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Generic competences acquisition through classroom activities in first-year agricultural engineering students

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Abstract

Generic skills need to be developed by university students to prepare them for lifelong learning. Higher education institutions play a key role in developing appropriate strategies for a competences-based approach with learning activities defined in terms of knowledge and skills. Although current knowledge assessments focus on individual grading, skill acquisition assessments require a social context. This paper proposes that generic skills can, and should, be developed from year 1 at university through active learning methods. The assessment of generic competences acquisition at university relies on the design and performance of useful activities rather than on specific outcomes in competence subjects of university programmes. Several active learning methods were applied to a first-year agricultural engineering course on Soil Science in the Polytechnic University of Valencia; these methods are described and their usefulness for students' skills acquisition is analysed.

Keywords: Active learning, Generic skills, Higher education, Problem-solving sessions, Learning assessment

Introduction

In the knowledge society context, higher education has become part of a new way of creating and using knowledge (Ramsden, 2003). The professionalisation of university curricula has brought about profound changes in the traditional academic education concept and faces the introduction of more professional courses into university systems. One response to these changes has been to clarify the relationship between university education and graduate skills, which has led to a competence-based model for curriculum development in universities: the Tuning Project. It started in 2000 as a European initiative to link the political Bologna process objectives to the higher education sector (González & Wagenaar, 2003). This Project has made a distinction between generic competences (transferable skills) and subject-related ones.

Why is developing generic skills in university students necessary?

The importance of generic competences and their acquisition through teaching and learning are now widely recognised. Higher education institutions need to demonstrate that more employable graduates are produced. So universities allocate resources to ensure that these skills are developed by graduates.

The list of attribute outcomes, such as intellectual abilities or ethical values, can be quite complex and often difficult to define. Barrie (2006) showed that variation in teaching and learning approaches in the classroom reflects different individual understandings of the graduate attributes concept. What is still quite a wide conception in academics about generic skills is that they have to be developed prior to attending university, or are individual intrinsic qualities. Barrie (2006) identified four academics' understandings of the graduate attributes concept: 1) as basic precursory abilities that students bring to universities; 2) as useful additional skills that complement or round out graduates; 3) as abilities that transform discipline knowledge through their application; 4) as integral abilities in discipline knowledge rather than learning outcomes. In the last two conceptions, graduate attributes are an integral substrate of discipline knowledge. It has also been shown that the epistemic culture of each specific discipline influences academic staff's conception of generic skills (Jones, 2007). For this reason, higher education institutions play a key role in developing appropriate strategies to adopt a competences-based approach with learning activities defined in terms of knowledge and skills. Performance must define not only required knowledge, but also objectives and learning activities. It is necessary to build a conceptual framework to help us advance in our understanding of the relationships between learning activities and skills acquisition.

Why must generic skills acquisition be assessed?

One of the higher education aims is to prepare students for lifelong learning. This implies necessarily preparing them for the task of making complex judgements about their own work and that of others, and also for making decisions in uncertain and unpredictable circumstances in which they will find themselves in the future (Boud & Falchicov, 2006). These authors argued that current assessment tasks in the university context show specific characteristics: they often emphasise problem solution rather than problem formulation; fragmentation of tasks inhibits a holistic approach to assessments and treatments as grading leads students to focus on marks. On the contrary, learning in work and life is always socially constructed, takes place through day-to-day activities, and learners have to identify what they need to learn.

The goal must always be for students themselves to learn to judge what constitutes good work and to be given opportunities to practice this. It is fundamental that students understand the importance of their meta-cognitive skills to be successful at university (Jonhson, Archibal, & Tenembaum, 2010). When meta-cognitive skills are integrated into the learning of a discipline, it is essential that students receive appropriate feedback in order to obtain a clear understanding of higher education requirements. Wingate (2010) argued that students need to be given more direct guidance on what they need to do in order to improve their skills. Crebert, Bates, Bell, Patrick, and Cragnolini (2004) strongly emphasised the importance of interactive group learning at university to develop generic skills and assessable abilities in formal teamwork exercises or group projects.

Biggs (2003) articulated these ideas according to the constructive alignment notion; i.e. aligning teaching and assessment to curriculum objectives. The teacher makes an alignment between the planned learning activities and learning outcomes. This provides learners with a clearly specific goal. Improvement in learning activities and good assessment criteria are useful to learners as feedback.

How can we develop generic skills in first-year students?

Skills acquisition must be integrated into a framework by gradually increasing their complexity level of ability. Nicols (2009) argued that first-year students need to learn how to assimilate the university culture, while also receiving the skills for them to control their own learning. Generic skills can, and should, be developed from year 1 at university by providing students with the tools they will need throughout the rest of their studies and in their future professional work (Thomas, 2011).

In 2002, a programme that has involved teaching innovation teams has been set up at the Polytechnic University of Valencia (UPV). Among the pioneers of the UPV innovation groups, GIIMA (*Grupo de Innovación e Investigación en Metodologías Activas*, Innovation and Research Group in Active Learning Methods) is a multidisciplinary team formed mainly by teachers of first-year courses who attempt to adopt active learning methods. These are methods that entail students' active participation in their own learning (Morera et al., 2012, 2005). The efficiency of these methods and their implementation in the classroom have been assessed during successive courses by analysing students' opinions, which are collected at the end of each academic year (Atienza et al., 2014).

Recently, the UPV institutional programme (Vicerrectorado de Estudios, Calidad y Acreditación (VECA) de la Universitat Politécnica de Valencia, 2013) has attempted to assess students' degree of generic competences acquisition in order to incorporate them into general degree curricula. In year 1 at university, students face several challenges: groups are numerous, students normally receive less feedback than in secondary education, and they must collect and integrate information from different sources. Another problem is the heterogeneous formation they received at high school. One of the ideas that first-year teachers must take into account is that students' degree of independence may be increasingly acquired as their intellectual maturity progresses. So learning activities have to be done according to students' levels.

This paper focuses on generic skills acquisition through its applications to disciplinary knowledge. It also proposes that using active learning methods may improve the skills considered necessary in first year students for a professional career. The remaining of this paper is structured as follows: Methodology provides a description of several techniques used to increase active participation of students and Results and discussion analyses the opinions of students of the 2014–2015 academic course about the degree of usefulness of these techniques and their awareness of generic skills acquisition. Finally, a few conclusions are drawn in Conclusion.

Methodology

The study has been performed with students of Soil Science from Agricultural Engineering degree at the Polytechnic University of Valencia during the academic year 2014–2015. A wide range of teaching techniques are used at university and each is applied differently by each teacher. Today's tendency is to diversify methods, but lectures are still the most common. The use of active methods provides active feedback because students learn by doing work, and they receive information about their progress. Hence formative design is a very important aspect of active learning. Several methods have been implemented with time, of which some have proven effective and have already been incorporated into the teaching system.

Implementing new learning activities requires an organised strategy; i.e., Soil Science students face experimental sciences for the first time. They have to measure soil properties by many methods, so they have to acquire laboratory skills to work with changing units. This paper is based on a previous work that centred on students' response to active learning methods, and was disclosed in a national congress (Bautista, Lidón, Lull, & Serrano, 2011). Some of the methods, such as self-correcting spreadsheets and problem-solving sessions, were successfully used in other groups.

Several participative techniques were used during academic year 2014–2015:

- Participative lectures that attempt to encourage student participation by providing examples and asking questions with a view to relating new knowledge with the students' experience. In this way, students learned not only to answer but, more importantly, to ask questions.
- At the end of each lecture, students had to write the answer to a single question about some of the explained contents (a 1-min paper), which was also used to assess attendance to and participation in the session. In previous years, students knew the questions before the lecture began, but during 2014–2015, the question was posed at the end of the lecture so they could answer it well only if they had paid attention.
- Problem-solving sessions were organised in seminars. During these sessions each student had to solve a numerical exercise. Input data were dependent on a combination of random factors. In this way, students acquired different data to customise exercises. The sequence of steps that led to solve the exercise is shown (Fig. 1). Students had to progress with their own data following the specified procedure, and could compare their results with those of peers. They were free to work individually or in a group, and to search for information online. At the end of the sessions, students had to deliver the solution to the teacher, who used a spreadsheet program that allowed different input values to correct each exercise step by step. Exercises were returned to students during the following session, which provided them with feedback about the degree of their solving capacity.

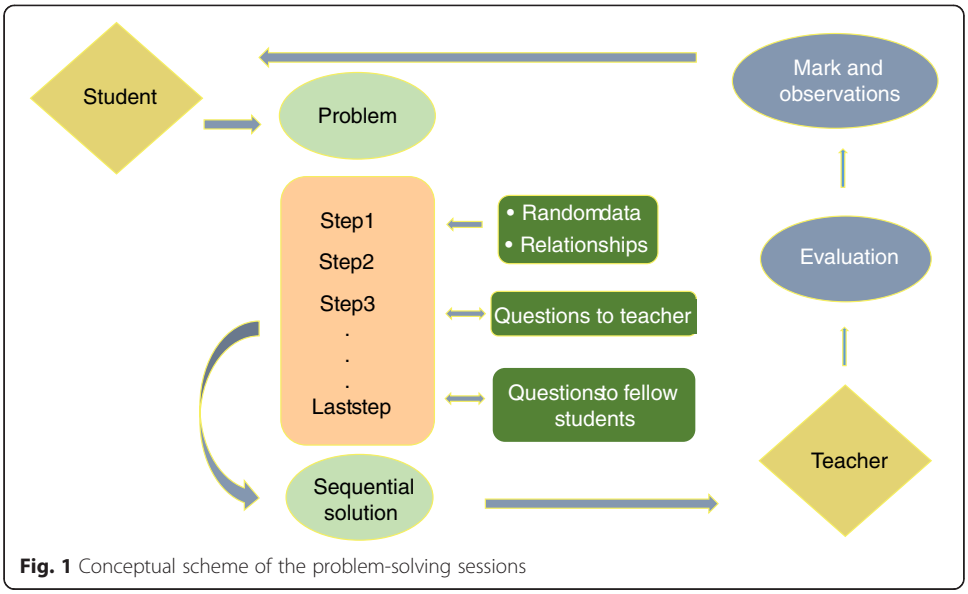

Fig. 1 Conceptual scheme of the problem-solving sessions

In this way, they could analyse their mistakes and go to tutorials to clarify any doubts they had both before and after corrections. Such activity was an attempt to improve critical thinking, but also showed the effectiveness of collaborative work.

- During laboratory sessions they worked with different soil samples and simple experiments were also carried out so they could begin to conduct research on a small scale. Students had to check their calculations using a self-correcting file that was designed with Excel macro-functions (Lull, Bautista, Lidón, Llinares, & Serrano, 2009). The use of worksheets started in the academic year 2007–2008 and involved a change in the way students worked with laboratory data and in the evaluation system. Students had to deliver the corrected data in the specified time through the Polytechnic University platform (PoliformaT). In this case the student, besides analysing laboratory data, learned to use one of the most common spreadsheets. Adequacy of calculations and punctuality in delivering were used as evaluation criteria. By means of this method, students had to develop task-planning skills.
- During 2014–2015, students were asked to write a short laboratory report that included the proposed objectives and the conclusions they obtained during each laboratory session. This allowed them to critically go over their own results.

Awareness about generic skills acquisition was tested at the end of the second semester during academic year 2014–2015. To assess the impact of the active learning methodologies on learning objectives and students' skills acquisition, the opinions of the participants in one of the theory groups (55 registered students) were collected by means of qualitative and quantitative questionnaires. Students were asked to answer an anonymous quantitative questionnaire (on a 5-level Likert scale) about the degree of usefulness they found with the different active learning methods used. They completed another questionnaire (also on a 5-level Likert scale) about their awareness of the degree of generic skills acquisition. They also had an open answer space to itemise the positive or negative aspects of the overall specific subject.

Results and discussion

At the end of the academic year 2014–2015, the anonymous student answers showed their perception of the usefulness of the active learning methods employed (Fig. 2). The highest degree of usefulness was found during the problem-solving sessions. When students set out to solve the exercise, they were free to form groups according to common data and to establish dialogue to help them remember concepts. They began to do collaborative work and learning. They should follow the procedure step by step because they had different results. They found this activity not only very useful for learning, but highly satisfactory (84 % of them found them useful or very useful). Moreover, students were provided with opportunities for self-assessment, peer dialogue and engagement with feedback from teachers. These good results reinforce the idea that the framework provided by the teacher to study the problem acts as a scaffold to support immediate knowledge construction by learners (Thomas, Davis, & Kazlauskas, 2007). Students also had the chance to solve the new exercises proposed by the teacher at home and were provided with only the final solution. This meant that they had to find their own way

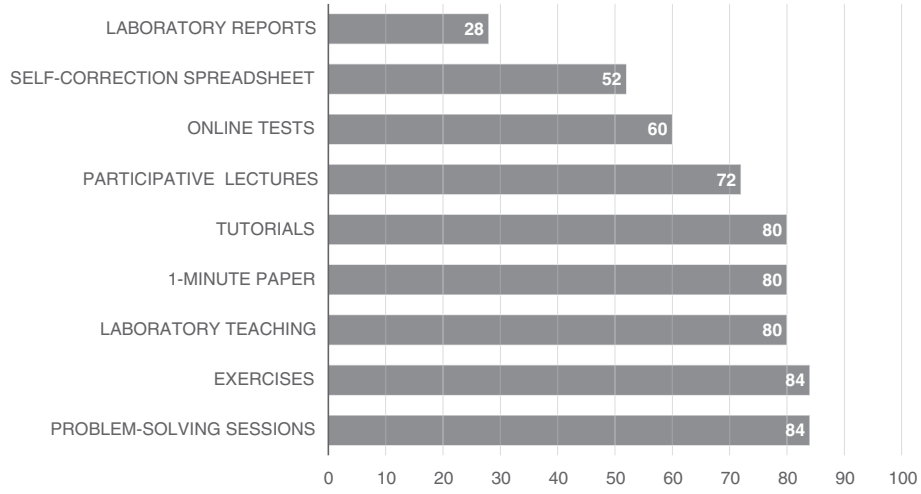

Fig. 2 Percentage of students who found the different learning activities useful or very useful (Course '14-'15, group B, $n = 25$)

to solve the problem. They also thought that this activity was extremely useful (84 % of the students stated so).

The following activities in order of usefulness were the 1-min paper, laboratory sessions and the possibility of attending tutorials with their teacher (80 % of the students).

The 1-min paper was not only highly marked (80 %), but was also demanded by students at the end of the theoretical class because they realised how much they had learnt. Thus they became active agents in the assessment process, and not merely the subject of the assessment.

It is noteworthy that the laboratory teaching sessions were considered as highly useful (80), but self-correcting files and the task of summarising main ideas in laboratory reports were not considered as useful (only 46 and 28 % of the students, respectively). The problem with self-correcting spreadsheet was the lack of experience of the student in elementary computer skills. It would probably be more useful if computing and information technology was considered a skill to be learnt transversally. The academic course 2014–2015 was the first year that laboratory reports (considered less useful) were resorted to, and this year students did not receive feedback, only a final mark. The laboratory reports were designed to scaffold the students' learning by inducing them to think about their own achievements from different perspectives.

After finishing each subject, online tests were also positively evaluated (60 % of the students found them useful). These results reinforce the main idea that the best way to assess student work during a learning process is feedback. The continuous efforts made by students must be acknowledged, but it is also important to assess their degree of improvement. Assessment has two main purposes: to provide certification of achievements (summative aspects) and to facilitate learning (formative aspects). Both formative and summative aspects of evaluations must be adjusted accordingly. Theoretical development for formative assessments is necessary (Yorke, 2003).

Using active methods provides active feedback because students learn by doing work and they receive information about their progress, which make the formative design a very important aspect of active learning.

Students were explicitly asked about the acquisition of nine skills selected from those in the UPV Programme (Vicerrectorado de Estudios, Calidad y Acreditación (VECA) de la Universitat Politécnica de Valencia, 2013). As regards students' opinion of the impact of active-learning methods on skills acquisition (Fig. 3), a high percentage of students considered that such activities enhanced generic skills acquisition, such as teamwork (76) and responsibility (68 %). Improvement in both competences was considered when running problem-solving sessions.

Surprisingly, the third competence that students considered as improved was planning (60 %). Students knew beforehand the work they had to complete during each session, and that the mark they obtained would depend on task completion. After the second session, they began to work collaboratively, organising the time and combining knowledge in order to finish on time. Other competences that improved with these activities included communicative skills and interpersonal understanding. The assessment of generic skills acquisition at university level must rely on the design and performance of useful activities rather than on specific outcomes in competence subjects of university programmes. Our results match the guidelines proposed by Hounsell (2003) for formative assessment development; i.e. students' involvement in the generation of feedback, and a more open and collaborative approach to assessments.

The answers to the qualitative questionnaires indicated that a high proportion of students thought that a good working environment was a very important factor for well-being while performing activities.

Conclusions

Several methodologies designed to promote students' classroom activity were developed and their impact on generic skills acquisition was analysed with first year students from Agricultural Engineering degree at the Polytechnic University of Valencia. According to the results, using active methods seemed to be a very good strategy to facilitate acquisition of knowledge, skills and positive attitudes. The design and implementation of active methodologies improved students' learning and their integration

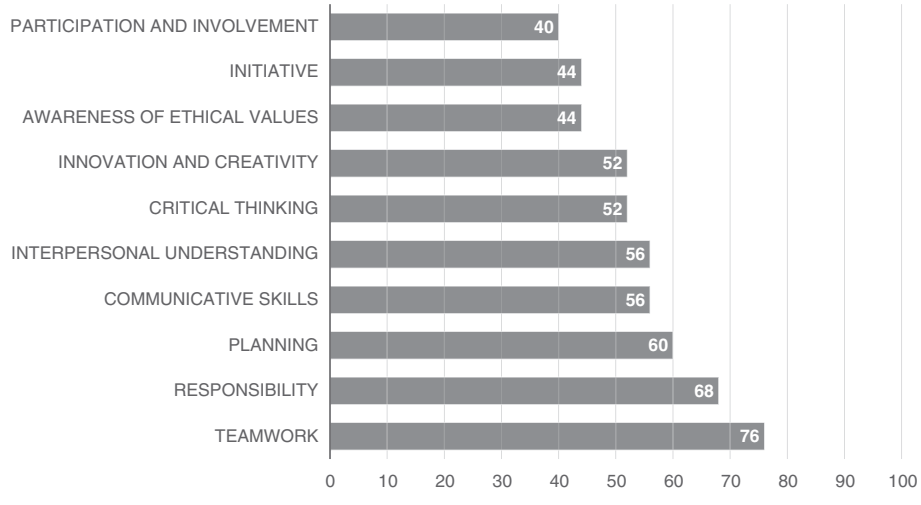

Fig. 3 Percentage of students who thought that the different learning activities helped improve their generic skills (Course '14-'15, group B, $n = 25$)

into the classroom during their first year at university. This paper provides some examples of how we can integrate students' understanding of generic skills into their classroom learning through activities. This work focussed on first-year students, and it would be desirable for academics in successive academic years to contribute to build on these skills in order to produce graduates capable of adequately solving problems and evaluating solutions. Some analysed techniques, such as problem-solving sessions and the 1-min paper, involved investing time primarily in the design phase. Their implementation does not take up too much additional time, and extraordinarily reinforced students' learning. These methods can also be considered suitable for large groups. At present the university is working to develop assessment tools for the acquisition of generic skills. The development and implementation of active learning methods correspond to teachers who are responsible for designing activities to help improve student learning. Teaching techniques must include student learning activities and the concomitant assessment of learning achievements. Convincing the rest of the teaching staff to invest part of their time to develop active learning methods and to assess their usefulness is still a pending matter.

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