Effectiveness of mobile apps in teaching field-based identification skills

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24   **Abstract**

25   It has been suggested that few students graduate with the skills required for many ecological careers,

26   as field-based learning is said to be in decline in academic institutions. Here, we asked if mobile

27   technology could improve field-based learning, using ability to identify birds as the study metric. We

28   divided a class of ninety-one undergraduate students into two groups for field-based sessions where

29   they were taught bird identification skills. The first group has access to a traditional identification

30   book and the second group were provided with an identification app. We found no difference between

31   the groups in the ability of students to identify birds after three field sessions. Furthermore, we found

32   that students using the traditional book were significantly more likely to identify novel species.

33   Therefore, we find no evidence that mobile technology improved students' ability to retain what they

34   experienced in the field; indeed, there is evidence that traditional field guides were more useful to

35   students as they attempted to identify new species. Nevertheless, students felt positively about using

36   their own smartphone devices for learning, highlighting that while apps did not lead to an

37   improvement in bird identification ability, they gave greater accessibility to relevant information

38   outside allocated teaching times.

39   **Keywords**

40   Field-based teaching; identification skills; mobile apps; technology in teaching; teaching/learning

41   strategies; smartphone devices

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Introduction

Teaching in the environmental biosciences (e.g. botany, ecology, environmental biology, zoology) focuses on supporting students as they gain an appreciation of the diversity of life, how species interact with their environments and how we as a species affect their abundance and distribution. The ability to identify taxa to appropriate levels and to study these organisms in the field is therefore a key skill for field biologists (IEEM 2011a; IEEM 2011b). In spite of the importance of field skills to these subjects, it has been suggested that the provision of field teaching is in decline (Scott et al. 2014; Smith 2004) as we see a generational attrition in academic staff with the required knowledge of field natural history to appropriately teach such courses. For example, taxonomy is under-represented in many undergraduate bioscience degree programmes (Leather and Quicke 2009), which will have a negative effect on global conservation efforts, as protecting species starts with putting the correct name to it (Hopkins and Freckleton 2002).This also has important implications for graduate employment, as many employers in the ecological sector are looking for graduates with these skills (IEEM 2011a; IEEM 2011b). However, Maw et al. (2011) argue that higher education programmes contain reasonable levels of field work and that this practice is not in decline. They demonstrated that this field work took place in the UK as well as part of overseas field courses, which are considered important for student recruitment. Either way, field work remains an important aspect of many higher degree programmes, especially in the natural sciences, and also in secondary and primary education (Tilling 2004, Boyle et al. 2007, Hope 2009).

The benefits of field experience in education as an important mode of active learning have been demonstrated (Boyle et al. 2007; Easton and Gilburn 2011; Goodenough et al. 2014), and are crucial in placing the subject in its real-world context. Field work can be of benefit to a wide diversity of students (Fuller et al. 2006) and it provides a novel learning environment away from traditional classroom teaching (Falk et al. 1978). There is a strong tradition of field work in the biosciences as a way to develop practical skills (Goulder et al. 2012), as well as increasing higher order learning (Rickinson et al. 2004) and student confidence (Boyle et al. 2007). For example, Hamilton-Ekeke (2007) found that students learnt more about biodiversity and ecology by undertaking a field trip than students taught in the classroom.

The ability to correctly identify species is the basis of field biology; field work can be used to actively engage and encourage students to identify the species they encounter (Scott et al. 2012). Birds are a tractable group for students to work with because most students start with some familiarity with the group, their relative visibility and the comparative ease at which identification can be taught, when compared with groups such as invertebrates or plants. In the UK, there are only around 250 regularly encountered species, bird identification guides are easy to use and the bird does not need to be caught to be identified. While birds therefore provide a useful entry group to enable students to gain key field

88   skills, it remains the case that finding effective methods to teach large groups in the field can be

89   challenging, and so it is important to consider a variety of teaching methods. Previous research found

90   that hands on teaching of bird identification skills using stuffed specimens led to better grades in

91   subsequent testing (Randler and Bogner 2006), although previous studies found no difference when

92   compared with a teacher centred slide presentation (Randler and Bogner 2002). To date, research

93   using field work based teaching of identification skills is lacking.

94   Tablet devices and mobile apps are increasingly being used in education to enhance learning

95   opportunities (Morris et al. 2012) and they are increasingly being used in the field (Welsh and France

96   2012). Many students now own their own personal smartphone or tablet device (Welsh and France

97   2012), and these are now often used formally or informally in classes for learning (Woodcock et al.

98   2012). This presents an opportunity to engage students in their learning while improving digital

99   literacy. They also present a novel learning tool, which could be used to improve field teaching of

100 species identification skills although whether they are a more effective learning tool compared with

101 more traditional methods remains unknown.

102 Here, we ask if the ability of students to identify bird species following three one-hour field sessions

103 was affected by the tools used to support teaching, in this case a traditional field guide and a

104 comparable mobile app. Furthermore, we asked if the use of mobile technology increased student

105 engagement with bird identification.

106 **Method**

107 *Participants*

108 Ninety-one undergraduate students from the University of Reading, UK, participated in the study (63

109 females; 28 males) in January-March 2013. All participants were enrolled in an introductory Part One

110 Ecology module and represented a variety of undergraduate disciplines, although most students were

111 undertaking BSc Zoology. It was explained to the students that participation was not compulsory, and

112 consent forms were completed by the students after the study had been explained (all students

113 consented to take part). The project was subject to ethical review, according to the procedures

114 specified by the University of Reading Ethics Committee and was formally approved.

115 *Procedure*

116 During the module, the students were divided into two groups (A and B) for practical lessons, with

117 each group getting three two-hour field-based sessions over a period of six weeks. Within the groups

118 A and B the students were divided into two further groups (A1, A2; B1, B2) with students in group 1

119 (n = 51) being allocated a traditional bird identification guide (Pocket Guide to British Birds, RSPB)

120 and students in group 2 (n = 40) being asked to download a bird identification app (Birds of Britain,

121   CleverMatrix Ltd) onto their own personal smartphone or tablet device. Twenty nine percent of the

122   students did not own their own personal smartphone and these students were automatically allocated

123   into group 1, and of the 71% who did own their own device 40 students were randomly allocated into

124   group 2 and the remainder were allocated to group 1.

125   In the field-based sessions the groups were further divided into four smaller groups where they were

126   allocated a demonstrator (to help them with bird identification) and each student spent one hour in the

127   field identifying the birds they came across, working in pairs or groups of three. The demonstrator

128   was allowed to aid in identification, but they were instructed to not give the answer straight away to

129   the student, but to instead encourage them to identify the species themselves using the book or app as

130   appropriate. The students were also asked to record weather conditions, each species encountered and

131   an estimate of the number seen, as well as any records of interesting behaviour (e.g. feeding, singing).

132   Following completion of the hour in the field, the students returned indoors, where any unidentified

133   bird species were discussed with the demonstrators.

134   *Bird identification skills*

135   To get a baseline of existing knowledge of each student's ability to identify common UK bird species

136   all students were asked to complete an initial spots test (hereafter known as spots test one). The spots

137   test was undertaken under exam conditions and consisted of individual PowerPoint slides showing

138   photographs of 30 species commonly found on the University campus. Each slide was shown for one

139   minute and each student independently wrote down the species common name if it was known to

140   them (they were not able to use an identification aid to help them). These were collected and each

141   student was given two marks out of a possible 30. The first mark was given if the student had given an

142   inaccurate but almost complete answer (e.g. if the student had written the word gull for the Black-

143   headed gull; hereafter known as the generous mark), the second mark was given if the student knew

144   the complete common name of the species (hereafter known as the harder mark). It was important to

145   distinguish the two marks as the first tests for a general knowledge of the species and the second tests

146   that the student had fully and correctly identified the species. The marking was completed by the same

147   individual to reduce bias. Neither mark contributed towards their overall module grade.

148   Following completion of the three field-based sessions, the students were asked to complete a second

149   spots test (hereafter known as spots test two). This test followed the same format as spots test one,

150   although different species and/or photographs were used, and the students were not able to use any

151   aids as before. The students were again given two sets of marks (generous and harder marks) for each

152   of the 30 species, the marking was completed by the same individual as before and the marks did not

153   contribute towards their overall module grade. A third spots test (hereafter known as the video spots

154   test) was used to test the students' ability to identify bird species that they would likely not have

155   encountered before and was carried out following spots test two. In this test, six videos were shown

156 twice for one minute. The students were told that they were allowed to use their identification aid

157 (either the book or smartphone app, depending on their group) to help them identify the species.

158 *Questionnaires*

159 Each student was asked to complete a questionnaire before the experiment began (hereafter known as

160 questionnaire one). The questions were designed to ask the students about ownership and use of

161 smartphone devices; their opinions about using smartphone technology in teaching; how the student

162 judged their interest in field biology and wild birds; and how the student rated their bird identification

163 skills. A second questionnaire was used following completion of the three field-based sessions, one

164 version for the students who had used the traditional bird identification guide and another for the

165 students who has used the smartphone app (hereafter known as questionnaire 2a and 2b respectively).

166 Each questionnaire used a 5 point Likert Scale and was subject to ethical review, according to the

167 procedures specified by the University of Reading Ethics Committee, and was formally approved.

168 *Data analysis*

169 In all cases data were tested for normality and where appropriate parametric tests were performed. All

170 analyses were carried out using Minitab (Minitab 17 Statistical Software 2010). To compare the

171 differences in bird identification knowledge in all students, between the pre and post field-based

172 sessions, paired t-tests were used. To compare the differences in learning between the app and book

173 groups, two-sample t-tests were used. Mann-Whitney tests were used to compare the change of

174 opinions in the questionnaires (Questionnaire 1 and 2a or 2b) between the pre and post field-based

175 sessions and between the app and book groups.

176 **Results**

177 *Bird identification skills*

178 There was a significant improvement in total number of birds identified between spots tests one (ST1)

179 and two (ST2) for the harsher mark ($t_{90} = 13.73$, $p < 0.001$, mean ST1 = 9.7, mean ST2 = 15.6; Figure

180 1) and the generous mark ($t_{90} = 12.44$, $p < 0.001$, mean ST1 = 15.6, mean ST2 = 20.7; Figure 1). No

181 significant differences were found between the groups of students using the app or book measured

182 with the harsher mark ($t_{88} = 1.18$, $p = 0.24$) or the generous mark ($t_{86} = 1.41$, $p = 0.16$). In the video

183 spots test, there was no significant difference in the ability of students to identify unfamiliar birds

184 between the app or book groups ($t_{80} = 1.68$, $p = 0.1$), although when students who had correctly

185 identified over 20 species in spots test one with the hasher mark were removed (n = 9), the students

186 from the book group were able to identify significantly more birds than students with the app ($t_{74} =$

187 2.02, $p = 0.047$, mean app = 2.49, mean book = 3.11; Figure 2).

188 *Questionnaires*

189   Ninety one percent of students considered themselves to be interested in field biology, 70% were

190   interested in wild birds and 23% of students watched birds on a daily or weekly basis. Only 12.5% of

191   students rated their ability to identify UK bird species as good or excellent. Seventy one percent of

192   students owned a smartphone, with only 14% having used it formally and 65% having used it

193   informally in classes. In week one 70% of students thought that using a smartphone in teaching and

194   learning was a good idea, and there was no significant change of opinion between week one and seven

195   between the students in the book and app groups ($w_{40, 51} = 1962.5$, $p = 0.290$). Seventy four percent of

196   students would be happy to use their own smartphone for fieldwork when asked in week one and there

197   was no significant change of opinion between week one and seven between the students in the book

198   and app groups ($w_{40, 40} = 1659.5$, $p = 0.677$).

Discussion

200   Over the course of the three field-based sessions the students' ability to identify common bird species

201   increased significantly, although no differences were found between the students who has been using

202   the bird identification book or those using the mobile app downloaded to their smartphone device.

203   Before the field-based sessions, students on average were able to identify ten species of common UK

204   birds (out of a possible 30) and at the end this has increased to 16 species. When asked to identify

205   previously unknown bird species, using a video spots test (and having removed those students who

206   already had good bird identification skills) and either the bird identification book or the mobile app,

207   students were more likely to correctly identify the species with the field guide. This is likely due to

208   the relative ease of skimming through the book rather than searching through the smartphone app.

209   While nearly all of the students (91%) considered themselves to be interested in field biology and

210   many (70%) considered themselves to be interested in wild birds, this did not translate into an active

211   interest for many. When they were asked whether they watched birds on a daily or weekly basis, only

212   23% of students actually actively watched birds on a regular basis. This figure matches well with our

213   findings of the actual ability of the students to identify common UK bird species (using the spots

214   tests) and unless rectified would contribute to the lack of identification skills among UK graduates of

215   relevant disciplines (Leather and Quicke 2009; IEEM 2011a; IEEM 2011b).

216   Graduate employability is an important element of many higher education league tables and

217   something which universities will constantly strive to improve. It has been suggested that few

218   graduates have the identification skills to be employable in the ecological sector without further

219   training (Warren 2015), and although this has been disputed, it is acknowledged that there is still an

220   important skills gap. Using smartphone devices with identification apps could be a useful way of

221   engaging students outside of formal teaching opportunities, as many students here reported that they

222   had begun using their apps more regularly outside of classes, whereas none of the students with the

223   identification books reported using them outside of the standard teaching time. This is likely due to

224 the accessibility of the students' smartphone devices and that they were unlikely to carry their

225 identification book with them. One student commented 'I feel that the app was very helpful in

226 identifying birds, mainly for the fact that I would always have my phone with me so it was convenient

227 when I found a bird I didn't recognise to look it up'. Other students still had a preference for the book

228 arguing that it was more challenging which helped them to learn more, 'I was part of the book group

229 and find this also helped my score to increase. This is because you have to really look and remember

230 specific details on the birds in order to identify them in the book. It takes longer and is harder I feel

231 than the app'.

232 It is important to note that allocation of students to smartphone user/non-smartphone user was not

233 random, for two reasons. First, logistically, it would have been exceptionally difficult to purchase

234 sufficient smartphones for a highly replicated, randomised trial. Second, and more important, every

235 student will be familiar with using books, while not every student will be familiar with using a given

236 smartphone/operating system. Here, we assume that students who own smartphones are proficient at

237 using them, and also at using smartphone apps. If we allocated non-smartphone using students to the

238 smartphone using group, then we would expect that we would in essence be testing the difference in

239 ability to develop a competency in using the device and app, rather than the ability to use an app or

240 book to identify birds. Given the near ubiquity of smartphones among the 16-24 age group (currently

241 90% in the UK; Ofcom 2015), the relative educational similarities of the cohort tested and the

242 outcome of the initial test, we see no strong reason to assume *a priori* differences between our

243 experimental groups.

244 A large number of our students owned their own smartphone devices (71%); these figures are similar

245 to those found by Welsh and France (2012), where in 2012 they found that 70% of their students

246 owned smartphones. They suggest that educators should encourage smartphone use in the field to aid

247 students learning (Welsh and France 2012). Although very few of our students have used their

248 smartphones formally in their teaching (14%), many more have used it informally (65%) to access

249 information during lectures for example and they feel positively about using their own devices in class

250 (70%) and in field classes (74%). Increasing smartphone use in teaching has many benefits when used

251 alongside face-to-face teaching, such as improving digital literacy skills (Woodcock et al. 2012), but it

252 also comes with its own challenges as not all students own their own device. Here we used a 'bring

253 your own device' policy, but if apps were to be used more formally and consistently in our teaching

254 we would need to make devices available for those students who do not own them. This could present

255 a challenge for some higher education institutions, but this will undoubtedly change over time.

Conclusions

257 The growth of mobile, smart devices has resulted in the suggestion that this may provide a new

258 opportunity to engage students in active learning. However, we found no differences between student

groups tasked with improving their bird identification skills between those using traditional (field guide) and new (mobile app) approaches. Indeed, once we excluded individuals who started the class already possessing strong bird identification skills (nine individuals), those who used the field guide were more likely to correctly identify novel species, suggesting that in this situation at least, traditional technology provides a superior support to learning. Nevertheless, mobile devices offered more opportunities for students to engage with the subject outside of the allocated teaching time, due to their general portability and accessibility. Field-based learning is an important method for teaching environmental bioscience students species identification skills, and utilising mobile smartphone devices and apps is a novel approach to doing this. Here, students were both happy to use their own devices and more generally were supportive of using their own smartphone devices in their learning. Smartphones and other mobile devices offer a positive way to enhance field-based learning, with the ever increasing development of apps for species identification and recording, note-taking, geo-tagging, as well as others to enhance teaching and learning in the field.

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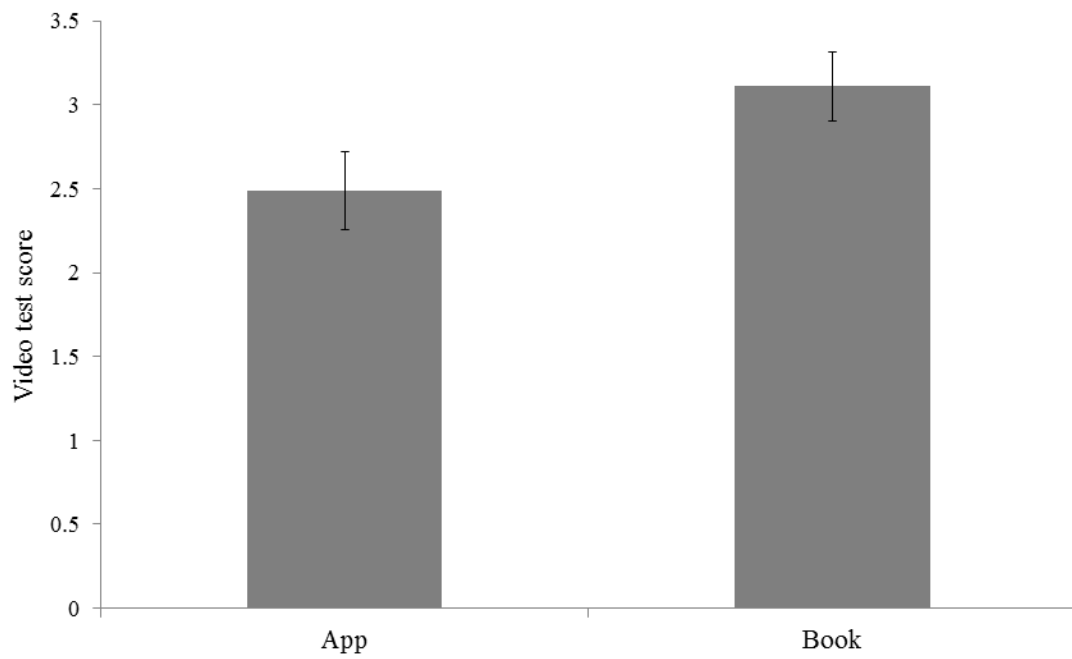355 Student Engagement and Experience Journal, 1(1).
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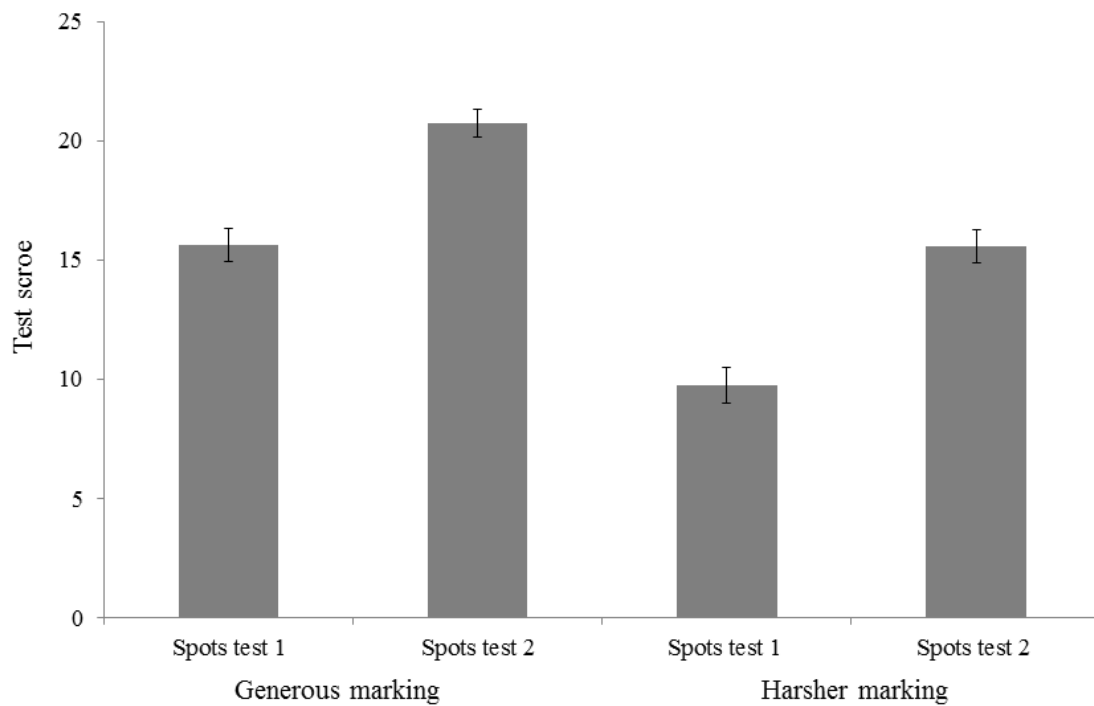
Figures

359 Figure 1: Mean number of birds identified (out of a possible 30) in the first and second spots
360 test in the generous and harsher marking for all of the students (±S.E.).

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Figure 2: Mean number of correctly identified (out of a possible 6) 'un-encountered' birds
during the video spots test, when the students with good bird identification skills (n = 9) were
removed from the analysis (±S.E.).

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