WEAK INDUCTIVE TEACHING METHODS AND GAMIFICATION. RESULTS BASED ON STUDENTS NETWORKS ANALYSIS

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Abstract

The aim of this paper is to present an experience of teaching innovation and their results, which focus on a weak variant of the inductive teaching methods and flipped classroom with gamification, as an intermediate way considered between deductive and inductive methods of teaching.

Moreover, to deny the versatility of the technological advancement close to its continued use by teachers and students it would be a contradiction. In other words, if the student does not find a friendly environment, they turn its attention and interest in the conceptual and practical contents that, in the future, could determine their social-labour inclusion. On the other hand, the relationships among students who participate in these inductive methods or in the gamification experience generate cliques (a maximally complete subgraph, a group) of students that displace the average mark to the right, improving the academic achievement at the same time that the gamification motivates them to the previous class preparation. Furthermore, the paper finds some relationships between social-academic indicators and social networks indicators of student groups.

Keywords: Flipped Classroom, Gamification, Inductive Teaching, Social Networks Analysis.

1 INTRODUCTION

This paper briefly describes a teaching innovation experience and its derived results, through a weak variant of an inductive teaching methodology called flipped learning (flipped classroom, FC). In other words, a combination of inductive channels (with an open, practical, critical, creative nature in step with the times), rather than based on deductive or conventional methods (with a nature that is, compared to the previous one, closed and a transmitter and reproducer of contents). Scholars in this area regard it as a third way to the two previous ones.

A good part of the reason for implementing these strategies comes from the meaning of being a teacher, from living its reality and its circumstances. If the times are changing, however much we strive to admit that “there is nothing new under the sun” (Ecclesiastes 1:9), denying that evidence and denying the versatility of technological progress toward teaching, both in hardware and in software applications, it does not make sense. Reality shows the teacher using new technologies and the learner familiar with their daily use, especially with interactive, network applications. Therefore, students tend to disconnect their attention and interest in conceptual and practical content, which may determine their socio-labour inclusion, because they do not find a friendly learning environment.

Such use in current teachers and learners of Information and Communication Technologies (ICT) is the only thing that separates us from the intentions, already documented almost 250 years ago, in the Study Plan of Pablo De Olavide for the University of Seville, in 1768, noting that “We consider the fact that professors dictate and their disciples write down their lessons every day absurd and worthy of correcting. This method produces no effect other than to make the youngsters waste their time and writing” [1].

The paper begins with a section expounding some brief fundamentals about the mixed methodology that it has been implemented, given the vast literature, which is increasing, on the subject. It continues with a description of the experience and the results according to certain socio-academic indicators. Some conclusions close the article.
GENERAL CONTEXT OF THE EXPERIENCE AND METHODOLOGY: USE OF INDUCTIVE METHODS, FLIPPED TEACHING AND COOPERATIVE AND COLLABORATIVE LEARNING

Aware of the controversy of offering a synthesis on what FC is, and following Bergmann and Sams [2] or William Hoover, consultant of the Department of Science and Engineering of the Bunker Hill Community College (BHCC), Massachusetts¹, it can be argued that it consists of the student consuming content autonomously and prior to a subsequent stage of the strengthening of the learning and going into depth in the appropriate materials in the time when present in the classroom; always in a process in which the elements of training assessment, not only summative -traditionally focused on results- in addition to the contribution of the learning of the student and of the group [3].

The inductive methods are justified by neurological and psychological research [4], and educational research, which stimulates learning and intellectual development [5] [6]. It is, nothing more and nothing less, about being creative. In addition, it should be borne in mind that traditional methods -deductive- are concentrated on transmitting, exemplifying and subsequently checking by the teacher and the students, and not on identifying what needs to be learned, exploring, discovering and inducing conceptual and applied contents, which would be competences associated to inductive methods [7].

As a result, there would be no better way to achieve the adaptation to the learning needs of students: assess their training, and not only their academic results (for example, reduced to an objective test or to tasks to present to the teacher). In addition, the implementation would result in a better approximation of the result of the effective learning to the potential of the learner compared with that resulting from traditional methodologies. That is to say, it would sum the value added of offering an image of modernity to the teacher and to the institution, together with a certain “contagion” or “pull” effect to other students who are not the subject of the methodology. There is also evidence on its transfer to a greater number of students and, therefore, to the improvements in performances of the group [8] [9], or weblogs such as “Growth in Flipped Learning,” https://www.sophia.org/flipped-classroom-survey, among others. All of this, also aware of the limitations arising from the heterogeneity of the potentiality of the prior training of groups of students. Thus, in the inductive methods, unlike the deductive ones, the training is assessed.

Inductive methods include, in the experience presented, Cooperative Learning (CL), that is, generically, a set of pedagogical strategies the aim of which is to unite efforts of different students, in groups, to achieve common objectives in the learning [10] [11]. Outstanding and less gifted students help each other, particularly the former help the latter. The rule that follows is that there is no group success if there is no result of the members. The difference of CL with Collaborative Learning (CoL) is that the latter can allow a certain disorganization in the structure of the learning where the teacher proposes “the problem” to the group and the personal competence of each member tries to approaching his/her potential learning for the common benefit of the group.

Accordingly, they are not simply ways of grouping students. Their relevance comes hand in hand with the group achieving a common reward, unlike traditional Teaching-Learning Process (TLP), in which an individual, or group, reward was obtained, but based on a group study task, not on a group reward based on obtaining individual learning [12]. CL requires distribution of tasks between the components of the group, each member in charge of the solution or their part that ends up connecting with the CoL on making the latter responsible, partially, for the results of his/her learning in agreement with the rest of the members of the group: among these a TLP is started. If there is an auto- distribution of the teamwork mark between the members, then a self-assessment of the group is also added, and the responsibility and the incentive for the TLP to be effective increases and, thus, the group and the individual academic results that guarantee “a priori” the apprehension of specific competences of the subject. I addition to this, is summed other indirect content potentially retained in the form of cross-curricular competencies that are not reflected in traditional academic results. That is to say, more density of social relations, ethics in the work or interpersonal cooperation, among others.

¹Professor recognised for the development of individualised and alternative methods of teaching. The Professor is a leading scholar and spokesperson in the design of courses associated to flipped teaching in Higher Education with McGraw-Hill Education. He belongs to the BHCC as company consultant and agent dedicated to introducing creativity into learning; he is a leader in the implementation of distance learning technologies and methodologies based on computing to improve and strengthen the learning environment, and has won prizes for the diversity of his students: both in terms of the number of languages, 75, as well as in countries, 100.
3 WEAK PROPOSAL ON INDUCTIVE METHODS. INTENTIONAL EXPERIENCE AND FEASIBLE EXPERIENCE

If the goal is for the student to continuously study without realizing it, without coercion, with the aim of obtaining better academic results through ICT, platforms, and web databases, games on contents, both individually and in pairs and in groups of students, then the feedback is essential, as the intentional experience will be different to the feasible experience.

The experience presented is a non-invasive strategy to increase the actual hours of work of the student to get used to research, in parallel to the teacher learning what are the difficulties of students of understanding the theoretical-practical content, and to get a better understanding of what the student considers more and less interesting. The result is an optimization of times for the teacher and for the student, that provides a prize to the work of teachers and learners, thanks to providing Just In Time Teaching (JITT, hereinafter; [13]) questionnaires, and with groups of questions in platforms such as “Kahoot!” between pairs (with random selection of them) in real time. In other words, including the Peer Instruction [14] to the Gamification. Delivering group activity newsletters implementing CL and CoL is also added (section 2). The resulting group is a weak version of inductive-inverted teaching or FC [2].

Accordingly, the 2nd year of International Economy in the Degree on Business Administration for the academic year 2015-2016 (Faculty of Economics and Business of Albacete, University of Castile-La Mancha) is a yearly subject. Its assessment is divided into two: 70% by examination (35% if partial: fifteen test questions, four concepts and two questions that occupy one page), and 30% (1.5 points each four teaching units) made up of productive attendance (to participate and to answer questions in class), classification in the Kahoot! games. (first four teaching units), the score for participating in the four JITT questionnaires, one per unit of the topics, and the delivery of one group activity newsletter.

The flipped teaching methodology based on “strong” version would require for each teaching unit (Screenshot 1): first, availability of bibliographic and audiovisual materials; second, the students must work; subsequently, asking for an answer to a questionnaire on line (Screenshot 2) of Google Docs (either via Survey Monkey or other); finally, control and credit research answering the questionnaires on line (JITT) and through gamification (Screenshot 3), on competitions in pairs through queries and Peer Instruction) in class. Moreover, in our case, CL+CoL is added, with the delivery of pack of exercises in applied economics with queries in international socio-economic databases on the internet (UNDATA, UNCTADSTAT, LABORSTA, DATABANK of the World Bank, among others), to construct, to compare and to interpret socio-economic indicators, its evolution (time) and between countries (space).

The procedure would be to flip the class together with the JITT, with the students filling in questionnaires on the difficulties in understanding the content, on what they consider most and least interesting or going more into depth, and trying to follow the objectives marked by teaching unit. Hence, training is assessed and rewarded, and not only the results. With this information, classroom teaching is focused on the difficulties of the students, what has been best assimilated is put into context and an attempt to go into depth into what is the most interesting is made. However, in the case presented, the results are not very positive: 12.6% of the class has studied the subject continuously and with research before the flipped class: 20 students out of 171. Accordingly, the experience had to be corrected, including a theoretical and practical master class, to get a second wave for the JITT of the teaching unit. This added the involvement of more students (motivate-check-score scheme). The most frequent difficulties were then strengthened and were stressed to the participants. The median participation was 1 out of every 5 students in JITT; falling from 31 students, in the first subject, to 11 in the fourth teaching unit.

All of the variables above are correlated with the class attendance. The course has 171 students (for whom nicknames were generated to enter the games and be identified), in two groups: 96 and 75, for morning and afternoon, respectively, with very low attendance levels, that only increased from 47.8% to 48.5% of those enrolled. They do not come to the class because they think that the materials in the web of the subject (Moodle platform) are sufficient. Depending on groups, attendance in the morning group drops and increases above all on the gamification days, when they must demonstrate that they know of the contents. The morning group drops from 53 to 49 students and the afternoon group increases from 32 to 35. A total of 102 out of 171 students have played, entering and exiting each of the 4 competitions of the 4 teaching units of the first four months, which ends on 19 January 2016, the day of the partial exam of the course. Only 63 pupils (out of 171) took this exam, 21 of whom passed,
33.3% of those attending: all the passes take part in the flipped methodologies of a weak nature described. It seems that attendance, research, participation and results of the exam are related.

Finally, the introduction of CL+CoL strategies, to be carried out outside the classroom, showed that 13 out of 171 students do not participate and there are 20 students who use social loafing (hereinafter, SL; [15] [16]. The contribution of the student to the group effort is difficult to identify, but if the teacher requires from the group an agreed distribution of the group’s mark he/she may detect the SL: these are the students with the lower academic performance in all dimensions of the evaluation considered.

**Tema 1**

**LA ACTIVIDAD ECONÓMICA Y SU MEDICIÓN**

(Remember the study of the Lección 1 of "Lecciones sobre Economía Mundial", directed by José Antonio Alonso, in each semester since 2009, as part of the first chapters of the texts recommended in the Guía Docente sobre Introducción a la Economía Mundial)

- Presentación del Tema 1
- Big Mac Index actualizado
- Notas técnicas IDH 2014
- Base datos del IDH 2014
- Informe sobre Desarrollo Humano 2014
- Práctica 0: Indicadores absolutos y relativos
- Database Banco Mundial

Para cambiar a otro base de datos, modificar el campo Base de datos en la ficha desplegable. Por defecto está "indicadores del desarrollo mundial"

- Práctica 0: Indicadores calculados para su comentario
- Práctica 1: Competitividad Internacional vía Coste laboral Unitario
- Práctica 1: Tablas 1 y 2 para cálculos
- Práctica 1: Indicadores calculados para su comentario
- Cuestionario Just In Time Teaching TEMA 1

**TAREA NO OBLIGATORIA.** Contestar entre el 22/10 y las 17:30 del 27/10, y solo después de haber introducido el tema, sea con varias lecturas, sea con un estudio más profundo de notas y materiales.

**SCREENSHOT 1. General configuration of a teaching unit in the Moodle platform (The subject is taught in Spanish).**
### Cuestionario Tema 2 para Just In Time Teaching

- **Objetivo:**
  
  Apellidos y nombre

  Indica cuál de las opciones te parece más importante que esté aprendida en el tema.

  ¿Qué parte del tema te parece más importante en clases? (Por qué?)

  ¿Qué parte del tema te parece más importante en cuestiones? (Por qué?)

  ¿Qué es lo que te ha quedado más claro del tema? (Por qué?)

  ¿Qué parte del tema no necesitas que te explicuen? (Por qué?)

  ¿Cuánto tiempo has tardado en leer las materias (notas y fuentes recomendadas) y contestar este cuestionario?

  Nivel de autonomía (0-10)

### Información adicional

- **Resultados en Excel obtenidos de Google Docs (abajo).**
- **Training assessment I**
  
  El (el) tema es taught in Spanish.
4 RESULTS

The global average mark of the two groups at the start of the course was 5.07, and the course has an equivalent mark of 4.60, although 58.4% of the students have taken part in weak inductive learning methods and almost 1/3 have taken the partial exam (63 students). The differences are:

a) Morning group, with an average mark of 5.28, and 4.7 in the course as equivalent mark of the four months; group in which 65% of the students take part in weak inductive methods.
b) Afternoon group, with an average mark of 4.8, and in the course has an equivalent mark in the four months of 4.5; group in which 51% of the students adopt weak inductive learning methods. However, those taking the exam from the afternoon group obtain a higher academic performance, which is somewhat related with the students’ social networks. Hence, the reciprocity of students in networks is also a relevant aspect. The morning group’s network for the students taking the exam is more reciprocal than that of the afternoon, each student knows 18 classmates and on average 12 know them. While the afternoon group's network, always for those taking the exam, it is seen that a student knows an average of 19 students while 11 students know him/her, on average (Table 1). Accordingly, the student who studies on an ongoing basis and prior to the classes is a person who is more socially confident. In the general networks, considering both the students taking the exam and those not taking it, in the afternoon group it is seen that the average student knows 12 students and 11 students know him/her, while the average student in the morning group knows 13 and 12 students know him/her, with a similar reciprocity (Table 1).

Table 1. Network Cohesion\(^{(a)}\)

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Morning Group</th>
<th>Afternoon Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree Centralization(^{(b)})</td>
<td>0.623</td>
<td>0.357</td>
<td>0.682</td>
</tr>
<tr>
<td>Density(^{(c)})</td>
<td>0.055</td>
<td>0.061</td>
<td>0.053</td>
</tr>
<tr>
<td>Fragmentation(^{(d)})</td>
<td>0.602</td>
<td>0.684</td>
<td>0.651</td>
</tr>
<tr>
<td>Arc Reciprocity(^{(e)})</td>
<td>0.076</td>
<td>0.093</td>
<td>0.068</td>
</tr>
<tr>
<td>Dyad Reciprocity(^{(e)})</td>
<td>0.039</td>
<td>0.049</td>
<td>0.035</td>
</tr>
<tr>
<td>Bonacich Power(^{(f)}) Beta value</td>
<td>0.101752767</td>
<td>0.237879168</td>
<td>0.148074716</td>
</tr>
</tbody>
</table>

Notes: (a): Indicators to explain the network cohesion. The specific Cohesion Indicator is found in the next two Graphs, 1 and 2. The length of a path is the number of edges it contains. The distance between two nodes is the length of the shortest path. The distance matrix can be converted to a nearness matrix by taking reciprocals of the distances. (b): For a given binary network with vertices v1,...vn and maximum degree centrality cmax, the network degree centralization measure is \(\sum (c_{max} - c(v_i))\) divided by the maximum value possible, where c(vi) is the degree centrality of vertex vi. (c): The density of a network is the total number of ties divided by the total number of possible ties. The density of a network is simply the average value of the binary entries and so density and average value are the same. (d): Fragmentation is the proportion of pairs of nodes that cannot reach each other. Distance weighted fragmentation is one minus the average reciprocal distance between all pairs of nodes. Node level fragmentation are these values that involve the specified node. Fragmentation centrality of a node is the difference in the total score with the node removed. (e): A tie is reciprocated if whenever a tie is connected from actor A to actor B then there is a tie from actor B to actor A. We can either count the number of dyads connected by a tie (which may or may not be reciprocated) and calculate the proportion of dyads that have reciprocated ties (the dyad based method) or we can count the number of arcs (directed edges) and calculate the proportion of arcs that are reciprocated (the arc based method). The routine also calculates the amount of reciprocated ties between partitions of the actors, in this case a combination of arc based and dyad based measures is possible and this is known as the hybrid method. (f): Given an adjacency matrix A, the centrality of vertex i (denoted ci), is given by \(ci = \sum \alpha A_{ij}(\alpha + \beta c_j)\) where \(\alpha\) and \(\beta\) are parameters. The centrality of each vertex is therefore determined by the centrality of the vertices it is connected to. The value of \(\alpha\) is used to normalize the measure, the value of \(\beta\) is an attenuation factor which gives the amount of dependence of each vertex's centrality on the centralities of the vertices it is adjacent to. The normalization parameter is automatically selected so that the square root of the sum of squares of the vertex centralities is the size of the network. (That is the Euclidean norm of the vector equals the number of vertices). The parameter \(\beta\) is selected by the user, negative values should be selected if an individual's power is increased by being connected to vertices with low power and positive values selected if an individual's power is increased by being connected to vertices with high power. Note a value of zero would give the out-degree of each vertex. Source: The Ucinet software tells us how to cite it: Borgatti, S.P., Everett, M.G. and Freeman, L.C. 2002. Ucinet 6 for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.
Graph 1. Network of morning group students (n=96). Centrality=0.1157. Cohesion=0.078 (number of links between the maximum possible). Nuclear nodes (cliques-red), those most related, part of flipped methodologies, but these do not correspond fully with the best academic performance. Of the students taking the examination from the morning group (38), 73.4% take part in the weak inductive methodologies. Source: Student surveys and Borgatti, S.P., Everett, M.G. and Freeman, L.C. 2002. Ucinet 6 for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies (The authors of UCINET software tell us how to cite it)

Graph 2. Network of afternoon group students (n=75). Centrality=0.2199. Cohesion=0.058 (number of links between the maximum possible). Nuclear nodes (clique-red), those most related, part of flipped methodologies, but these do not correspond fully with the best academic performance. Of the students taking the examination from the afternoon group (25), 88% take part in the weak inductive methods. Source: Student surveys and Borgatti, S.P., Everett, M.G. and Freeman, L.C. 2002. Ucinet 6 for Windows: Software for Social Network Analysis. Harvard, MA: Analytic.

According to the experience described, the more centralized networks but less cohesive around a denser clique—which is the one that is part of weak flipped teaching methodologies—obtain better academic performances in the subject, despite coming from groups of students with higher average overall marks (Graph 1 and 2). They move the average mark of the groups who have chosen inductive
learning to the right compared with the group that does not implement it, or with respect to the group that does so with less intensity (Figure 1). In the meantime, Figure 2 shows some association between the flipped teaching implemented, the best academic record and the female sex.

**Figure 1.** Histograms of equivalent marks [HipotéticaMI (*)] for the first teaching units of International Economics: Morning (M) and Afternoon (T) Groups depending on having accepted weak inductive methods of learning ((Metind, Yes=SI or No=NO) (n=171). Notes: (*) The contribution of the score of the first four months to the total of the course must be multiplied by 2. Source: Student surveys.

**Figure 2.** Histograms of the average global marks at the beginning of the course (Notamedia), acceptance of weak inductive methods of learning (Metind, Yes=SI or No=NO) and sex (Male=M, Female=F) (n=171). Source: Student surveys.
Finally, the academic performance of the subject under previous work or study is explained inversely to the popularity of the student; directly with the membership of the afternoon group, which has the highest density of students in inductive teaching methods; directly with the female sex; as well as with the condition of taking part in these methodologies; and strongly with attending class and overall academic performance at the start of the course (Table 2).

5 CONCLUSIONS

The weak inductive teaching methods with gamification, based on use of ICT by the students and CoL, increase the academic performance of the subject, which is powered by traditional variables like the student attendance, and the mark average previously course starts, and it is specially boosted by the cohesion (density, centralization, reciprocity) of the student social network instead of by fragmentation or by the popularity of the student in the social network. In addition, cohesion helps to increase student involvement and his work and, consequently, increases academic performance. Moreover, these methods is mostly followed by female, which obtain higher average mark. Finally, the above results are independent of the student group used in the models.

REFERENCES


[2] J. Bergmann & A. Sams, 
Flip your classroom: reach every student in every class every day.


