Group tutorials: Some experiences

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Abstract

Mentoring is an accompaniment and teaching support that seeks to help students adapt to the university environment, foster the development of skills and the achievement of academic goals. It is considered a crucial issue within the European Higher Education Area. In this paper, we present some proposals on Group Mentoring that our working team has developed in recent years. On-line student support, Fundamental Concepts, Support and Remedial Group Mentoring sessions were carried out aimed at avoiding students dropping out of the course, as well as facilitating urgent assimilation of the concepts that semester subjects require and increased academic performance. Secondly, we worked on the acquisition of instrumental and interpersonal skills via the application or mainstreaming tutorials and a reading/discussion workshop. Finally, the academic achievement of some goals that enable students to meet the requirements of professional practice are addressed through tutorials in which we worked with Problem-based Learning (PBL) and Puzzle Solving techniques.

1 Introduction

Our educational process begins the day we are born, and as time goes on, it continues to develop itself through personal experience and the guidance of others. This is why we usually talk about the so-called educational triangle, as shown in Fig. 1, which is comprised of family, teachers and students.

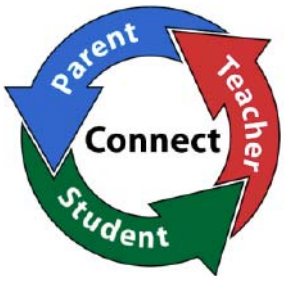

Fig. 1. Educational triangle

The school system aims to provide its students with knowledge, skills and abilities in specific areas. Within the school, teachers act as both counsellors and advisers, whereas students act as learners, therefore having to take on the responsibility of being autonomous learners.

The term "tutor" comes from the Latin word "Oris", which means "person that acts as tutor, defender, guardian." In pedagogical jargon, the usage of the verb "to mentor" is understood within the educational field as the act of helping, guiding, advising and instructing students by way of a teacher. The Larousse Encyclopaedia states that a tutor is a person in charge of orienting and advising students enrolled in a term or course or who are studying towards a degree.

In this paper, we adopt the following definition of tutoring, proposed by **Tejada and Arias** [1], as our own:

"Educational accompaniment and teaching support based on providing students with a personalised attention that facilitates a better understanding of the problems they must cope with in terms of adapting to the university environment, so that they can perform well throughout the academic year, and be able to attain the academic goals which will allow them to face the obligations required by their future professional endeavours."

2 Tutorial action within the University: Why and what for?

University tutoring responds to typical and recurrent situations from a new learning perspective. Moreover, it is also a core determinant of quality in the formative process and an answer to the pressure felt by certain students to achieve better results [2]. The added value of university tutorial action relies on treating the student as the primary focus and finding new ways of approaching and responding to the subject matter [3]. It was with good reason that we moved from the German model, whose focus is teacher-researcher, to the Anglo-Saxon one, whose main objective is to train individuals who are capable of meeting the needs of new companies and states. We must also bear in mind the need of developing new ways of teaching, which foster student transitions: from upper secondary or vocational training education to university, from general courses to those that have a more specific focus and from university to the job market. This attention to diversity seeks to limit the number of drop-outs (40% to 50% of students who enrol in university never get their degree). The current number of drop-outs supposes a loss on behalf of the university, which is valued at €3.3bn. The attention to diversity also allows us to seek out the best students, and compete with other universities as well as achieve quality acknowledgements.

So, why the need for university tutorial actions? There are many approaches and tasks regarding university tutorial actions, but these can be summed up in the following aspirations:

- To identify the academic and personal weaknesses of each student so that we can provide him/her with necessary guidance, and do so in a timely manner.
- To assist the student in his/her learning process in order to improve his/her academic performance, as well as to reduce the number of university drop-outs.
- To provide the student with guidance when faced with academic pressures.

All of the goals mentioned above must be pursued within the frame of the European Higher Education Area. In other words, they must focus on the student's personal work and lifelong learning and mobility, and doing so within an open and multidisciplinary formation. This highlights the fact that accompaniment lends fundamental relevance in the elaboration and consolidation of one's professional project. In addition, and as a novelty, we also implement work on skills. Skills are, on the one hand, the combination of knowledge and its application, and on the other hand, the combination of abilities, attitudes and responsibilities that are required in order to carry out tasks: 50% knowledge and 50% behaviour. If you lack knowledge, you do not know how to do things and if you do not know how to do things, you cannot prove what you know, and if you cannot prove what you know, you cannot act, as shown in Fig.2.

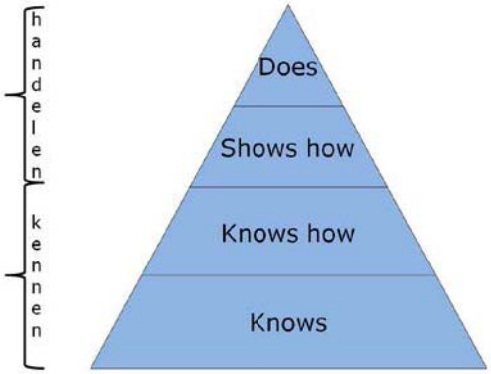

Fig. 2. Miller Pyramid

We are all tired of seeing students who memorize and systematically repeat problem-solving algorithms, and yet fail at the top level of the pyramid, when it comes to performing.

The development of professional and crossover skills demands a more personalised attention and guidance during the learning process and throughout the integration of different contents. This gives us more freedom to innovate and break the mould imposed by classic teaching methods and programs. In summary, we need and demand some form of tutorship, and must academically support and monitor the student during his/her personalised process of learning.

3 The teacher-tutor and tutorials

The university tutor cannot be the same as the secondary and upper secondary school tutor; given that his/her main role is no longer being the interlocutor between family and school. Within the university context, the tutor must be a teacher who knows the previous academic background of his/her students, has a working plan, chooses and carries out the most convenient techniques, guides the educational process, orients and advises and, in short, stimulates the ability of his/her students so that they take responsibility for their own learning and educational development. All of the above must be matched with a coherent attitude between the evaluation and the methodological approach [4].

Individual tutorship (online and one-on-one) is an interpersonal tutor-student relationship established through the interview process. The group tutorial consists of carrying out a tutorial session led by the tutor in a student group setting. Its key points are mutual support in the learning process, development of team working strategies, and efficient management of time. It has a triple dimension: instructive (teacher's role), human (given that an integrative education is what is actively sought out) and administrative (teachers often overstep their official duties).

The first tutor-student interview is crucial, because its main goal is to get to know the student: his personal and professional situation, his motivations and expectations, his study routines and strategies, etc. Once the academic year has begun, we start with what we can call "on-going university tutorials", aimed at galvanizing the student's impressions regarding the school, the teachers, the subjects, the didactic methodology used, the timetables, the activities and/or his/her personal concerns. This kind of tutorial also seeks to know the student's academic situation and assess his/her learning outcomes, study routines, and support needs. Finally, it answers any specific needs related to counselling and guidance. On a second level, we also have another kind of "on-going university tutorial", aimed at following and assessing the student's academic performance and personal learning. It seeks to develop general and/or crossover learning skills. Moreover, it looks to provide the student with specific information regarding curricula and available scholarships, as well as aids and resources. Lastly, we have the job market insertion tutorials,

whose goals are to provide continued educational counselling (master's degree, etc.) and provide information concerning job offers, public examinations, companies looking to hire new employees, etc. These tutorials also help the student write and prepare the necessary material in order to apply within the job market (forms, CVs, etc.). Ultimately, the job market insertion tutorials deal with holding informative sessions with graduates, professional bodies, associations and other related entities.

Concerning the group tutorial method, it can be defined as an attractive set of learning and group problem-solving experiences, which involves all the group members. Its main features are as follows:

- Cooperation: both the students and the teacher support each other mutually in order to attain a double goal: to master the content knowledge and develop team work skills. The students share goals, resources, achievements and an understanding of each other's roles and problems.
- Responsibility: the students take individual responsibility for their own tasks, as well as issues that are strictly personal, and which must be managed accordingly.
- Communication: the team members exchange important information and contents, efficiently and effectively support themselves, provide feedback so that they can improve their future performance, and analyse their personal conditions and reflections in order to attain better results.
- Collaborative work: together, the students learn how to solve problems, developing leadership, communication, trust, decision-making and problem-solving skills.

In sum, the group tutorial generates support systems that foster academic development, facilitate the acquisition and development of working skills, and promote improvement in peer relationships while also having an impact on the educational process. These systems also ease the transition into the job market (after having created a professional project within the university), and allow for an efficient use of time.

4 Some examples of group mentoring

We present some examples developed by our group which have afforded quite good results: Fundamental Concepts, Support, Remedial, Mainstreaming, Application, Reading-Debating Workshop, Puzzle Solving Technique or Problem Based Learning (PBL) [5] and [6].

4.1 Fundamental Concepts of Mathematics GM

Goals:

General: Increase academic performance in Mathematics subjects; Engender a positive attitude aimed at avoid frustration and students dropping out of the course; Develop capabilities: study, teamwork, creativity and decision-making

Specific: Establish basic concepts and algorithms; Standardize mathematical skills that facilitate adaptation to the university environment; Work on handling mathematical language

Procedure:

Diagnostic assessment aimed at identifying student needs. Selection of group members. Application of mentoring activities aimed at providing students with support in identified gaps in learning. Follow-up assessment, supplemented with a final exam.

Guidance regarding how to proceed: Progressively cover topics in an orderly way. Read the topic guides carefully. Be sure to understand and know how to solve all the examples. Attend self-assessment sessions. Once you know how to do the examples, move on to the next topic.

Methodology: Working groups of 7 students in classroom sessions; 1st session: The tutor presents the topics in a highly practical way and hands out notes on the topic and the tasks to be carried out by the group; 2nd session: public defence of the completed group assignment; the same format is repeated for each block of topics.

Contents: Algebra: Polynomials, factoring, algebraic fractions; Trigonometry; Vectors in the plane and in space; Equations and systems of equations; Matrix Calculus and Analytic Geometry. Calculus: Real and complex numbers; Inequalities and inequations; Sequences and functions; Limit and continuity; Derivatives, derivative applications; Immediate integrals, methods of integration and calculus of areas

Assessment: Spoken answers to questions to demonstrate understanding and the capacity to use the basic concepts of the subject successfully. Solving of problems aimed at testing competence in the required skills. Assessment exercises done outside the classroom.

4.2 Support GM

Goals: Improve academic performance; Take action regarding topics of proven difficulty in previous courses; Develop capabilities: study, teamwork, creativity and decision-making.

Procedure: Diagnostic assessment aimed at identifying student needs. The tutor/coach reinforces the concepts, helps discern the goals and their ramifications and encourages active participation. Application of mentoring activities aimed at providing students with support with respect to encountered difficulties.

Methodology: Working groups of 7 students in classroom sessions; 1st session: Employing a highly practical approach, the tutor reinforces the topics in which difficulties are usually encountered; the tasks to be carried out by the group are handed out; 2nd session: public defence of the completed group assignment; the same format is repeated for each topic addressed.

Contents: Improper integrals. Parametric Integrals. Functions of Several Variables: Domain, Image, Contours; Limits and continuity; Derivability and differentiability; Extremals.

Assessment: Spoken answers to questions to demonstrate understanding and the capacity to use the basic concepts of the subject successfully. Solving of problems aimed at testing competence in the required skills. Assessment exercises done outside the classroom.

4.3 Remedial GM

A group that is particularly sensitive to tutorial mentoring support is that of students who have failed the subject in the first semester. In some cases, failure is not a problem of lack of effort or ability, but rather a problem of a mismatch between the demands of the subject and learning outcomes. The aim is to provide effective guidance on how students should study, thus enabling them to learn what is being taught in a particular subject, placing special emphasis on the kind of exercises in which the most mistakes have been detected in previous tests.

Goals: Overcome academic failure; Take action regarding topics of proven difficulty in different assessment tests; Develop: study techniques, teamwork, creativity and decision-making.

Methodology: Weekly sessions covering the theory of the subject, solving of remedial exercises and pubic defence of these solutions.

Assessment: Self-assessment tests to measure the level of understanding and skill in using the algorithms for solving problems.

4.4 Mainstreaming GM

Many students have a vision of the subject as something alien to other parts of the degree. The aim is to work on mainstreaming or interdisciplinary skills such as the ability to analyze and synthesize and the development of interpersonal skills

Goals: Build systems to support academic development; Quality of teaching. Decrease the dropout rate; Develop: study techniques, teamwork, creativity and decision-making.

Methodology: Exercise involving searching for applications of the topics studied in the subject in other course subjects. Pooling of knowledge within the group to prepare a tree diagram, the branches of which represent the links between subjects.

Assessment: Pooling of knowledge and public defence of the completed assignment.

4.5 Application GM

Mathematics and the world: The aim is to work on finding practical applications. Students can choose any topic from the syllabus. In Fig. 3 basic guidelines are established and the group is given free rein to prepare a presentation that will be publicly defended, questioned and assessed.

Fig. 3. Applied learning

4.6 Reading/Discussion Workshop

We tend to separate reading, writing and speaking skills from performance in Mathematics. However, the main obstacle students encounter is problem solving, in which reading comprehension underlies the ability to develop the necessary strategies to solve the problem itself. Students have great difficulty in expressing concepts in words (and even more so in mathematical language). Despite this, they may be capable of solving the exercises they are set. Using texts on Mathematics and the world, reading/discussion workshops can help diminish the perception that the subject is unrelated to the real world.

Reading programme: We have chosen a text that allows the basic concepts of numbers, geometry, trigonometry and functions to be reinforced at the same time as linking them with the world around us in an entertaining way: "*Reflexiones sobre la Matemática y el Mundo que nos rodea*" [Reflections on Mathematics and the World Around Us] by Francisco Rivero Mendoza, lecturer at the University of the Andes. (www.saber.ula.ve , Monografías Facultad de Ciencias).

Reading/discussion: A month before the discussion, all the students receive the text and a Reading, Fig. 4, or Observer Sheet, as appropriate. Students in the subgroups acting as active observers (who also have to read the text) fill out an opinion sheet. The tutors use an assessment table containing ten items to assess oral and written expression on an individual level.

RECORD READING/DISCUSSION Reading/Discussion: "*Reflexiones sobre la Matemática y el Mundo que nos rodea*" Student:
1- Quote six Key-words that you consider highlighting in book reading
2- List ten words you did not know before reading the text, look them up in the dictionary and describe briefly
3- Describe three recount facts in the book that have particularly impacted you (historical, scientific, biographical, imaginative, etc..)
4- Make a summary of the main theme of the text and provides a scheme where its major parts and subsections are indicated (15-20 lines)
5- Make a reasoned overall rating of the text (I liked it before .... I did not like it before ... it has been difficult for me to follow ...)
6- Investigate a brief biography of the author. Do you already know him? Does he have other similar works? Does he have any awards? ...

Fig. 4. Reading Workshop

Discussion: An hour in length. Students in the two subgroups into which the large group is divided express their opinions and answers to questions and suggestions from the tutor/moderator, Fig. 5. The roles of the discussion and observation subgroups are exchanged in subsequent discussions.

Fig. 5 Discussion Workshop

4.7 Puzzle Solving GM

A group of students must autonomously recompose a topic from the syllabus that has been previously split up by the tutor. To do so correctly, they have to: understand, become experts, integrate and apply the concepts they are given as well as related concepts. The learning process is led autonomously by the group of students and is cyclical in character, generating new learning needs.

Goals: Puzzle solving (Aronson) is a cooperative learning technique: It promotes self-directed learning and increases academic performance. It encourages continued study of a subject, thereby enabling the furthering of knowledge. It develops the social skills needed to interact with other members of the group and assertively expound one's own point of view. It promotes learning autonomy.

Methodology: The tutor splits up a lesson into three parts as shown in Fig. 6. Groups of 6 students are formed, assigning one part to each pair of students. First phase: individual reading time (15 minutes). Second phase: those responsible for the same part, but from different groups, come together to clarify any doubts that may have arisen (15 minutes). Third phase: students

return to the original group for each of those responsible for each part –now experts in the matter– to explain their part of the topic to the group (30 minutes). Fourth phase: an example proposed by the tutor is solved as a team (30 minutes). Fifth and final phase: each student solves an exercise individually (15 minutes).

Assessment: There are two marks: The mark corresponding to the exercise solved by team (fourth stage) and the mark corresponding to the exercise solved individually (fifth phase). The grade will be the average of the mark obtained in the two tests.

Second order linear differential equations: $y''(x)+a(x)y'(x)+b(x)y(x)=f(x)$

General solution: $y=y_h+y_p$, where y_h is the general solution of associated homogeneous equation and y_p is the particular solution of nonhomogeneous equation.

Case homogeneous: the associated homogeneous equation with constant coefficients, $y''(x)+ay'(x)+by(x)=0$, a,b ctes.

The objective is finding two **linearly independent** solutions y_1, y_2 and the general solution is a linear combination of them: $y_h= C_1\, y_1+ C_2\, y_2$.

Definition. The algebraic equation $k^2+ak+b=0$ is called the characteristic equation (ch. eq.) of the differential homogeneous equation with constant coefficients $y''(x)+ay'(x)+by(x)=0$.

We distinguish three cases:

1. Two real and distinct roots: k_1, k_2;..... $y_h = C_1e^{k_1x} + C_2e^{k_2x}$
2. Two real and equal roots: $k_1= k_2$;..... $y_h = C_1e^{k_1x} + C_2xe^{k_1x} = e^{k_1x}(C_1 + C_2x)$
3. Two Complex roots: $k = \alpha \pm i\beta$..... $y_h = e^{\alpha x}(C_1\cos(\beta x) + C_2 sen(\beta x))$

Case nonhomogeneous: The objective is finding a particular solution y_p of nonhomogeneous differential equation. We consider two methods: Method of Undetermined Coefficients and method of Variation of Constants.

Method of Undetermined Coefficients

The right side $f(x)$ of a nonhomogeneous differential equation is often an exponential, polynomial or trigonometric function or a combination of these functions. A choice for the particular solution y_p should match the structure of $f(x)$.

$f(x)$	y_p	k
$P_m(x)$	$A_m(x)x^k$	k=0 if 0 is not a root of ch. eq. k=s if *s* is the order of the root 0 in the ch. eq.
$e^{\mu x}P_m(x)$	$e^{\mu x}P_m(x)\,x^k$	k=0 if μ is not a root of ch. eq. k=s if *s* is the order of the root μ in the ch. eq.
$P_m(x)\cos(qx)$ $P_m(x)sen(qx)$	$(A_m(x)\cos(qx) + B_m(x)sen(qx))x^k$	k=0 if *qi* is not a root of ch. eq. k=s if *s* is the order of the root *qi* in the ch. eq.
$e^{px}P_m(x)\cos(qx)$ $e^{px}P_m sen(qx)$	$e^{px}(A_m(x)\cos(qx) + B_m(x)sen(qx))x^k$	k=0 if *p+iq* is not a root of ch. eq. k=s if *s* is the order of the root *p+iq* in the ch. eq.

Superposition Principle. If the right side of a nonhomogeneous equation is the sum of several functions of kind exponential, polynomial or trigonometric or a combination of these functions then a particular solution of the differential equation is also the sum of particular solutions constructed separately for each term in the right side.

Method of Variation of Constants

If the general solution y_h of the associated homogeneous equation is known, then the general solution for the nonhomogeneous equation can be found by using the *method of variation of constants*.

Let the general solution of a second order homogeneous differential equation be

$$y_h = C_1\, y_1 + C_2\, y_2$$

where y_1, y_2 are linearly independent solutions of associated homogeneous equation.

Instead of the constants C_1 and C_2 we will consider arbitrary functions $C_1(x)$ and $C_2(x)$. We will find these functions such that the solution $y_p = C_1(x)\, y_1 + C_2(x)\, y_2$ satisfies the nonhomogeneous equation with the right side $f(x)$.

The unknown functions $C_1(x)$ and $C_2(x)$ can be determined from the system of two equations:

$$C_1(x)y_1 + C_2(x)y_2 = 0$$
$$C_1(x)y_1' + C_2(x)y_2' = f(x)$$

Fig. 6. Puzzle Solving Example

4.8 PBL GM

A group of students has to find the answer to a question or solve a problem, both autonomously and guided by the tutor. To do so correctly, they have to: programme, search, understand, integrate and apply basic as well as related concepts. The learning process is led by the students and is cyclical in character, generating new learning needs.

Goals: For students to be able to find out what they need to know to advance in the solving of the set question or problem. As the programme advances, they will be responsible for planning, reading up on and developing those aspects needed to solve the problem. It fosters: interdisciplinary learning and integration of knowledge, teamwork, creativity and decision-making.

Methodology: It consists of 8 phases:

1 - Read and analyze the problem

2 - Brainstorming

3 - Listing the known

4 - Listing the unknown

5 - List of actions needed to solve the problem

6 - Defining the problem

7 - Getting the necessary information

8 - Presenting results

An example: Mosquito Control

Presentation of the problem: As can be seen in the provided newspaper article, we are suffering a hitherto unknown plague of mosquitoes. The usual methods of controlling mosquitoes do not seem to be effective against this plague. Students have a week to determine its causes and recommend the most suitable solutions.

Identify what we know, what we need to know and our ideas about the problem:

We know that: We have to find the causes of the problem. Time available: one week. Mosquitoes can travel large distances ranging between 50 and 60 kilometres. The amount of rainfall was normal this year.

We need to know: The geography of the area, whether the mosquitoes are indigenous, the conditions that make mosquitoes proliferate, budget, whether local drainage systems have recently changed.

Ideas: Perhaps there is a large amount of stagnant water in the region. Some kind of natural event may have led to the water stagnating (logging). Mosquitoes have become resistant to the fungicides employed against them due to mutation or adaptation.

State the problem: How can we reduce the mosquito population to its usual size so as to then consider the environmental impact, reduce health risks and prevent this phenomenon from happening again, all within a feasible budget?

Gather information: Information on varieties of mosquitoes and their control, information on changes in population and land use in the affected area was gathered from the Internet and the nearest public library.

Possible solutions:

Strategies: Education campaigns (announcements in the press, talks with representative community groups, etc.); and application of chemicals

Advantages: Low cost, public funds, etc. Drawbacks: Cost, fear, lack of interest, is it not the responsibility of public bodies?

Consequences: Change the way people think and behave; potential help to reduce the problem of mosquitoes; spread knowledge of the ecosystem.

Determine the best solutions: A combination of: an educational campaign, application of chemicals and further research.

Presentation of the problem: A group of specialists was formed who listened to the proposals and gave their views on these proposals.

Final Report: The entire group gets together to discuss the lessons learned on the topic and their experience as researchers. Students answer two questions in writing: What do you think of the problem and what did you find out? What questions remain unanswered?

Assessment: Monitoring tests. Pooling of knowledge, public defence of the report and a proposed questionnaire.

Other examples: What do the police do when they want to check the speed of a vehicle?
Why is there harmony in nature?

5 Results and conclusions

The following is a list of some of the achievements of Group Mentoring sessions of this kind:

- We have achieved the involvement and participation of a large group of students
- Over 85% of students coming from Vocational Training regularly attended the Fundamental Concepts, Support and Remedial GM sessions.
- Approximately 40% of these students achieved the minimum established grade.
- We have achieved the participation of 8 groups of students in the Mainstreaming GM, who made interesting contributions
- The reading/discussion workshop, which was established as obligatory for one experimental group, was a very enriching experience for tutors and students alike.
- We highlight the surprise expressed by students when achieving learning goals via the Puzzle Solving GM
- Students score mentoring very highly on account of it being specific, involving small groups and the fact that it fosters self-learning
- Participation in GM sessions started off with almost 33% of all students (5 groups of 7), but fell to 24% (5 groups of 5) over the semester
- The joint action of different types of group mentoring sessions favoured results that were made evident in continuous assessment tests, classroom practicals and laboratory practicals. Between 30 and 50% of the students participating in these GM sessions passed the subject in one or other of the exam periods.

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