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Critical thinking, questioning and creativity as components of intelligence

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Abstract

For a long time, intelligence has been viewed as a fixed trait and solely connected to analytical skills and memory-based capacities. However, in our fragile, uncertain and unknowable world, this kind of abilities does not necessarily promotes success in life and, more specifically, in university. With this paper, we aim to present a project whose objective is to throw light to a modern notion of intelligence. We will show how intelligence can be characterised by an integrated set of high order cognitive skills: critical thinking, questioning and creativity. We propose to design innovative instruments to characterise and assess this contemporary notion of intelligence. Furthermore, since these skills are modifiable, rather than fixed, we will design, implement and evaluate strategies to promote higher level questioning, critical thinking and creativity in university students, and, ultimately, enhance intelligence.

Keywords: Intelligence, creativity, questioning, critical thinking

1. Introduction

Intelligence is the incorporated group of abilities needed to attain success in life within each individual's context. People are intelligent by recognising their strengths and making the most of them while at the same time recognising their weaknesses and finding ways to improve or compensate them. Intelligent people manifest their skills by adapting to, shaping and selecting environments through a balance in their use of different kinds of abilities. Students and teachers alike employ intelligence every day, inside and outside the classroom. In doing so, they go well beyond the conventional definition of intelligence.

According to Sternberg, Jarvin and Grigorenko (2009), the abilities that make up intelligence are analytical, creative, and practical. Our recent research, developed in higher education (Almeida, Pedrosa de Jesus & Watts, 2011; Almeida, Teixeira-Dias & Medina, 2010a; Almeida, Teixeira-Dias & Medina, 2010b), has shown that analytical, creative and practical abilities are directly related to questioning, critical thinking and creativity. So, we argue that intelligence is characterised by the integrated set of these high order cognitive skills: critical thinking, questioning, and creativity.

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We agree with Sternberg (2007), when stating that conventional tests of abilities, dating back from Binet and Simon (1916) and Spearman (1927), are not fully adequate because they so heavily emphasise memory-based abilities to the near or total exclusion of higher order cognitive skills. Such tests predict a large variety of performances, but perhaps not at the highest level that can be achieved. Likewise, University assessments, like standardised tests often emphasise memory-based skills. For instance, the A-levels widely used in United Kingdom and the SAT, used in United States, measure, among other things, memory for knowledge learned in secondary education and solutions of mathematics exercises.

However, the intended learning outcomes of many university programmes are now written in terms of higher order cognitive skills. For instance, several degree level programmes at the University of Aveiro, in Portugal, asks that students are able to: (1) *ask adequate questions and to possess a critical and constructive attitude towards the analysis and resolution of problems*; (2) *possess abilities that allow them to become autonomous long life learner*s; (3) *construct knowledge through the interaction between the 'know how to think' and the 'to know how to do'*. Such intended outcomes are not unusual at this level and the expressions 'asking questions', 'long life learners' and 'know how to think' signal a requirement that the students on the course operate with higher order cognitive skills. These are recognised as key competences in higher education. For instance, critical thinking, creativity and questioning are considered key competences for lifelong learning. Success in university, as well as success in life, depends on a broader range of abilities than what conventional tests measure. Thus, the first research question of our project is:

1. *How is it possible to assess intelligence in broader ways than has been possible in the past?* How is it possible to assess university students' critical thinking, creativity and questioning? What are the relationships between critical thinking, creativity and questioning? Are there differences between critical thinking, creativity and questioning skills of university students from different disciplinary fields?

If intelligence can be broken down into a set of underlying skills, then it is clear what we can do to improve intelligence: we can intervene at the level of higher order cognitive skills, teach students what processes to use when, how to use them, and how to combine them into workable strategies for task solution. Thus, the second research question of the project is:

2. *How can intelligence be enhanced?* Is it possible to enhance intelligence through the implementation of teaching, learning and assessment strategies in university classes? What kind of strategies can be designed and implemented in order to improve university students' critical thinking, questioning and creativity? What kind of support/training should be given to university teachers in order to optimize the implementation of these strategies? Should these strategies be different, according to the disciplinary field?

In the next sections we will briefly present the theoretical background, the methodology of the project, and its intended contribution.

2. Theoretical background

A crucial role for higher education should be the promotion of students' lifelong learning, through the development of '*different kinds of knowledge and skills; ones that go away beyond anything we have traditionally taught*' (Boud, 2004, p.39). The development and promotion of critical and creative thinking, and question formulation are fundamental to the development of lifelong learners and should be central during higher education (Boud, 2004; Dierick & Dochy, 2001).

Critical thinking is considered a key competence for lifelong learning in terms of an '*attitude of critical appreciation and curiosity, an interest in ethical issues and respect for both safety and sustainability - in particular as regards scientific and technological progress in relation to oneself, family, community and global issues*' (Commission of the European Communities, 2006, p.15). The Boyer Commission Report (1998, p.4) argues that courses should be '*structured in such a way as to create student-centred learning environments where inquiry is the norm, problem solving becomes the focus, and thinking critically is part of the process'*: critical and self-critical

abilities are identified as important generic competence to be developed by students. However, it is well known that frequently university classes do not promote students' criticality.

Cuccio-Shirripa and Steiner (2000) conceptualise critical thinking as directly related to constructive questioning. In fact, it has been demonstrated that the promotion of a true spirit of inquiry can improve the quality of learning (Graesser & Olde, 2003). In recent years there has been an increasing emphasis on the important role that students' questions play in lifelong learning, as questions are an essential component of discursive activity, dialectical thinking, and dialogic teaching. The act of questioning encourages learners to engage in deep and creative reasoning. Zoller and colleagues (1997) argue that the development of students' abilities to ask questions, reason, problem solve, and think critically and creatively should become a central focus of education reform.

In two recent studies, we have made an attempt to link questioning to creativity (Almeida et al., 2010a), and to link questioning to critical thinking (Almeida et al., 2011). We have defined a hierarchy of approaches to creativity, a taxonomy of approaches to criticality, as well as a categorisation of students' questions, and we have concluded that students tend to ask questions that are coherent with their approaches to creativity and to criticality. We see a lower level of creativity and criticality associated with the students that ask mainly closed questions, and a higher degree of creativity and criticality related to those who are able to ask all kinds of questions (low level and higher level questions). Both criticality and creativity seem to involve the ability to ask different kinds of questions, according to the circumstances and to the student needs.

Even if several studies emphasise the importance and the role of critical thinking, questioning and creativity in higher education, the truth is that usually these higher order skills are not took into account in three strategic points: admission, instruction and assessment in higher education. In this project we will not analyse or intervene at the admission level, but we will conduct an intervention at the instruction and assessment levels. One purpose of university education is to create active and engaged citizens. If it is essential for students to have potential to become this kind of people, the university must provide opportunities to develop students' higher order cognitive skills.

3. Research design

The design of this project is unique in its original combination of qualitative and quantitative methods. The absence of instruments to qualitatively assess critical thinking, questioning and creativity in higher education, as well as the lack of systematic studies reporting the implementation of strategies specifically conceived to enhance these skills, sets the agenda of the project. Actually, there are two main studies in this project. The *first study* aims to conceive, design, validate and apply instruments to qualitatively assess critical thinking, questioning and creativity; the *second study* aims (i) to conceive, design, validate and implement teaching, learning and assessment strategies to enhance critical thinking, questioning and creativity; and (ii) to analyse the effect of these strategies on the critical thinking, questioning and creativity skills of university students.

3.1. Study 1

The construction of a questionnaire aiming to assess critical thinking, questioning and creativity containing mainly open questions is one of the innovations of this study. Sternberg (2007) emphasises the importance of using open questions, since '*using a multiple-choice format consistently seems to benefit some students.*' Cohen, Manion and Morrison (2007) also emphasise the importance of this kind of questions, stating that open questions '*contain the 'gems' of information that otherwise might not be caught in the questionnaire'* (p.255). However, the almost exclusive use of open questions also constitutes a difficulty. It will imply more time and resources to score the assessments. Multiple judges will be used to obtain satisfactory reliability.

The questionnaire will be administered to a sample of university students from sciences, engineering, humanities and economics. Several authors support the division of disciplinary fields into a fourfold typology that leads to four

quadrants which are defined according to the amount of concrete vs. abstract and reflective vs. active abilities required in each one. With the insertion of students from these four disciplinary quadrants in our sample we intend to analyse critical thinking, creativity and questioning skills of students with diverse academic backgrounds, since these usually excel in different skills. Humanities and arts students are traditionally associated to a higher degree of creativity, while science and economics students usually possess a higher degree of criticality.

3.2. Study 2

Study 2 consists of a common pre-test to all students, plus administration of an instructional intervention, followed by a post-test. The questionnaire designed in Study 1 will be administered to a sample of university students from the four academic fields previously mentioned.

The main innovation of this study is the combination of a quasi-experimental design with an instructional intervention that will consist in an action research approach. The global sample will be divided equally between 4 experimental groups and 4 control groups, as shown in Table 1.

We will analyse the data so that critical thinking, questioning and creativity gains in the 8 groups will be compared. The main hypothesis is that critical thinking, questioning and creativity gains in the experimental conditions will exceed those in the control conditions.

Table 1: List of the 8 conditions

Group		Description of the conditions
1	Control group	Science students + standard instruction
2	Experimental group	Science students + instructional intervention
3	Control group	Humanities students + standard instruction
4	Experimental group	Humanities students + instructional intervention
5	Control group	Engineering students + standard instruction
6	Experimental group	Engineering students + instructional intervention
7	Control group	Economics students + standard instruction
8	Experimental group	Economics students + instructional intervention

The intervention phase will be carried out in a naturalistic setting, within the context of university classes. This phase of the study will count with the active participation of university teachers of sciences, humanities, economics and engineering. The project team, in full collaboration of these teachers, will design teaching, learning and assessment strategies that will be implemented in regular classes of the four academic fields (sciences, humanities, economics and engineering). The main aim of these strategies is to improve university students' critical thinking, questioning and creativity. This intervention – action research approach - will take place during one academic year and will consider two cycles of intervention (two semesters). During this period of time, we will work with the teachers of sciences, humanities, economics and engineering in order to help the implementation of the teaching, learning and assessment strategies: (i) workshop meetings will be scheduled before and throughout the implementation of the strategies; (ii) an educational researcher (a member of the research team) will be present in all classes during both cycles of intervention (all classes will be audio-recorded and some will be video-recorded); (3) the educational researchers will give feedback to each teacher.

After the instructional intervention phase, the questionnaire to assess intelligence will be administered to students (post-test).

4. Contribution of the project

Contemporary society is characterised by fast and complex change processes (Barnett, 2007) covering all spheres of life. Consequently, learning should also be seen as a process of change. However, in a society rapidly changing and requiring informed citizens, '*the educational system has not changed at all*' (Correia, Valle, Dazzani & Infante-Malachias, p.678). This project aims to contribute to this desired change, and moves beyond existing research in three prominent respects. In addition, it will generate curriculum relevant conclusions about the effects of implementing teaching, learning and assessment strategies to enhance critical thinking, creativity and questioning in the university classroom.

First, the project leaves the traditional concept of intelligence and opens up a new research agenda on the notion of intelligence. Critical thinking, creativity and questioning are seen as fundamental cognitive skills (Almeida et al., 2010a; Barak & Dori, 2009; Chin & Osborne, 2008), and more than that, are conceived as integrant parts of intelligence.

Second, the project develops innovative instruments to assess critical thinking, creativity and questioning in university students. Traditional tests measuring intelligence are almost exclusively quantitative. The assessment of intelligence through qualitative methods keeps unexplored. The project presents an innovative and qualitative questionnaire to assess critical thinking, questioning and creativity.

Third, the project offers a battery of innovative teaching, learning and assessment strategies to improve university students' critical thinking, questioning and creativity. The project also opens up a new agenda on the development of higher order cognitive skills. The project adopts a combination of an action research approach and a quasi-experimental design research, exploring the effect of the implementation of teaching, learning and assessment strategies. The project will help university teachers to enhance their already considerable teaching skills by showing them ways in which critical thinking, creativity and questioning can be integrated into their teaching and assessment strategies.

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