

Chapter 2

An Experience in Teaching Innovation Based on Collaborative Learning and the Aronson Jigsaw Technique

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Abstract Jigsaw technique is a collaborative learning technique that can be used as an alternative to conventional teaching methods. Basically this technique boosts group work cohesion since each member of the group is in charge of one part of the learning objective of the whole group. This work shows the experience of using the jigsaw technique in an undergraduate course named “Innovation and Competitiveness”. The learning objective of the activity consists of highlighting the most important ideas of the “Oslo Manual” which is a reference manual in innovation concepts. The process is divided into five steps: (1) initial groups of five students are formed; (2) professor gives five parts of the “Oslo Manual” and the group decides which member will be the “expert” of each part; (3) experts of each part work together to understand and summarize main concepts; (4) experts come back to the initial group and transmit their expertise to the rest of the group; (5) professor asks for a “one minute question” regarding one concept or idea of the Manual. Results from this experience show that students feel that they are not only responsible for their own learning but also for the learning of the rest of the group. The inclusion of the “one minute question” after the process further enhances this feeling. Furthermore, it is known that sharing our knowledge with other people requires a deep understanding of the topic. As a conclusion, this experience improves not only the self-confidence of the student, but also the communicative competence and group work performance whilst students work and assess important concepts related to the course.

2.1 Introduction

The process of establishing the European Higher Education Area, EHEA, has meant a reorganisation of University education at each of its different levels. With this in mind, the Spanish Ministry of Education and Science released, on the 26th

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September and 21st December 2006, and the 15th February 2007 respectively, three work documents with general directions for the creation of university qualifications for Degree and Master's in accordance with the EHEA directives. To this same end, on the 29th October 2007 a Royal decree, RD 1393/2007, was passed by way of which the structure of Spanish university education was established (Degree, Master's and Ph.D.). From this point on, new Degrees are designed in accordance with the skills that a graduate will need in order to carry out his or her profession. These skills are defined in the study programme and, by way of the modules and subjects studied; skills are acquired as a result of the learning process. Once a Degree course is completed, a European Supplement is incorporated into the qualification as established by the Royal Decree RD 1044/2003, of the 1st August 2003 which details the skills acquired with a view to enabling the graduate to gain access to a Master's Degree course and later a Ph.D. course at any university in the EHEA (Spanish Ministry of Education, Culture and Sport 2003).

The entry of Spanish universities into the EHEA has meant a change in routine in the university classrooms and lecture halls. The main change revolves around considering the student as the epicenter of the teaching-learning process. This implies that the teacher must play the role of a guide in the learning process, replacing their traditional role as imparter of knowledge. Adapting to the EHEA has also led to a profound curriculum-based change in course programmes, which must adapt to the demands of the labour market, developing with this end in mind, learning opportunities based on professional skills.

As a consequence of all the above, more and more examples of active techniques are to be found in the classroom. Thus, for example, videos, case studies, debates, portfolios, learning based on solving problems or projects, etc. are increasingly used as habitual teaching tools. However, these techniques are often in reality used as a way of motivating and implicating the student in the teaching-learning process, without much thought into why each of them are used and, above all, which skills they are helping the students to acquire. With this in mind, the great difficulty of the new teaching-learning paradigm involves the choice of the most suitable methodology, especially in the case of the so-called generic or transversal competences, in which wide-ranging skills are developed which are more related to "know how" (skills) and "know how to act" (behaviour) in a particular profession than "to know" (knowledge) purely for its own sake. One valid solution in these situations is to employ collaborative learning strategies, which allow work on competences such as group work, time-management, ethical responsibility towards work, etc. considered, in most degrees as being part of the generic competences which might be expected of all graduates.

In this study, the collaborative learning technique, the Aronson Jigsaw, was used as a teaching method during the teaching of part of the syllabus of "Innovation and competitiveness", a subject which is part of the Business Administration and Management Degree at the Universitat Politècnica de València. The aim of the experience is to increase the degree of student involvement both in their own learning process and in that of their classmates, through the ethical responsibility of each student, group work and communication. This article is set out in the following way. After the introduction there is a description of collaborative learning, consisting of its main characteristics and the advantages which it provides. In the next section, the

Aronson Jigsaw technique is explained in general terms, as a way of introduction to the following section which deals with the application of the technique to the present experience. The phases and their scheduling and the method used for evaluating the experience are explained. The next section is dedicated to the results achieved by the experience. Lastly, the main conclusions drawn by the study are presented and the future direction of the study is outlined.

2.2 Collaborative Learning

The main characteristic of collaborative learning is that it is the students themselves, working as a team, who play the role of tutors in the learning process of their classmates, while, at the same time, being tutored themselves by the other students. In this way, a healthy interdependence is produced, given that each one can achieve their objectives if the others also achieve theirs. The students do not depend excessively on the teacher; they are the constructors of their own learning and, fundamentally, of that of their classmates. For this reason, it is classified as a meaningful learning technique as it considers the student to be the main protagonist of the teaching-learning process (Bisquerra 2006).

Within this type of learning there are various techniques, which are differentiated by the amount of autonomy the student is given. The benefits of using it in the classroom are twofold: (1) it encourages students to learn in a co-operative way, and (2) it allows the achievement of different learning objectives, not only in terms of content, but also in the development of skills and interpersonal dexterity linked to the acquiring of competences (Prieto 2007).

In fact, the five key distinct elements of collaborative learning are directly related to the development of interpersonal competences (Johnson et al. 1999), generally, they are considered as generic competences in course programmes. The five elements can be summarised as follows:

1. **Cooperation.** Students are linked with each other in order to carry out a task. If they each obtain their individual goals, the final objective of the task is achieved. There exists a healthy interdependence between the students. The success of one student, thus, depends on the success of the whole team. Consequently, the students support each other mutually and share goals, resources and achievements.
2. **Individual Responsibility.** The students are individually responsible for the part of the task which has been assigned to them. At the same time, however, they are also responsible for the final results of the group, which complements the concept of cooperation.
3. **Communication.** The members of the team must work together and learn from their classmates if they are to achieve the objectives expected of them. This requires the exchange of information and materials, helping each other, debating the different points of view, explaining the assigned task to the others, giving feedback and everything that involves communication in order to achieve the best quality results.

4. **Teamwork.** Students learn to solve problems together, developing leadership skills, communication skills, trust, decision-making, conflict resolution, and all types of social skills necessary for a group to function well.
5. **Group Self-assessment.** Teams must have the opportunity to assess the learning process that the group has followed through, so as to analyse which actions have been useful and which have not. The result of this assessment provides valuable information when it comes to identifying what changes must be carried out in order to improve their work in the future.

2.3 The Aronson Jigsaw Technique

One of the most commonly used techniques in collaborative learning is the Aronson jigsaw or puzzle (Aronson et al. 1978). In this technique students “teach” part of the curriculum of a subject to a small group of their classmates (Moskowitz et al. 1985). The Aronson jigsaw has been applied to many different fields, although it is usually used at secondary school or university level, given that it requires a series of social capabilities and skills to bring it to a successful outcome. The great advantages of this methodology are particularly based on the cooperation between the students; this, amongst other things (Martínez and Gómez 2010):

- Improves collaborative learning.
- Fosters a positive attitude amongst members of the group.
- Improves academic performance.
- Encourages meaningful and self-led learning.
- Fosters continued study of the subject, in such a way that, rather than merely memorising, the student widens their knowledge.
- Develops solidarity and social commitment amongst the students.
- Develops social skills geared towards relating to the group and presenting points of view assertively.
- Presents the results of group learning in an organised way.
- Fosters autonomy in learning.
- Takes account of the diversity of interests, values, motivations and capabilities of the students.
- Assigns responsibility for a task to each member of the group in order to achieve a final proposed outcome.
- Converts the role of the student in the process into that of the tutor.
- Works on enhancing consensus.

An analysis of these advantages leads us to conclude that most of them refer to skills, knowledge and capabilities related to the “know how” and “want to do” common to all professions, and which can be considered as generic competences in different areas of study. This leads to the conclusion that this technique is a valid strategy not only for working on collaborative work between students, but also on the development of generic competences. In addition, this technique is especially useful for working on areas of knowledge which are open to being “fragmented”

Table 2.1 Description of the Aronson jigsaw technique

Technique	Description	
Aronson jigsaw	A collaborative learning technique in which the students are split into heterogeneous work groups and each member takes responsibility for a different part of the task. The students from different groups with the same task then gather together into groups of specialists to develop their tasks. They later return to their respective initial groups in order to present the part they have specialised in to the rest of their group	
Advantages	Recommendations	Teacher-student roles
It is motivational	The subject worked on must be fragmentable	Teacher: Divides and provides the material. Guides idea sharing, debate and reflection. May carry out a final synthesis of the information, emphasising the most important areas of each part
Allows work on long theoretical topics	The students must understand clearly which part of the work corresponds to them	Students: Are active. They tutor their classmates. They trust in the other members of the group. They participate in active learning
Facilitates the development of generic competences	The groups must be heterogeneous and there must be a level of trust between the members of the group	
Fosters consensus, cooperation and peer tutoring in the teaching-learning process		

Source: prepared by authors with reference to (Aronson et al. 1978) and (Martínez and Gómez 2010)

into different parts. In Table 2.1 there is a description of the Aronson jigsaw technique, a list of its advantages, and recommendations for its application and the role of the teacher and the student in the process.

A process utilising the Aronson jigsaw technique should be organised following the phases detailed below (Babiloni et al. 2013; Martínez and Gómez 2010):

PHASE 1. Explanation of the Aronson Jigsaw. The teacher explains to the students what the technique consists of, the different phases involved and scheduling. The topic to be considered is also explained along with the learning objectives. Finally the necessary material is handed out, subdivided into sub-topics, in order to get the process going.

PHASE 2. Formation of the jigsaw group. Students are grouped together making up the so-called “jigsaw groups”. Although there is no established consensus concerning the optimal number of students per group, a recommended size is four or five students. One thing that is essential is that the number of members in the group is the same as the number of sub-topics into which the assignment is divided. It is important to give the group time to get to know each other, discuss the topic and even create rules of work for the process. Once the group has been formed, each member chooses a sub-topic.

PHASE 3. Design and formation of the groups of experts. Once each student has chosen their part, each member of the different groups gathers into a new group with other students from different groups who have chosen the same sub-topic. In this new group, which is called “the group of experts”, the relation between members is topic based. Each group of experts works on and develops the sub-topic they have been assigned, creating a final group report as experts in their particular topic.

PHASE 4. Re-forming the jigsaw group. Once the task of the groups of experts has come to an end, each expert returns to their original jigsaw group and shares and explains information about their sub-topic with the other members of the original group. In this way, each member of the jigsaw group learns about each of the sub-topics from their fellow members (at this point they are working on collaborative learning) in such a way that, in the end, all the members are experts in each of the sub-topics.

2.4 Application of the Aronson Jigsaw Technique to an Undergraduate Subject

The area of application of the teaching innovation described in this article is an optional subject from the second term of the 4th year of the Business Administration and Management Degree at the faculty of Business Administration and Management of the Universitat Politècnica de València entitled “Innovation and Competitiveness”. This subject is part of the block of optional subjects “Organisation of Industrial and Service Companies”. The experience takes place with a group size of 60 students. Theory classes have a duration of 180 consecutive minutes, which enables us to start and finish the activity in one session. The teaching innovation has been carried out in the academic year of 2014/2015.

The first part of the subject looks at the management of innovation and the Oslo Manual is used to work on important concepts in this area. The Oslo Manual is a document developed by the Organisation for Economic Co-operation and Development (OECD) and EUROSTAT and proposes “Guidelines for the measurement and study of scientific and technological activities”. Although it was edited for the first time in 1992, in the classroom, the third edition from 2005 is used. The Oslo Manual, thus, is the basis of the documentation which will later be used in the Aronson jigsaw.

The following is a description of the phases of the teaching technique as applied in the context of the subject:

PHASE 1. Explanation of the Aronson jigsaw technique.

In this phase, a presentation is given to explain what the Aronson jigsaw consists of. In addition, the concept of teaching innovation and collaborative learning is introduced. The chapters of the Oslo Manual which are to be used in the session are then introduced. For each of the chapters, the learning objective consists of summarising and extracting the principal concepts.

The class dynamics are explained, such as the size of the jigsaw group and the scheduling of each of the phases. How the activity is to be assessed is also explained: On the one hand, any part of the content may be tested in the subject's multiple choice exam. In addition at the end of the activity, the teacher will ask the same "one minute question" to each of the groups about one of the chapters which have been studied. This last part emphasises the need for all experts to work on and transmit the information from their chapter correctly. The one minute question will account for 5 % of assessment marks.

This phase lasts 20 min.

PHASE 2. Formation of the jigsaw group

The students divide up into groups of five, forming 12 jigsaw groups. Once this is done, five chapters of the Oslo Manual are handed to each group: Chapter 1: Objectives and scope of the Manual; Chapter 2: Theory behind the innovation and why it needs to be measured; Chapter 3: Basic definitions of innovation and types; Chapter 5: Linkages within the innovation process; and Chapter 6: Measuring the expenditure on innovation.

Within each jigsaw group, it is the students themselves who use their own criteria to distribute the chapters to be studied.

This phase lasts for 15 min.

PHASE 3. Design and formation of the groups of experts

The jigsaw groups break up and the groups of experts are formed. The class is redistributed into 5 groups of 12 students, who are going to work on each of the chapters in the Manual. One of the first problems to arise during this phase is that of the size of the group, which hinders the shared tasks. This has led the students to use much of the time in this phase working autonomously and, only when they have finished the task do they share it with the rest of the experts for the purposes of reaching a consensus on the concepts which they have considered to be the most relevant in the chapter and preparing a joint report.

This phase lasts for 60 min.

PHASE 4. Reforming the jigsaw group

Once Phase 3 is over and the experts trained, each one returns to his/her jigsaw group. At this point, each expert, in order of chapter, explains to the rest of his/her jigsaw group what the chapter consists of and which concepts are considered to be the most relevant. Each student should take notes on what the experts on other chapters explain.

This phase lasts for 50 min, with 10 min allotted to each expert's explanation.

2.5 Assessment and Sharing Information

Once the activity as such has been performed, two further phases have been added for assessment purposes. In order to carry this out, it is necessary to gather and analyse the information. The information for the assessment is basically obtained from two

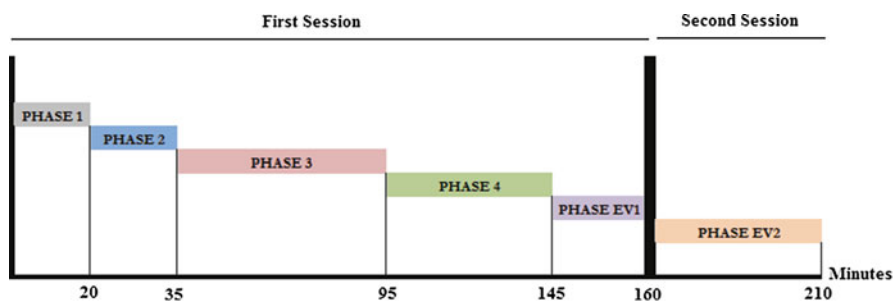


Fig. 2.1 Chronogram of the activity. *Source:* prepared by authors

sources: the individual or collective tests and from directly observing the student (Llopis 2001). Obviously, the assessment is one of the most important elements in the teaching-learning process. However, this is not simply because it enables the student to pass the subject, but because if it is well-defined: (1) it makes a great deal of information available both to the teacher and the student; (2) it clearly regulates the learning process and allows corrective steps to be taken throughout; and (3) it conditions the depth and level of learning which has a direct influence on its quality.

During the first assessment phase (ASSESSMENT PHASE 1), a “one minute question” is asked about one specific part of the contents of one of the chapters of the Oslo Manual which have been worked on. In the second assessment phase (ASSESSMENT PHASE 2), the experts on each part give a class presentation on the most relevant concepts of each chapter. Figure 2.1 shows the complete chronogram of the whole experience.

Below, the last two assessment phases are explained in detail.

2.5.1 Assessment Phase 1: The One Minute Question

After Phase 4 has finished, a one minute question is asked, which represents 5 % of the subject’s final assessment. The aim is twofold. On the one hand, the content which makes up part of the summative assessment of the course is assessed. The summative assessment is a process which aims to appraise the student’s performance, certify that the proposed objectives have been reached and unify the different value judgments made regarding the student throughout the course. The activity is also assessed, as, in function of how the question is resolved, it is possible to know whether the collaborative learning process has been completed correctly. This phase lasts for 15 min: the first 5 min for the explanation of what has to be done and the next 10 to solve the question and gather the results.

The content of the different chapters of the Oslo Manual which the students have worked on is taken into account very closely when the one minute question is being planned. One of the most relevant concepts, and one which appears in several chap-

ters, refers to the types of innovation that an organisation can adopt: product innovation, process innovation, organisational innovation and marketing innovation. The fact that the Aronson jigsaw technique is included within the so-called techniques of educational innovation makes it suitable for classification according to the Oslo Manual. Therefore, the one minute question is related to the technique itself and its classification as innovation. The one minute question is formulated as follows: "Describe the Aronson jigsaw technique and classify it according to the types of innovation which appear in the Oslo Manual. Justify the reason for classifying it as such". In order to answer this one minute question correctly, and bearing in mind the acquisition of competences based on Bloom's taxonomy [Bloom et al. (1973)], the student must "Know" the subject, "Understand" the concepts and "Apply" or "Classify" them, which corresponds with the first three levels of this taxonomy.

2.5.2 Assessment Phase 2: Presentation of the Experts

In the first classroom session after the Aronson jigsaw technique, the five chapters of the Oslo Manual that have been worked on are shared. Taking the chapters in order, the corresponding experts give a presentation on the content of the chapters and which concepts they have taken to be the most relevant. This helps the students to synthesize, structure and present information or to develop communications skills, among others; this phase, therefore, also helps to develop generic competences.

This phase has two basic objectives. Firstly, it allows all of the students, regardless of their jigsaw group, to validate the information which their expert has transmitted. It also permits the teacher to stress the basic concepts in each chapter. It must be remembered that what is shared from each chapter is assessed in the subject's multiple choice exam, and as such, it is very important for the teacher to supervise what the experts have taken as fundamental and to underline what they consider to be the most relevant according to the aims of the course. This feedback from the assessment process has a formative function, since the students can verify whether they have been able to achieve their learning targets.

2.6 Results of the Experience

2.6.1 Group Work and Commitment to Learning

The group work has been reinforced by the responsibility assumed by each of the members of the jigsaw group as experts in one area. From the beginning of the experience, the students are aware of the impact which their performance has on whether the group's learning targets are attained or not. There is, therefore, a commitment not only to the student's own learning but also to that of the group. There can be no doubt that the fact that the experience has an impact on the assessment,

which on the one hand is reinforced by the one minute question that counts towards the final assessment mark and, on the other hand, by the content itself, as it will be assessed in the multiple choice exam at the end of the course, contributes to the success of the experience.

This experience, therefore, works on generic competences such as the capacity to work efficiently in a group, the ethical commitment understood as the responsibility assumed in both the student's own teaching-learning process and that of his/her classmates, the capacity to analyse information or the ability to present information compiled by other students in an efficient way.

2.6.2 *Results of the Assessment*

The assessment of the one minute question has given rise to several conclusions. On the one hand, as far as the part of the question concerning the description of the experience is concerned, 100 % of the students were capable of providing a clear explanation distinguishing between the different phases of the experience's implementation (Phase 2, Phase 3 and Phase 4). However, the conclusions from the second part of the question, that which refers to the classification of the teaching innovation according to the Oslo Manual, were more divergent. As regards this part, and bearing in mind that the Aronson jigsaw innovation is a process innovation as it consists of introducing a new or significantly improved process for the purposes of performing a task, we can make out three types of answers: type 1, corresponding to a correct answer; type 2, corresponding to an incorrect answer in which the innovation is wrongly-classified; and type 3, in which the innovation is either not classified or is done so according to a classification which does not exist in the Manual.

Figures 2.2, 2.3 and 2.4 show examples of the three types of answers, as written by the students.

The percentage of students who gave a type 1 answer is 52.2 %, a type 2 answer 39.1 % and a type 3, 8.7 %. Therefore, as regards applying the concepts to the types of innovation and, although more than half of the students have answered correctly,

TYPE 1 Answer
<p>This consists of forming groups with a fixed number of people and assigning a task to each member of the group so that each person then joins up with someone who has the same task. This will be the group of experts who, between them, will analyze the task to be carried out in order then to share the knowledge, thus obtaining the main ideas and arriving at the best solution.</p> <p>Once the knowledge has been shared, each member returns to their first group and explains the task. This is process innovation because the method varies depending on the type of task, according to the Oslo Manual.</p>

Fig. 2.2 Example of type 1 answer

TYPE 2 Answer
<p>The Aronson jigsaw which we used in today’s class consists of forming groups or experts amongst which tasks or activities are divided up, each person then splitting off from the group with the task that has been assigned them and forming new groups with the people who have the same task. In this way, groups of experts are formed that will focus on the task in hand and carry out the assignment; once this is done, they will go back to the first groups to explain what the rest of the group has done and perform all the tasks together. This is a way of sub-dividing tasks for the purposes of carrying out an activity more efficiently.</p> <p>This innovation is classified in the Oslo Manual as organizational, as its aim is to organize the activity so that it can be performed with greater efficiency.</p>

Fig. 2.3 Example of type 2 answer

TYPE 3 Answer
<p>The Aronson jigsaw consists of forming groups of 5 people (for example) giving each member a chapter. Then all those people with the same chapter form new groups. In these groups, the task is studied for approximately one hour and, once this is done, conclusions are drawn.</p> <p>This is how the groups of experts are formed to deal with the different tasks. They then return to their original groups to explain their chapters to the other members. Every member of the group is an expert in his/her respective chapter, so at the end everybody will gain some knowledge of the whole syllabus.</p> <p>This technique can be classified as both an internal and external type of innovation; external because the members of the group “leave” to compile information and obtain some background in new ideas and “internal” because they then go back to the group to explain what they have learned. This is a new way of spreading information in which all the efforts made are mutually beneficial.</p>

Fig. 2.4 Example of type 3 answer

47.8 % (the result of adding the percentages of the type 2 and type 3 answers) have not. This raises the question of what we should change in the experience so that a greater number of students are not only able to “know” (the lowest level in Bloom’s taxonomy) but also to “understand” and “classify”.

2.7 Conclusions

The Aronson jigsaw technique is a teaching-learning technique in which the students put collaborative learning into practice in the classroom. It not only permits the students to tutor their own learning and that of their classmates, but it also promotes group work and responsibility. This study describes the application of the

Aronson jigsaw technique in an optional subject called “Innovation and Competitiveness” in the degree course of Business Administration and Management in the Faculty of Business Administration at the Universitat Politècnica de València.

The Aronson jigsaw technique is made up of four phases. In Phase 1, the technique is explained to the students. In Phase 2, the jigsaw groups are formed. In Phase 3, the groups of experts are formed and, lastly, Phase 4 is when the experts go back to their jigsaw groups to explain their part. What's more, two more assessment phases have been added to this experience. The first of these consists of using a one minute question to assess the knowledge and the concepts learned during the experience and how to apply them. Furthermore, the Aronson jigsaw technique itself is used as a reason for explaining and applying such concepts. In the second assessment phase, the experts share the content of their part of the task so that the whole class can take notes and the teacher can underline what they consider to be most relevant for the final assessment.

By means of this experience and via collaborative learning, we have been able to work on: (1) content: everything related to the five chapters of the Oslo Manual which are used in the experience; (2) generic competences, especially group work, ethical responsibility and effective communication. Moreover, through the one minute question, it has been possible to assess several things. The one minute question concerns the teaching innovation of the Aronson jigsaw, and as such, the students have to describe it. This is a way of obtaining very important feedback which permits us to know if the student has understood what the technique consists of. In this regard, 100 % of the students provide a suitable description of the essence of the technique. In the second part of the one minute question, the students have to classify the innovation of the Aronson jigsaw within one of the four types of innovations explained in the Oslo Manual. To this end, the students not only have to know the four types of innovations, but they also have to be able to understand them and apply them for the purposes of suitably classifying the teaching innovation. According to Bloom's taxonomy, this implies a progression in the acquisition of competences from the lowest level, corresponding to “knowing”, to higher levels which involve “applying”. The results from this part indicate that 52.2 % of the students are able to classify the technique correctly; 39.1 % classify it wrongly; and 8.7 % either do not classify it or invent a classification. In our opinion, these results leave much scope for improvement and, as a future line of work, we have to plan the use of mechanisms which will improve the ability of the students to apply the key concepts and not only to acquire them.

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