Proposing Problem-Based Learning for teaching future forensic speech scientists

Abstract

In the last 10-15 years, Masters programmes and undergraduate modules have emerged in the UK that teach forensic speech science. Forensic speech science is the forensic subdiscipline concerned with analysing speech recordings, such as telephone calls of unknown speakers, when they arise as evidence. In order to answer questions surrounding the identity of the speakers in these recordings, forensic speech analysts draw on their expertise in phonetics and acoustics. Even though existing UK forensic speech science programmes do not claim to train students to a level where they are in a position to carry out real-life forensic casework, a proportion of the graduates from these programmes do go on to fill discipline-specific roles in security organisations or for private providers of forensic speech analysis. It is therefore surely in the community's interests to review educational approaches to capitalise on the current training opportunities. This paper specifically proposes to explore the potential of a Problem-Based Learning (PBL) approach to forensic speech science teaching. PBL is a student-centred learning approach that heavily relies on the students' independence in the solving of ill-structured problems. PBL has shown to be beneficial to programmes that directly lead on to discipline-specific professional roles, and has even become the standardised teaching approach in some of those areas (medicine being the flagship example). Given its reported success in other disciplines, the question arises as to whether PBL could bring similar benefits to prospective forensic speech practitioners and to forensic speech science as a whole.

Keywords: Problem-Based Learning, forensic speech science, higher education, problem design

1. Introduction

Forensic speech analysis may be deployed when a speech recording (often an incriminating telephone call) arises as evidence in a legal case or investigation. Usually, the objective of a forensic speech analysis is to answer questions around the identity or non-identity of speakers in different recordings by evaluating their voice and speech features – this is known as *forensic speaker comparison*. As a relatively young field, forensic speech science has been incorporated into UK Higher Education in the last 10-15 years, in the form of Masters programmes and undergraduate modules. These programmes are not "vocational" in the sense that a medicine degree or the Bar Training Course is, in that it is not generally expected that someone studying forensic speech science goes on to be a forensic speech practitioner. To their credit, existing forensic speech science programmes do not claim to train students to a level where they are in a position to carry out real-life forensic casework. It is also recognised that such programmes equip students with numerous analytical and transferable skills to carry out other kinds of work. Nevertheless, when engaging with the forensic speech science field, it

soon becomes apparent that a proportion of graduates from these programmes do go on to fill forensic speech analysis roles and so it is surely in the forensic speech science community's interests to entertain a full range of educational approaches that could optimise existing training opportunities. Through conversations with relevant stakeholders, it is clear that there is a rather heavy burden on the employers of newly recruited forensic speech analysts to invest in the in-house training required to bring graduates to a level where they are "casework-ready". This is of particular relevance to "niche" areas of forensic science (like forensic speech science) where providers are typically small and therefore have limited resources to invest into the training required. This, in a way, can prevent providers from growing and meeting demand, illustrating the importance of making the most of existing training programmes.

Recently, there has been further motivation to actively review and explore educational approaches that forensic speech analysts receive. In September 2020, the *International Association for Forensic Phonetics and Acoustics* (IAFPA) revised its Code of Practice, to which active members working in casework roles are expected to adhere. One of the new additions to the Code of Practice, encapsulated in section 2.2, states that:

> *Members must be suitably qualified and experienced to carry out the specific type of casework they are undertaking. This may be achieved through a combination of experience, education and method-specific training.*

This overt focus on forensic speech practitioners' training and experience is another reason to think further about which teaching approaches might be the most fruitful in forensic speech science programmes.

Research has repeatedly shown the educational benefits that result from Problem-Based Learning (PBL) [1], and this is reflected in its standardised use in certain professional training programmes (particularly within medicine and engineering). The current paper speculates about whether it could have a place in forensic speech science education. In short, PBL is a student-led teaching and learning approach where students are presented with ill-structured problems to solve. This contrasts with the author's own current teaching of forensic speech science in a UK university, where a rather traditional tutor-led approach is adopted. Within this approach, lectures are delivered and followed by practical tasks which have been carefully designed to accompany the lecture content. The students being taught typically have some previous undergraduate training in phonetics. Although some of the practical tasks may be presented as problems, and therefore incorporate an element of problem solving, the overall package of teaching is not an example of PBL as there is too much teacher-directed input into the programme. It is suspected that there is relatively little PBL currently embedded in forensic

72 speech science curricula on a broader scale, but as the present paper is one of very few exchanges on
73 teaching and learning in forensic speech science, it cannot be said for certain.
74
75 PBL is thought to bring about a deeper understanding of a topic, longer retention of information, and
76 positive lifelong learning habits in individuals [2]. The current paper therefore has two key objectives.
77 First, it aims to further justify exploring PBL as an appropriate educational approach to implement in
78 forensic speech science programmes. However, it can be difficult to determine what a PBL approach
79 would look like in new disciplines that have not previously implemented PBL. This is because one
80 disadvantage of the PBL literature is that it is difficult to extract details about the types of problems
81 that have been used in PBL studies or in other disciplines [3]. The paper's second objective is
82 therefore to propose the problems that could be used as the "centrepieces" of a PBL forensic speech
83 science programme.
84

85 **2. Problem-Based Learning**

86 Problem-Based Learning (PBL) is a student-centred learning approach that, according to Dolmans in
87 [3], generally carries the following characteristics:
88 • learning in small groups;
89 • a teacher is facilitating learning in the group;
90 • learning takes place by means of problems that are first discussed in the group;
91 • learning by means of self-study, which is followed by a discussion.
92
93 Dolmans follows this characterisation by summarising PBL in the following way [3, p.215]:
94
95 *"The problem is the trigger for students' learning, for raising questions, searching for*
96 *information and for self-study, and the ultimate aim is to better understand the problem."*
97
98 It is thought that the learning happens as a result of students adopting a greater degree of
99 independence to solve "ill-structured" problems. This contrasts with other more traditional teaching
100 and learning approaches that place a greater degree of responsibility on the teacher to structure and
101 convey information and skills. Indeed, more traditional approaches may include some problems for
102 students to solve (in the form of practical tasks in seminars, for example), but these are often
103 supportive tasks or have been preceded or accompanied by related content delivered through lectures
104 or other teacher-directed means. In contrast, the purest examples of PBL would erase the lectures and
105 other teacher-directed input and present the students with problems to solve from day one of the
106 programme. Students are then left to research and find the relevant information that will help them to

107 solve those problems, rather than be provided with the relevant information by a teacher. It is thought

108 that by learning through a PBL approach, learners more effectively gain *epistemological* and

109 *phenomenological* knowledge (i.e. procedural and experiential knowledge) and [2, p.488] claim that

110 these are "richer, more meaningful and memorable representations" of knowledge. This idea is

111 supported by a breadth of research papers that largely report beneficial outcomes of PBL approaches

112 [1]. There is therefore a clear argument to explore whether PBL could benefit more disciplines.

113

114 Despite PBL's substantial history in some disciplines, implementing PBL undoubtedly comes with its

115 challenges. The following subsections unpack some of the key benefits, challenges and unknowns that

116 surround PBL in order to feed in to how it could be implemented to educate forensic speech science

117 students.

118

119 **2.1 The Benefits of Problem-Based Learning**

120 There are cognitive arguments in favour of introducing a problem-based approach to curricula. Three

121 key reasons that [4] offer are:

122   1. Superior acquisition of new material (because of previously activated knowledge structures to

123   which the new material connects)

124   2. Superior recall of new material (due to an increased number of cognitive retrieval paths)

125   3. Superior integration of new material with existing knowledge structures (leading to

126   restructuring and enhanced conceptual coherence).

127

128 These are cognitive effects that are suspected to result from PBL, but there are more measurable

129 effects of a learning approach that have been supported by educational research. We can distinguish

130 between two types: *local effects* and *global effects* [4]. Local effects are those that are contained

131 within the curriculum (i.e. benefits to the learners' assessment performance). Global effects extend

132 beyond the PBL curriculum (e.g. development of long-term independent learning habits). It has been

133 suggested that PBL yields both beneficial local and global effects, including a positive effect on the

134 overall performance of learners, a positive effect on learners' self-perception and a positive effect on

135 the learners' lifelong learning habits. These key beneficial effects are expanded on below:

136

137 *2.1.1 Overall Performance*

138 [4] carried out a study on the education and performance of two large classes (over 60 students) of an

139 Executive MBA course at a business school. The researchers managed to control a number of

140 variables that are often uncontrolled in other similar studies. For example, the students in each class

141 were taught by the same experienced tutor. All students were already familiar with both broad types

142 of educational approach, i.e. the traditional lecture-based and problem-based teaching and learning

143 styles. The researchers selected two concepts from the syllabus to teach to the students; the concepts

144 were reasonably unrelated to one another and perfectly possible to teach via lecture-based or problem-

145 based approaches. [4] reported that students displayed better explanation capabilities of a concept

146 when they were taught through the PBL method, compared to when they were taught a concept

147 through a lecture-based method. Within meta-analyses of PBL studies (e.g. [1]), it seems that such

148 performance trends reported in [4] are commonly observed.

149

150 *2.1.2   Self-perception*

151 It is generally thought that PBL increases students' confidence in their own capabilities in a subject

152 area, and this is supported by various research studies across disciplines (e.g. [5] in the context of

153 nursing and [6] in the context of chemical engineering). There are also studies that report how the

154 self-confidence gained from PBL learning promotes more effective learning of course content [7].

155 Having said that, it is right to acknowledge that there are examples of studies that report a decrease in

156 confidence [8]. Confidence has an important role in the context of forensic science as analysts need to

157 be confident in their analysis and confident in presenting it (in court or otherwise). If PBL presents a

158 way to more effectively develop student confidence, then perhaps this is another argument to

159 introduce it to forensic science curricula.

160

161

162 *2.1.3 Lifelong learning*

163

164 One of the most commonly mentioned effects of PBL is its lasting impact on lifelong learning [2].

165 Studies have suggested that recipients of PBL approaches develop positive and proactive lifelong

166 learning habits, such as information-gathering skills and reasoning skills [9]. Like many other forensic

167 disciplines, forensic speech science is constantly evolving, and it is actively encouraged by regulatory

168 bodies to evolve, improve and update its methodologies. This places an expectation on forensic

169 speech analysts to continuously learn new knowledge and skills throughout their careers. Establishing

170 the lifelong learning habits that can be gained from PBL is therefore expected to benefit forensic

171 speech scientists going forward.

172

173 **2.2   The Challenges of Problem-Based Learning**

174 [10] provide a comprehensive account of the "tensions" that come with attempting to implement a

175 PBL approach. There are numerous practical challenges. Firstly, the role of the tutor within a PBL

176 approach is different from more traditional lecture-style approaches to teaching, and so there is some

177 reliance on the adaptability of tutors. Secondly, there are challenges that are associated with the
178 constraints that are often set by Higher Education institutions and the system in which they operate.
179 University modules and programmes are often bound by measurable learning objectives and outcomes
180 that are required by the institution. This raises a couple of issues: the first is that a certain quantity of
181 material is expected to be covered within a given timeframe, the second is that the students' learning
182 needs to be assessed. Both of these issues are arguably easier to control with the traditional lecture-
183 based approach and so it could be viewed as the "safer" option, despite the potential advantages to
184 trialling other types of approach.
185
186 Although these challenges do not make the adoption of PBL straightforward, they are not impossible
187 to overcome. There are examples, albeit rare, of entire universities that have now committed to PBL-
188 based teaching as the default educational approach, e.g., Maastricht University in the Netherlands[1].
189
190 There are also more inherent challenges attached to PBL including the fact that there are many
191 unknowns. In [3]'s discussion of the challenges that face upcoming PBL research, one of the key
192 issues they raise about existing studies on PBL is that there is often very little detail given on the
193 types of problems that the students are given to solve. That is understandable as PBL tends to be
194 implemented in Higher Education settings where, presumably, the problems are very high-level and
195 discipline-specific. For a more general audience interested in educational approaches, it would be
196 difficult to communicate the details of the problems and their relevance to the specific discipline.
197 Further, going into the level of detail that would be required to appreciate the relevant aspects of the
198 problem would deviate from the educational purpose of the papers. Having said this, [4] make a good
199 attempt at educating the reader on the two business management concepts the students in their study
200 were expected to learn. However, a lack of context and experience still impacts on our ability to take
201 inspiration from these studies because outsiders do not know which concepts are easy or difficult to
202 grasp. By presenting problem types to a forensic science audience, however, it is hoped that this paper
203 overcomes this issue because it is likely that the kinds of problems that are relevant to forensic speech
204 science are in some way shared by other forensic science disciplines.

205 *2.3   Problem types in Problem-Based Learning*

206 As the section above confirms, developing the problems that form the "centrepieces" of PBL curricula
207 is challenging as it is difficult to extrapolate information about the problems used in previous PBL
208 studies. To address this challenge, some researchers have put forward models of problem construction
209 for the purpose of PBL. [11] discusses the characteristics of a "good" problem in a PBL approach.
210 She talks about how the problem should capture the attention of students, include components that the
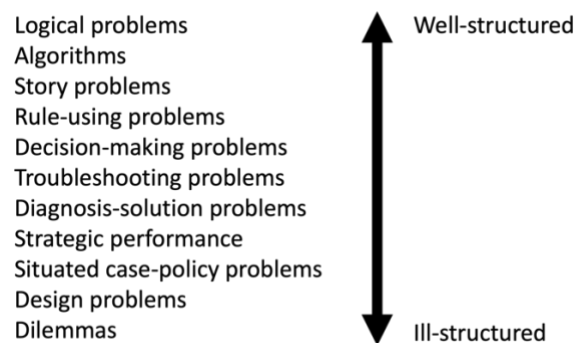
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[1] URL:https://www.maastrichtuniversity.nl/education/why-um/problem-based-learning

211 students do not necessarily have directly related knowledge about, and that there should be sufficient

212 complexity to the problem. She advises that the educator should link components of the problem to

213 the programme's learning objectives, and even make contact with individuals working in related

214 professional settings to help inspire authentic problems.

215

216 [11] also comments on the "structured-ness" of the problems, and there are many indications

217 elsewhere in the PBL literature that state that the problems presented to students are relatively "ill-

218 structured" [12]. It is difficult to grasp what "ill-structured" might mean for different disciplines.

219 Shedding a little more light on what constitutes an ill-structured problem, [13] put forward a model of

220 problem types on a spectrum of "structured-ness" in his consideration of problem-solving. Figure 1

221 below summarises [13]'s problem-solving model:

222

Logical problems   ↑ Well-structured
Algorithms
Story problems
Rule-using problems
Decision-making problems
Troubleshooting problems
Diagnosis-solution problems
Strategic performance
Situated case-policy problems
Design problems
Dilemmas   ↓ Ill-structured

223

224

225

226 **Figure 1:** Summary of [13]'s spectrum of problem-solving.

227

228 The spectrum ranges from 'logical' and 'algorithm' problems that are expected to require already-

229 learned rules to solve, all the way to 'dilemmas', which hold a great deal of complexity and may not

230 even have a solution to them at all. There are, of course, more considerations involved in problem

231 design than this spectrum of structured-ness, but this acts as one useful framework when considering

232 PBL problems for a discipline for the first time.

233

234 [14] made an active attempt to address the challenges around designing problems for PBL and put

235 forward the *3C3R Model*. He made the case that the success of a PBL programme is largely dependent

236 on the quality of the problem, and so a structured approach to designing problems is warranted.

237 Unpacking this model, '3C' refers to *content*, *context* and *connection*, while '3R' refers to

238 *researching*, *reasoning* and *reflecting*. The 3C components of the model guide us to including the

239 relevant knowledge components of a problem, while the 3R parts of the model allow us to engage

240 with the processing components of the problem (i.e. key processes that learners undergo in problem-

241 solving). Bringing all of the components together can guide us to design and develop rich and

242 successful problems for the purpose of a PBL programme.

243

244 While [14] brings a framework and some welcome guidance to educators to assist with designing

245 PBL problems, the guidance is still generic, and it is recognised that different disciplines have

246 different needs. The following section therefore applies some of the general education guidance and

247 models that have been put forward in relation to problem design for PBL to the forensic speech

248 science setting.

249

250 **3   Implementing Problem-Based Learning in Forensic Speech Science**

251 There is remarkably little in the PBL literature that confirms whether and how PBL approaches are

252 implemented in forensic science curricula of any kind. That is not to say that PBL is not being

253 implemented at all. [15] is one of the few reported examples of how PBL can be implemented within

254 a forensic discipline. In this case, the authors identified a part of the process that is typical of digital

255 forensics casework, but which is not typically taught in digital forensics curricula, i.e., the retrieval of

256 digital evidence from a crime scene. The fact that it is often not taught in digital forensics courses was

257 attributed to the impracticalities attached to teaching it (little or no access to crime scenes, etc.). The

258 authors demonstrated how PBL was able to fill an existing gap in the digital forensics curriculum and

259 reported positive effects overall in implementing it. However, importantly, [15] did not implement

260 PBL in order to replace teaching; PBL was implemented where teaching did not exist in the first

261 place. For forensic speech science, rather than filling an existing gap in the course content, this paper

262 suggests considering embedding PBL into the core content that is already taught through more

263 traditional means, so as to possibly improve the training and longer-term learning behaviours of future

264 forensic speech analysts. A key element of implementing a PBL approach will be to design high-

265 quality problems to form the foundations of PBL units. The following subsections therefore consider

266 the types of problems that could shape a forensic speech science curriculum

267 *3.1   Proposing problem types in forensic speech science*

268 Using [13]'s spectrum of problem "structured-ness" as a framework (see Figure 1), Figure 2

269 illustrates a range of problem types that could be embedded within a forensic speech science

270 curriculum. The spectrum captures *analysis-focused problems* (i.e. problems that are influenced by

271 key analytical tasks that forensic speech practitioners are asked to carry out) as well as

272   *communication-focused problems* (i.e. problems that are influenced by the kinds of communications

273   that forensic speech practitioners – and other forensic practitioners - regularly have to engage in)[2].
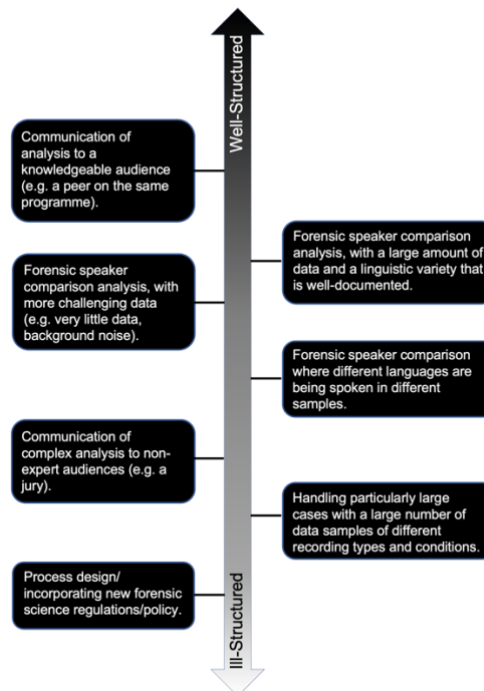
274

275

276   **Figure 2:** Spectrum of problem types that could be embedded within a forensic speech science

277   curriculum, largely influenced by [13]'s spectrum illustrated in Figure 1.

278

279   The "structured-ness" of a problem can be determined by different factors. In the context of the

280   *analysis-focused problems* in forensic speech science, it is suggested here that the following factors,

281   among others, will contribute to a problem's structured-ness:

282   • quantity and quality of speech data to work with;

283   • familiarity with the language varieties involved in a case;

284   • amount of literature available on the speech data types.

285   One of the more unusual analysis-focused problems that has been placed relatively far down the

286   spectrum is 'Handling particularly large cases…'. While at first it may seem that this sort of problem

287   is just a case of carrying out a larger amount of the same work and problem-solving of smaller cases,

288   there are additional factors to consider which make problems attached to these large cases more

289   complex. One multifaceted issue is resource. Often, instructing parties have budget constraints which

290   can mean that some selection may be required. This would involve trading off significance of samples

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[2] For the purposes of this initial demonstration, emphasis has been placed on *forensic speaker comparison*, as this is the most common type of analysis task, but other forensic speech science activities could be added to the spectrum.

291 to a case and the quality of the samples for analysis. There is also the issue of practitioner availability.
292 With forensic speech science being such a niche area, it is not uncommon for the current forensic
293 speech analysis provisions to be unable to accommodate cases in the time required by instructing
294 parties. This is a particular issue for larger cases with a larger amount of data samples and would
295 require a solution to be found. These sorts of considerations could be embedded into a problem to
296 expose students to these practical issues.
297
298 In the context of *communication-focused problems*, factors that determine a problem's structuredness
299 include:
300   •   audience (e.g. expert vs. non-expert);
301   •   complexity of the analysis or issue being communicated.

302 Communicating a complex analysis to non-expert audiences is placed relatively far down the
303 spectrum. This is because a deep and comprehensive understanding of the relevant topic areas is
304 required in the first instance, and then it requires the development effective ways to then appropriately
305 and accurately communicate that understanding to non-experts.
306
307 There is also a type of problem on the spectrum that is not necessarily immediately associated with
308 day-to-day forensic casework. However, it is important to the context under which forensic speech
309 science casework is undertaken and is also relevant to a range of different forensic disciplines. This
310 problem type is about designing processes and protocols (possibly in response to new guidance and
311 recommendations released by forensic regulatory bodies). This problem type is placed far along the
312 spectrum because it is expected that a high level of discipline-specific knowledge and deep
313 understanding of the context is required to execute it well. It could be argued that this is a problem
314 type that is inherently ill-structured because process design usually requires developing something
315 that has not been developed before, therefore there is not necessarily a template to follow and so some
316 creativity and decision-making tend to be required. There is a connection here with what [16] call
317 "policy-making problems", which they point out are a high-level problem type that requires a
318 particularly deep understanding of the topic area and a comprehensive understanding of the
319 stakeholders involved.
320
321 ### *3.2   Example problems for teaching forensic speech science*
322 This section aims to provide more specific ideas as to how problems in forensic speech science
323 curricula could unfold. As explained in Section 3.1 above, many of the problems relevant to forensic
324 speech analysis can fall into one of two categories, *analysis-focused problems* and *communication-*
325 *focused problems*. The subsections that follow provide ideas within each of these categories.
326

327 *3.2.1 Analysis-focused problems*

328 Analysis-focused problems reflect key forensic speech analysis tasks that a practitioner would

329 typically be asked to carry out. The following problem outlines are therefore guided by these tasks.

330 Suggestions are given for well-structured and ill-structured problems for each task type.

331

332 *A1: Forensic Speaker Comparison*

333 **Task:** Students would be given two speech recordings (e.g. a telephone call of an unknown speaker

334 and the recording of a suspect in a police interview). The objective of the problem would be for

335 students to produce a conclusion that can be used to address whether the two recordings feature the

336 same or different speakers. In the true spirit of PBL, students would not be given any guidance of how

337 to pursue the problem at this stage. Although writing a report to represent this analysis is also part of

338 everyday forensic speaker comparison casework, it is not suggested that this forms a part of the

339 forensic speaker comparison problem, but instead forms a completely separate problem (see

340 *communication-focused problems* below).

341

342 **Materials for a well-structured problem:** Manufactured recordings that could be used for this

343 purpose can be found in publicly available corpora such as the DyViS corpus [17] and the WYRED

344 corpus [18][3]. The advantages of using recordings from these corpora are that they provide many

345 minutes of good quality speech, which enables students to access a wide range of speech features to

346 analyse, and the ground truth is known, i.e. we know which speech belongs to which speaker which is

347 helpful information to have after the analysis has been carried out. Data of this type lend themselves

348 to a more introductory stage of a curriculum.

349

350 **Materials for an ill-structured problem:** To form a more ill-structured forensic speaker comparison

351 problem, the data used could be selected or altered to introduce further limitations to the analysis. For

352 example, recordings can be shortened to form very brief speech samples which would naturally

353 reduce the number of features that can be analysed. Likewise, recordings can be selected to introduce

354 poorer-quality recordings (with lots of background noise, for example) – this would similarly limit the

355 analysis that is possible on such recordings.

356

357 **Follow-up discussion:** The group discussion that follows the problem-solving activity should contain

358 conversation around any preparation or screening of the recordings that the students undertook, the

359 speech features the students analysed and how they did so (allowing for students to compare their

360 approaches), their overall conclusions, and any problems they encountered.

361

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[3] These are corpora that contain the speech of male speakers of different varieties of British English.

362 *A2: Speaker profiling*

363 **Task:** Students would be presented with a single speech recording of a speaker, and the objective

364 would be to offer an account of different properties of the speaker (e.g., an idea of the speaker's

365 regional background)[4].

366

367 **Materials for a well-structured problem:** A range of publicly available databases of speech

368 recordings could be used for this purpose, ideally those that provide reliable metadata about the

369 speakers that could be used as "ground-truth" information later on. Those that were mentioned above

370 in *A1* could be used, but there is a broader range available that could be used for this purpose (as a

371 second recording is not necessary for a speaker profiling problem). For a more well-structured

372 problem, like in *A1*, the speech recordings chosen could be more advantageous (in terms of length and

373 quality of recording, for example). Additionally, the speaker selected could have a range of features

374 that place that speaker in a specific category (e.g. many speech features that would point towards a

375 specific regional background).

376

377 **Materials for an ill-structured problem:** More challenging recordings could be selected or created

378 for a more ill-structured speaker profiling problem (e.g. briefer recordings or recordings with

379 background noise). The speaker selected could also have fewer features that necessarily point towards

380 a distinctive speaker category, or perhaps even multiple linguistic influences that have resulted in an

381 unusual range of speech features.

382

383 **Follow-up discussion:** The discussion should allow the students to exchange the thoughts they had

384 about the recordings and how they went about justifying what speaker properties they can

385 comfortably offer. Importantly for this problem type, the discussion in the more ill-structured task

386 should, and is likely to, reveal how little information can be offered about a speaker, or how broad the

387 claims often have to be regarding regional and social categories of a speaker.

388

389

390 *A3: Transcription*

391 **Task:** Students will be asked to transcribe the speech in a poor-quality recording.

392

393 **Materials for a well-structured problem:** It is likely that the tutor will need to create a poor-quality

394 recording of some speech (e.g. a spoken interaction in a noisy environment or at a distance from the

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[4] These sorts of speech analysis tasks can be useful in investigative contexts where a suspect has not yet been
proposed.

395 microphone). The tutor will need to make a subjective assessment regarding how challenging a
396 recording is to transcribe.

397

398 **Materials for an ill-structured problem:** In the scenario of the more ill-structured problem, students
399 will form groups of two or three, and, in addition to the recording to transcribe, one of the students in
400 the group will be emailed a mock police transcript. The mock police transcript may well contain
401 errors. This problem will allow the students to think more carefully about suitable transcription
402 processes. Emailing only one student in the group will give the students the opportunity to come up
403 with an overall strategy they feel might manage possible effects of bias.

404

405 **Follow-up discussion:** This should be an exchange about challenges encountered and overall process.
406 Perhaps some student groups are more confident proposing transcriptions than others. Perhaps some
407 groups adopted a sense of level of confidence for the different parts of the transcription. A discussion
408 around the presentation of the transcript would also be appropriate (i.e. were there things that the
409 students chose to exclude from the transcript?). In the context of the ill-structured problem, there
410 should be a discussion around the overall process (i.e. did the students keep at least on member of the
411 group "blind" from the police transcript to allow for a completely fresh attempt that is independent of
412 the police transcript?).

413

414 *3.2.2 Communication-focused problems*
415 A significant part of a forensic speech analyst's work is communicating the analysis and conclusions
416 effectively. There are numerous scenarios in which a forensic speech analyst encounters a challenging
417 instance of communication and it is therefore proposed that these sorts of instances feed into the
418 problems that feature in a forensic speech science curriculum. This subsection offers just two initial
419 problem ideas:

420

421 *C1: Report writing*
422 **Task:** Students would be asked to write a report that reflects the forensic speech analysis of a mock
423 case recording and overall conclusion.

424

425 **Problem materials:** This would require students to have already carried out an analysis (perhaps,
426 most sensibly, from already carrying out a problem from *A1*, *A2* or *A3* above). It would also require
427 the relevant requirements of expert witness reporting. In the UK context, for example, there are
428 Criminal Procedure Rules (CrimPR 19.3(3) and 19.4) that experts must adhere to when preparing a
429 report. It would therefore be fitting to provide students with a copy of these so they can be taken into
430 account when preparing their reports.

431

432 **Follow-up discussion:** The discussions would involve the exchange of reports between students,

433 allowing for peer-to-peer feedback as well as a fuller group discussion about what is good and bad

434 practice in report writing for this specific purpose.

435

436 *C2: Responding to an email from instructing party*

437 **Task:** Students would be sent a mock email from their instructing party which might be asking for

438 further explanation or clarification. The students' task would be to respond appropriately. This is to

439 reflect the kinds of email that a forensic speech analyst can regularly receive.

440

441 **Problem materials:** The tutor would need to devise such mock emails to send to the students. Below

442 is an example of an email that could be sent for a student to respond to:

443

444 *Dear [student's name]*

445

446 *Thank you very much for your report. I note that your overall conclusion states that there is*

447 *"moderately strong support for the view that it is the same speaker". Does this mean that it is Joe*

448 *Bloggs speaking in the phone call?*

449

450 *Best wishes,*

451 *Fred*

452

453 Perhaps in some sessions, the tutor could send different emails (containing different types of query) to

454 different students which would set up a varied discussion. Other email ideas could include an enquiry

455 from a defence solicitor who states that they require an expert who can confidently point out the flaws

456 in an analysis carried out by another expert.

457

458 **Follow-up discussion:** If the above example email were used as the problem centrepiece, there

459 should be a discussion that facilitates the understanding of a conclusion scale that can be used for

460 forensic speaker comparison. One point would be that the conclusion leaves room for the possibility

461 that it could be different speakers speaking in the recordings. The other related point is that voice

462 evidence is regularly combined with other evidence, and there is a possibility that other evidence may

463 well contradict the direction of the voice evidence.

464

3.3 Questions arising from exploring Problem-Based Learning in Forensic Speech Science

While this paper has aimed to shed some light on the potential contents of a PBL forensic speech science programme, there is still plenty that requires thought. PBL is usually considered as being carried out in small groups [3]. That is not to say that PBL is exclusively carried out in groups, and it is not to say that many of the benefits cannot be gained from an individual going about solving a problem. It is difficult to ascertain whether a PBL approach should be implemented as group tasks or individual tasks in the context of forensic speech science. Reflecting on how this relates to practice, some forensic speech scientists do operate as a group, and some as individuals (some as sole practitioners). It is likely, however, that those who work within a team would benefit from individual problem-solving skills, especially since forensic speech analysis reports tend to have a "main" author, rather being a more collaboratively written piece. Weighing up whether the problems should be solved as a group or as individuals warrants further consideration, or even a discipline-specific study, but a first consideration of these factors would suggest that a combination of individual and group problems would be appropriate.

Another question that has arisen from this exploration concerns the benefits to be gained from students working on "authentic" problems. Authentic problems are likely to more effectively engage students, and they are also more likely to better-prepare students for discipline-specific employment. Creating authentic problems would be helped by using real forensic speech casework data in the problems presented to students. However, accessing real forensic speech casework data for teaching purposes has been a challenge for educators. It is still unclear, from a data protection point of view, whether real forensic speech analysis casework material can be brought into educational contexts. [19] carried out a detailed exploration of the issues that surround the storage and use of real forensic speech recordings and what measures might need to be put in place in order to use these sensitive recordings for research and teaching purposes. However, there is still a lack of clarity around what is required to enable the sharing of data between practitioners, researchers and educators.

4   Conclusion

While acknowledging the challenges that would be involved in bringing PBL to forensic speech science curricula, it is quite clear that there are possible benefits to be gained. It could be a way to boost the employability of forensic speech science students (and subsequently benefit their prospective employers and wider causes). To help to formulate PBL curricula, this paper has applied a spectrum of problem "structured-ness" and also offered some outlines of the kinds of problems that could be included in a forensic speech science programme.

In the Introduction, it was mentioned that graduates from existing forensic speech science programmes go into various roles including academia. In the context of graduates who go on to be academics in the field, it is not unreasonable to assume that a PBL-based education in the area would better-equip them to carry out more informed research and teaching. The knock-on effects of adopting more PBL in the forensic sciences could clearly have far-reaching benefits and is likely to be worth piloting in this context.

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