Problems with short battery life and access to
375 funding for new batteries could be seen either as technological or institutional failure. One
376 teacher felt this reflected a lack of institutional support and a budgeting problem. In

377 contrast, for another teacher these problems reflected a simple failure of the technology
378 itself.

379 *“its our fault we needed to know more about updating and changing the songs that*
380 *kind of thing and keeping them up to date and working... from my enrichment budget*
381 *I’ve spent , god, easily over £200 in batteries”*. S4

382

383 *“I think they’ve been very successful, but they were let down by the battery life”*. S3

384

385 **Measuring success**

386 How teachers measured the success of the programme varied, but there was little
387 expectation that the dance mats would impact on children’s PA levels within regular PE
388 classes. Teachers were surprised at the idea ‘one’ technology would even be considered in
389 this way.

390 *“Well I can’t see how they were ever going to impact on overall physical activity in*
391 *the region, we simply have too many things going on. How could you possibly*
392 *measure that anyway?”* S1a

393

394 Rather the ‘success’ of the dance mat intervention was as an adjunct to existing activities. In
395 particular, the dance mats helped to engage those disengaged from PA and provide a playful
396 alternative means of PA.

397 *“I couldn’t say that its had a significant impact overall, but I can say that for certain*
398 *children that may not like traditional sports they have engaged more with the dance*
399 *mats...it’s been a really good starter”*. S3b

400

401 Innovation in how the mats were used was very much at the behest of individual teachers.
402 One, who had used the mats to increase ‘reaction time’ for boys learning boxing, reported
403 that ‘the boys loved the dance mats’.

404 *“The boys loved the dance mats. All the boxers loved it. We love using them but they*
405 *are out of action at the minute”*. S1

406

407 Another justified the use of the mats in terms of improvements in mathematics skills and
408 multi-tasking (S3).

409

410 *“they know who’s coming first and what percentage they’ve got and what’s*
411 *happening on the sides. It’s beneficial [for mathematic issues] for sure.” S3*

412

413 Several teachers reported successful use of the dance mats with older girls disengaged from
414 PA, and where there was more time available to them to use the mats.

415

416 *“Some of the older students here, the dance mats have been a permanent option as part of a*
417 *PE programme. So they’ve had five choices and dance mats have been one of those choices*
418 *and it’s been the same group of girls and they’ve been the less abled, in the sense of sporty”*

419 S2

420 Both boys and girls said they enjoyed using the mats, when they were used. Some became
421 ‘bored’ after the initial ‘wow’ factor had worn off, particularly if the music had not been
422 updated to the latest tunes.

423 *“The dance mats, they are alright like, but after a while like once you’ve used them quite a*
424 *lot the novelty wears off – but they are still fun like. It’s like a laugh as well, for people*
425 *who aren’t as good as everyone else it’s a good laugh” Boy S5*

426 Girls and boys described ‘getting sweaty’ and teachers confirmed that the activity was high
427 intensity.

428 *“Initially I didn’t believe that people would expend a lot of energy. But from what I’ve seen of*
429 *people on dance mats, they work an awful lot harder than a) they would imagine they do,*
430 *and b) I think anybody saying – you are going on a dance mat- would imagine them to do.*
431 *I’ve watched some people on the dance mats and they are absolutely shattered at the end,*
432 *really. Much more exhausted from 30 minutes on a dance mat than they would be from 60*
433 *minutes in a PE lesson”. S1b*

434

435 *Discussion*

436 **Summary of results**

437 This qualitative component of a mixed method study offers critical insight into some of the
438 contextual factors that explain the successful and unsuccessful elements of the dance mat
439 programme.

440 The success of the dance mats were in encouraging engagement in PA amongst harder to
441 reach groups, particularly girls disengaged from ‘traditional sports’ like football, but also
442 with particular groups of boys – for example those interested in improving skills for boxing.
443 Moreover, girls appeared less inhibited in using the mats than in other activities. As others
444 have recognised, screen based exergames can lead to a feeling of ‘immersion’, that is, “a
445 metaphorical term derived from the physical experience of being submerged in water...the
446 sensation of being surrounded by a completely other reality, as different as water is from
447 air, that takes over all of our attention, our whole perceptual apparatus...”[26]. As Pasch
448 argues[27], movement based gaming may encourage engagement because it is immersive
449 and feels a safe, playful environment that reduces anxiety. There were other benefits that
450 had not been anticipated by teachers or students that included mathematical skills, reaction
451 times and co-ordination. Even though there were no expectations about the dance mats
452 value for PA, and despite limited time and opportunity to use them, the intensity of PA
453 during use surprised some teachers.

454 However, the dance mats were not employed to their full capacity, not least because of an
455 already full, and changing, agenda for school sport. Simple technological failures such as the
456 lack of batteries to run the mats, and lack of support to keep dance tunes updated, meant
457 that they were not used as much as they could have been, and pupils became bored by the
458 repetition. The combination of a change in the overall focus of school sports and the patchy
459 use of mats across the intervention area support the lack of demonstrable findings of an
460 overall impact on PA from our linked quantitative study[14]. But even more, the place of PA
461 within the curriculum, both within and without timetabled PE classes, was not as central to
462 the teachers as might have been anticipated by the project steering group. PA – despite its
463 benefits to health and well-being, was not always, if rarely, the imperative for PE lessons –
464 sport was.

465 The technologies themselves ‘created’ opportunities in some settings and in others were
466 not even considered as having the possibility of use. As Nancy and Bingham[28] argue, it is
467 all too easy in studies of technological innovation to focus on the innovation itself without
468 considering where it ‘fits’ in an already complex world. The analysis we employed involved
469 the abandonment of *a priori* distinction between the natural/physical and social world. That
470 is, we did not assume the technology to ‘be’ outside of the social context in which it was
471 employed. Employing this lens, it is possible to see how the technologies and people needed
472 to align in particular ways and that the dance mats did not get used with promotion of PA in
473 the school population in mind.

474 **Strengths and limitations**

475 In comparison to previous studies, key strengths of our approach were the longer term
476 focus on implementation of exergaming, the theoretical foundation informing our analysis,
477 and that it was conducted alongside a quantitative analysis. We included both teachers’ and
478 pupils’ perspectives and considered their expectations and views of the dance mats. This
479 longitudinal mixed method approach may be of value in other settings of similar complexity
480 in teasing out some overlooked elements of how innovative technologies are employed in
481 practice.

482 It should be noted that there was a high drop-out of number of interviewed teachers from
483 baseline (n=20) to follow-up (n=12) because of redundancy due to changes in government
484 scheme which might have underrepresented the views of teachers who were initially
485 exposed to the dance mat intervention. In fact the whole study took place during a period of
486 political change effecting school sports. This could be viewed as a limitation because the
487 findings are not generalizable to other settings; however, there were themes and issues that
488 were not related to the politics of use, but rather fundamental practical issues that could
489 have been easily overcome. Throughout this qualitative study there was a strong message of
490 a mismatch between what PE actually is (sports, motor skills, and cooperative behavior) and
491 what the intervention project instigators thought it was (PA). Moreover, we did not fully
492 explore how the national curriculum for school sports extended beyond regular PE classes
493 and the priorities placed on increased PA in other settings such as dance classes and
494 ‘enrichment’ programmes. In retrospect, formally capturing this by completing in depth

495 interviews with the project instigators and better exploring how the curriculum was
496 interpreted by school sports leads would have helped us to explore this mismatch further.

497 **Interpretation of results**

498 Under the agreement issued at the time of the implementation, all schools participating in
499 the programme were only required to utilize the mats in the first term in PE classes.

500 Moreover, the programme was disrupted by a change of government and funding cuts to
501 school sports less than 12 months into the programme. The top level management of the
502 programme weakened and many of the initiators and SSP leads lost employment. The
503 qualitative results suggest that beyond the initial 6 week timetabled programme, use
504 became patchy.

505 Part of the 'problem' with the dance mats for some teachers was their views of the mats'
506 appropriateness given their views of what the mats were 'for' (e.g. play, game or sport). As
507 Shaw[29] pg. 20 sets out; play can be typified as "behaviour for the purposes of fun and
508 enjoyment with no utilitarian or abstract goal in mind". Play becomes game when
509 competition is involved. Game is "any form of playful competition whose outcome is
510 determined by physical skill, strategy or chance". For example when not keeping score it is
511 play, when keeping score it becomes a game. Sport is "institutionalised competitive play
512 involving physical skill, strategy and chance". Sport involves a higher degree of organisation
513 with things such as governing bodies and leagues.

514 Dance mats could be, and were, used in different ways; for sport (eg. intercollegiate
515 competition), play (for fun) and/or as a game (because physical skill may be involved). Our
516 findings suggest that it is how teachers viewed and used the mats that determined whether
517 they were for play, game or sport, not the technology itself. One implication of this is that
518 pitching PA innovations such as dance mats as competitive 'sport' to PE teachers may be a
519 better way to achieve buy in for their use by these teachers, than letting teachers decide
520 what the innovations are for. However, for pupils, it is apparent that the game/play element
521 of dance mats is what provides motivation to participate. This is in line with the evidence
522 base cited earlier that the transitional drop off in PA warrants more focus on non-
523 competitive activities supported by peers[1, 5]. A further implication is that to ensure use of
524 exergames, more consideration of their value to different actors is required.

525 In addition, the suitability of the dance mats as play, game or sport in different settings
526 needs to be considered. Teachers seemed to consider play as something for extra-curricular
527 (lunch, after school) time, whereas game was appropriate for enrichment programmes, but
528 that it was sport that should go into PE lessons. Unfortunately the dance mats were often
529 seen as a diversion or at best enabled some quite targeted skill development.

530

531 *Conclusions*

532 Our evidence suggests that there is a need for a broader view of the value and effectiveness
533 of dance mat exergame systems especially in a school based setting. Our linked quantitative
534 study suggested the dance mats were not particularly effective in increasing PA, but the
535 qualitative results show that the dance mats were not used routinely enough to warrant an
536 examination of their impact on PA. The use of the dance mats could have been improved if
537 technological issues had been better addressed (eg batteries, updates) and if teachers had a
538 better understanding of their use in different settings and value beyond 'sport'.

539 This highlights the importance of using mixed methods to evaluate complex interventions in
540 real world settings[30]. However, if we truly want to understand the value of dance mats in
541 improving PA, a critical element is that the mats are specifically employed for that purpose.
542 In our research setting, this was not the case. There was a clear tension between sport and
543 PA given different stakeholders' views of their respective places across and beyond the
544 school curriculum. Those planning any intervention for promoting PA in schools need to
545 understand the distinction between PA and PE and the tensions that exist when PE teachers
546 are put under pressure to ensure pupils do more PA – particularly within PE classes.

547

548 *Declarations*

549 Ethics and consent to participate

550 The study received ethical approval from the Faculty of Medical Sciences – Newcastle
551 University (application number: 000318/2010). Eligible children attending the five schools
552 participating in the dance mat evaluation received an information pack which contained a
553 letter to their parent or guardian, an information booklet and written informed consent
554 forms for parent or guardian and an assent form for the child. All children had access to the
555 dance mats, but only pupils who signed the assent form and returned a completed informed
556 consent form from their parent or guardian were able to participate in the focus groups.
557 Teachers were invited to attend a presentation which explained the dance mat scheme and
558 the proposed evaluation. They also received written information on the evaluation and
559 were given the opportunity to ask questions. Teachers provided written consent to
560 participate in the interviews.

561 Consent to publish

562 Teachers and legal parents/guardians for children provided written consent to publish data
563 in the form of anonymised quotations.

564 List of abbreviations used

565 BMI body mass index
566 NHS National Health Service
567 PA physical activity
568 PE physical education
569 SSP School Sports Partnership
570 STS studies of science and technology

571 Competing interests

572 None of the authors have any competing interests.

573 Authors' contributions

574 DBW, JA, LA, CH conceived and designed the research. DBW, JA, LA, CH performed the
575 research. DBW analysed the data. DBW, JA, LA, CH wrote the paper and approved the final
576 version.

577 Availability of data

578 In line with the terms of consent to which participants agreed, the data are not publicly available.

579

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