Evaluation of the quality of Science Education programmes that use Web 2.0 tools – an Anglo-Portuguese Research Project

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Abstract: Two of the 21st-century requirements are flexibility and transparency in European Higher Education as far as organisation, curriculum, teaching and learning methodologies are concerned. The evolution of Information and communication technologies (ICT) and its increasing accessibility have led several European Higher Education institutions to adopt constructivist approaches to teaching and learning, whereby students should be actively involved in their learning. This work is part of an Anglo-Portuguese research project, involving the University of Aveiro (Portugal) and Bradford College University Centre (UK) where the team worked collaboratively on the identification of evaluation criteria to assess teaching practices, which use Web 2.0 technologies on primary teacher education programmes. This was achieved by means of the conception, implementation and validation of a data collection instrument, a questionnaire, which was applied to trainee teachers and in-service primary teachers (Bradford and Aveiro respectively) at the end of their programmes. This paper will focus on some of the preliminary results concerning valuable insights related to the evaluation of the quality of Science Education programmes, which use pioneering methodologies for the professional development of trainee teachers and in-service primary teachers.

Keywords: evaluation of training programmes, innovative education, teacher professional development, Web 2.0 tools.

INTRODUCTION

The 21st-century brings novel challenges to universities. Many institutions are responding to the pressures imposed by such challenges by embracing new technologies. Technology has a vital role to play in the development of transferrable and specific skills. These include broadening access to education and personalizing the learning experience to adapt teaching to the unique needs of each learner. Many of today's students come with existing knowledge and skills in the digital world and ready acceptance of new technologies. Their expectations also differ as to how, where and when technology could be used within their course (Ugur, Akkoyunlu and Kurbanogly, 2009). However, the development of a more flexible work force, together with financial instabilities, enables a significant minority of students to enter training as a result of career change and whose experience of technologies is more limited.

The information explosion, demands of workplaces, easy access to technology, among other factors, have strengthened and encouraged moves to utilize technologies in classrooms. There is a growing need to explore efficiencies in terms of programme delivery and, the opportunities for

flexible delivery provided by technologies (Oliver and Short, 1996); the capacity of technology to provide support for customized educational programmes to meet the needs of individual learners (Kennedy and McNaught, 1997); and the growing use of the internet and Web 2.0 tools for information access and communication. Redecker (2008) suggests that the integration of e-learning platforms, Web 2.0 tools (i.e. blogs, podcasts) and mobile instruments (i.e. phones) in the teaching and learning process might improve students' learning in several subjects.

Universities are taking advantage of technology to enhance communication with their students to improve the quality of learning; therefore the evaluation of the teaching and learning process is important in terms of promoting quality within the programmes. Technological evolution and its increasing accessibility has led several European Higher Education (EHE) institutions to adopt constructivist approaches to teaching and learning methodologies, whereby students should be actively involved in this process. Although evaluation in education is not a new concern, it has been recently revised in cases where the potential of Web 2.0 tools can be fully explored in innovative educational contexts.

Recently, Portuguese Higher Education Institutions had to reorganize their teacher education programs based on the underlying principles of the Bologna process, such as flexibility, life long learning, mobility and the integration of information and communication technologies (González & Wagenaar, 2008). The UK also signed the Bologna agreement. The Higher Education Unit outlines the UK's position regarding the second cycle in relation to the integration of Masters level work with the Postgraduate Certificate in Education (PGCE). However this is presently a one year course, not two as is commonly found within Europe (Europe Unit, nd).

Bearing this context in mind, the proposed work will enable researchers from two EHE institutions, University of Aveiro (UA) and Bradford College (BC) to shed light on the quality of the teaching and learning programmes offered to science education teachers. The two institutions will develop, evaluate and compare two case studies in similar curricular areas related to primary science education in a postgraduate context. However the context of the two programmes is different in that UA is looking at in-service training whereas BC is looking at pre-service training. Specifically,

the team will explore innovative methodologies, such as the adoption of a blended learning context, using Web 2.0 technologies to encourage creativity and engagement of students. The strategies to be implemented will include available social Web tools such as wikis, blogs, RSS feeds, shared bookmarks and tag clouds.

The research aim of this project is to evaluate the quality of primary teacher education programmes in these two institutions, i.e. to evaluate how the use of innovative teacher and learning methodologies supported by Web 2.0 technologies can improve learning outcomes for postgraduate students in their professional development and training, as they teach pupils in the age range 4 to 11 years. These technologies will be used in novel and imaginative ways in order to harness the potential of the internet for the empowerment of both teachers and students, and to engage them in the teaching and learning process with a view to develop autonomous learning within the classroom.

The context – the Treaty of Windsor Anglo-Portuguese Joint Research Project

The first contact between the Portuguese and British partners took place in the context of European Projects, funded by the European Union, designed to provide in-service training to science teachers in the primary sector (7-13 age range). One of the projects was the European Teachers Professional Development for Science Teaching in a Web-based Environment (EuSTD 129455-CP-1-2006-1-PT-COMENIUS-C21). This project was based on the assumption that Virtual Learning Environments could be a vehicle for the professional development of science teachers. The Portuguese team was responsible for trialling the e-module "An introduction to the Assessment of Children's Learning in Primary Science", created in Bradford College (U.K.) involving Portuguese primary science teachers (Smith and Pombo, 2009).

Therefore, both institutions share a common focus on the professional development of teachers using innovative teacher education methodologies supported by Web 2.0 technologies. This mutual interest lead the team to apply for financial support under the Anglo-Portuguese Joint Research Programme. The project was approved, by a Joint Coordinating Committee

consisting of representatives of British research institutions and Portuguese universities and polytechnics, appointed by the British Council and the Portuguese Council of Rectors and the Coordinating Council of the Polytechnics respectively. The work started in April 2010 and will finish in one year's time.

METHODOLOGY

The work will follow a case study and it has an exploratory and descriptive nature. The method is mixed, using quantitative and qualitative techniques of data collection and analysis (Creswell, 2003). The study includes the following four steps:

1 – Selection of a curricular area within a postgraduate context, namely in a primary teacher education programme in both institutions;

In this step, an initial meeting took place at the University of Aveiro (UA) between 26th and 28th April 2010. The overview of the visit will be described below.

In this meeting the Portuguese team prepared a tour of the UA's Research Centre laboratories for different aspects of educational research including Evaluation of teaching courses, Portuguese and Foreign Languages, Math, and finally Science. The main aim was to present to the British team the research foci and interests of the Research Centre.

In the second day of the meeting, each team gave an overview of the course organization for the Primary teacher Education programs held in their institution. The "cases"/curricular areas related to science education which were involved in this research were presented.

Aveiro's team presented the guidelines that were put into practice in the curricular areas related to "Science Teaching Methodologies" and "ICT in Science Education" for their Masters degree in Science Education (postgraduate). The central focus of each curricular areas aimed at developing innovative pedagogical competences in ICT related to in-service primary teachers' professional lives, namely: (i) integrating ICT into science teaching practices; ii) promoting and exploring interaction practices when planning pedagogical activities (for formal and/or non-formal contexts); iii)

developing collaborative work; and iv) developing research competences (Guerra, Moreira & Vieira, 2010).

As already mentioned the Bradford context is that of the pre-service training of prospective primary teachers. This is a one year course at postgraduate level. The trainee teachers study a number of curricular areas to develop subject knowledge as well as appropriate pedagogies. The course makes extensive use of a Virtual Learning Environment (VLE) to support the students, as well as providing a conduit through which the students can share best practice.

Each partner highlighted the ICT content and ways in which trainee teachers and in-service primary teachers were encouraged to integrate appropriate uses of ICT into their classroom practice, in each curricular area. The partners offered some examples of where this is followed up specifically in science sessions. It also raised initial thoughts as to where the team envisaged the project moving forward and where they could make a contribution in terms of data collection. Some of this data may be used to support the development of the next steps of the project.

Finally, the Portuguese team introduced research which has already taken place to look at the use of evaluating Higher Education teaching and learning practices associated with bLearning in university settings.

2 – Identification of quality evaluation criteria of teaching practices, in order to develop a data collection instrument (questionnaire).

This step occurred on the third day of Aveiro's meeting (28th April 2010). The two teams worked collaboratively on the identification of criteria to evaluate the quality of teaching practices that integrate Web 2.0 technologies.

The defined evaluation criteria were: i) effective teaching; ii) impact on learning; iii) suggestions for improving future content of the curricular areas. A questionnaire was developed with the aim of collecting trainee teachers' and in-service primary teachers' perceptions regarding the above mentioned criteria. The instrument was divided into three sections and organized with open and closed questions. In the closed questions section a 4 point scale was used: 1- totally disagree and 4 - totally agree.

The objectives of the questionnaire were: i) to ascertain if current provision prepares trainee teachers or in-service primary teachers with appropriate and sufficient ICT subject knowledge and pedagogy; ii) to determine the contribution (impact) of the curricular area on the personal, social and professional development of the trainee teachers or in-service primary teachers; iii) to identify which aspects of current ICT provision best support trainee teachers or in-service primary teachers in their wider professional duties; iv) to determine the effectiveness of the web-based course management systems in supporting progress of the trainee teachers' or in-service primary teachers course of study; v) to inform course providers about the value of including Web 2.0 technologies within their ICT provision – e.g., blogs, wikis and cloud computing; vi) to determine which additional aspects of ICT should be included within the provision; vii) to identify aspects of the current provision that require modification.

A matrix was developed by the team linking the formulated objectives with core questions, common to both institutions In addition questions that were specific to each institution were presented to the relevant student cohort.

3 – Implementation of the questionnaires to be applied to the teacher educators and to their trainee teachers or in-service primary teachers at the end of the selected curricular areas;

The administration of the questionnaire at the UA occurred during the end of the second semester of 2010 (first week of June) and was answered by all in-service primary teachers (9) who attended the "Science Teaching methodology" curricular area of the Science Education Masters degree.

The questionnaire was given to the 86 Bradford trainee teachers' with 45 responding, during the second week of June. The questionnaire was disseminated through the VLE and completed electronically. This was followed by a group interview to clarify and extend the data harvested from the questionnaire. Lesson observations were also used to corroborate the data set.

4 – Analysis of the results from the questionnaires for each institution

According to previous studies (Pombo and Moreira, 2010, in press), evaluation should take place during the development of the tasks and not only at the end and should use more than one instrument allowing for triangulation of data. Therefore, each institution used more than one instrument allowing for triangulation of data. Also Felder and Brent (2004:1) state that "effective teaching evaluation is to collect data from multiple sources (triangulation), making sure that all education-related activities are rated by the people best qualified to rate them."

Regarding the teaching and learning evaluation process, each institution will triangulate the data obtained from the questionnaire with other data collected from other sources such as: i) digital portfolios developed by trainee teachers or in-service primary teachers during the semester, with self-reflections; ii) interactions within online forums between the participants (trainee teachers, in-service primary teachers and teacher trainers); and iii) interviews were conducted by the teacher trainers (only in the case of the Bradford context).

RESULTS

This section presents some of the preliminary analysis of the answers from the questionnaire by each institution. Table I represents a matrix which related the evaluation criteria, one questionnaire objective and the adopted question.

The first section of the questionnaire focused on the evaluation of the quality teaching provided by course tutors. These issues were related to curricular content, face-to-face and autonomous tasks and teacher trainers' performances.

Evaluation Criteria	Objective	Question
trainee teachers'/in-service primary teachers' perceptions regarding teaching provided by the course tutors	To ascertain if current provision prepares trainee teachers/in-service primary teachers with appropriate and sufficient ICT subject knowledge and pedagogy	Closed question example: "The ICT element was appropriate in relation to: duration of training programme"
Trainee teachers' and in-service primary teachers' perceptions regarding the impact on learning within the classroom	To determine the contribution (impact) of the curricular area for the personal, social and professional development of the trainee teachers/in-service primary teachers	Closed question example: "The strategies implemented in the ICT element allowed you to develop/improve activities in science teaching using ICT"
Trainee teachers'/in-service primary teachers' suggestions	To determine which additional aspects of ICT should be included within the provision	Open question example: "Are there any other aspects of ICT that you would like to see included in the course provision? Please list, and give a brief reason why"

One of the questions in this section aimed to ascertain if current provision prepares trainee teachers or in-service primary teachers with appropriate and sufficient ICT subject knowledge and pedagogy. In other words, it was intended to verify the effectiveness of guidelines of the curricular area adopted in both institutions.

100% of in-service primary teachers (9) in Aveiro considered that the guidelines regarding: skills to develop; programme content, tasks; support materials; learning assessments and the duration of the training programme were very relevant objectives themselves.

The high level of student satisfaction was mirrored in the Bradford study (n=45) where: 87% of respondents considered the ICT element appropriate in meeting their needs; 85% felt the programme content was appropriate; 93% felt that the use of the VLE was appropriate; 96% evaluated good levels of subject knowledge demonstrated by the ICT tutors; 84% thought the tutors modelled effective teaching practices. Additionally, 57% of Bradford's respondents commented that the duration of ICT teaching was appropriate with 53% of respondents indicating they would have benefited from more ICT specific sessions.

These results show that the majority of trainee teachers and in-service primary teachers were satisfied with the overall provision and with specific session content.

Regarding the second section of the questionnaire, it was intended to collect trainee teachers' and in-service primary teachers' perceptions about the impact on learning in the classroom throughout the training programme. In this section, questions were focused on the effectiveness of the strategies and the technological resources adopted to develop and improve the pedagogical and professional skills of the trainee teachers and in-service primary teachers.

In this section, one of the questions aimed to collect trainee teachers' and in-service primary teachers' perceptions about which "strategies" implemented in the ICT element allowed them to develop and improve their pedagogical and professional skills.

All of Aveiro's respondents considered that the "implementation of activities in science teaching using ICT" allowed them to develop and improve their pedagogical and professional skills. This result could be related to the fact that this strategy aimed to provide in-service primary teachers with opportunities to implement small research projects that effectively utilized ICT-based research tools in their science classroom contexts. The ICT-based research tools should be available at their schools and/or accessible via the Internet (Guerra, Moreira & Vieira, 2010).

For Bradford, 66% of trainee teachers indicated their pedagogical and professional skills were developed through the ICT provision. However, in relation to science specific activities 67% of respondents felt that they did

not develop or improve these skills as they anticipated. It is interesting to note that 82% of respondents positively evaluated the impact of the ICT programme on their teaching practice and 100% were able to use ICT effectively to access resources for use in the classroom.

The development of subject specific ICT skills and pedagogy within Bradford is moving towards a model where it is delivered within a subject specific context i.e. through subject sessions. At the present time subject tutors are developing the skills they need to integrate and model ICT within their teaching. The evidence from the questionnaire suggests that there is still work to do before ICT becomes fully embedded within subject areas. During the trainee teachers' interviews this was further explored and it became clear that this was an issue from all curricular areas not just science.Several technological resources were incorporated in the ICT elements in Aveiro and Bradford programmes. One of the questions of the second section of the questionnaire aimed to collect trainee teachers' or in-service primary teachers' opinions about the Web 2.0 tool resources that allowed them to develop/improve their teaching and professional skills using ICT.

Aveiro's in-service primary teachers' learning outcomes followed continuous and formative assessment approaches. This was based on the scrutiny of products developed using Web 2.0 tools, such as: a scientific paper (Pbwork); a digital portfolio (Blog); a concept-map (MinMeister); and the interactions in the Ning forums (Guerra, Moreira & Vieira, 2010).One of the respondents of Aveiro's questionnaire negatively evaluated the use of the wiki tool (pbwork) to write a scientific paper collaboratively. Furthermore, one of the open questions was designed to collect in-service primary teachers' perceptions about the potentialities and constraints of this Web 2.0 tool. The respondent explained that one of the constraints was that the wiki tool did not allow him/her to integrate "Endnote" (bibliography tool) during the conception of the scientific paper.

Eight of Aveiro's respondents totally agree that the use of "Wordpress" helped them to organize their eportfolio during the curricular units. These results demonstrated that it is important to rethink the integration of wikis and blogging tools in in-service teacher education programs. This kind of Web 2.0 tools should be linked with the task/activity proposed in the programme. Therefore, in order to allow trainee teachers and in-service primary teachers to collaboratively write a scientific paper, teacher trainers should help them to use the potentialities of, for example, word processing tools such as "tracking changes".

Additionally, "Wordpress" is a blogging tool that could give trainee teachers and in-service primary teachers the opportunity to develop an e-portfolio. Aveiro's in-service primary teachers felt that this Web 2.0 tool allowed them to take on a self-regulating role in their learning process, integrating their critical reflections, activity resources, and other artefacts developed during the learning process.

Regarding the programme at Bradford, this was developed for trainee teachers and, as such, concentrated on the basic pedagogical skills appropriate for this stage of their career. For example, the use of some of the more advanced tools available in "Microsoft Word" such as "track changes" within paired writing activities, the forms feature to develop questionnaires and worksheets that could be available over the school intranet and so on supported students' learning. The use of Web 2.0 technologies was introduced more as an awareness-raising exercise than an essential component of the course. The use of wikis for example was introduced as a way of trainee teachers sharing web-based resources such as websites, online tests and so on. Nevertheless 30% of respondents said they would use wikis and blogs as part of their classroom practice in the future. The use of "GoogleDocs" (cloud computing) was introduced as a way of gathering and analysing data from pupils with 40% of respondents stating they would use this resource in the future as part of their teaching.

Trainee teachers were asked how they thought the ICT provision could be improved. Although 89% of trainee teachers said they were able to use interactive whiteboards in their teaching, some felt that further development of using this technology more effectively as an interactive tool would be beneficial. The other area raised was the need for a greater focus on how ICT could be used in specific subject areas.

FINAL THOUGHTS

The main purpose of the project is to contribute towards the evaluation of the quality of Science Education programmes that use Web 2.0 tools in each institution. Specifically, it is important to evaluate the quality of the strategies and activities adopted in each teacher education programme.

Despite significant differences in the programme contexts and stages of professional development of the two cohorts, what emerges is the benefit of integrating Web 2.0 technologies into teaching practices. According to defined evaluation criteria for this study (effective teaching; impact on learning; and suggestions for improving future editions of the curricular areas), the main results were:

- the overall ICT provision was appropriate to each Higher Education context, which enabled effective teaching in the curricular units involved in this study. Specifically, in the Aveiro programme, it was important to introduce in-service primary teachers (with experience in the field) to innovative web 2.0 tools for their professional and pedagogical development. Regarding the programme at Bradford, it was concluded that the integration of basic digital tools (such as word) for trainee teachers' pedagogical skills development, which was most appropriate for this stage of their career;

- the overall ICT provision had made some impact on trainee teachers and in-service primary teacher learning about the potential of using ICT in the classroom. Each ICT provision positively contributed, in their perceptions, to their professional and pedagogical development. This influences classroom practice but it is unclear to what extent it impacts on learning;

- finally, Bradford's trainee teachers' suggestions for improving future editions of the curricular areas was related to the need for a greater focus on how ICT could be used in other specific subject areas. On the other hand, despite Aveiro's teaching strategies focusing on the integration of ICT tools in science teaching practices, it was suggested that the development of other pedagogical and professional skills, such as the design of digital resources for science could be considered.

Future work will be focused on the collaborative work between both teams on the analysis and discussion of the results achieved so far, as well as the triangulation with other data collected using other instruments.

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Resumo: Uma das exigências do século XXI é a flexibilidade e a transparência no Ensino Superior Europeu quanto à organização, ao currículo, às metodologias de ensino e às aprendizagens dos estudantes. A evolução das tecnologias da informação e comunicação (TIC) e a sua crescente acessibilidade levou várias instituições do Ensino Superior a adoptar abordagens de ensino construtivistas de ensino, no qual os estudantes devem estar activamente envolvidos no processo de aprendizagem. Este trabalho faz parte de um projecto de investigação Luso-Britânico, que envolve a Universidade de Aveiro (Portugal) e a *Bradford College University Centre* (Reino Unido), onde a equipa trabalhou colaborativamente na identificação de critérios de avaliação das práticas de ensino e aprendizagem que integram as tecnologias da Web 2.0 no processo de ensino e de aprendizagem das Ciências. O trabalho implicou a concepção, implementação e avaliação de um instrumento de recolha de dados, um questionário, que foi aplicado aos estudantes no final dos dois programas de formação de professores do 1º Ciclo do Ensino Básico (inicial e prós-graduada em Bradford e Aveiro respectivamente). Pretende-se apresentar alguns resultados preliminares relacionados com a avaliação da qualidade de programas de formação de professores que promovem metodologias inovadoras para o desenvolvimento profissional dos estudantes/professores..

Palavras-chave: Avaliação de programas de formação, desenvolvimento profissional de professores, educação inovadora, ferramentas Web 2.0.