WEBQUEST: INFORMATION AND COMMUNICATION TECHNOLOGY TOOL FOR STATISTICAL PROBLEM SOLVING FOR MIDDLE SCHOOL STUDENTS

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We describe the design of a Statistical Unit "What is the incidence of smoking among young people?" based in developing a cycle of investigation. From a didactical point of view it is an authentic learning environment for grade 10 students. We present the results of the affectivity of this didactic unit through the analysis of the assessment based on students' reflection on their learning.

INTRODUCTION

In recent years there has been a change in the aims of the teaching and learning in Middle School, corresponding to Compulsory Secondary School. From traditional perspectives, related to the acquisition of knowledge, to the current competence driving-learning tendencies, there has been more than a change in the aims of learning due to the introduction of a large number of technological tools. From all the possible technological tools developed, WebQuest (WQ) gives a large window of opportunities for teacher innovation and active-student learning (Dodge, 2007). According to Bowman (2000), "*WQ can allow both learners and teachers to be creative and productive, using this powerful medium to spark the imagination, solve problems and promote discussion about important issues"* (p. 100).

This assertion about the use of WQ to solve problems is not well known in the field of statistics. An interesting hypothesis to investigate is whether WQ promotes learning of statistical-problem solving processes. Under this premise a WQ, *"What is the incidence of smoking among young people?"* was constructed and analyzed in order to investigate about how it promotes learning of statistical-problem solving. In particular, in this paper we introduce the results of the affectivity of this didactic unit through the analysis of the assessment based on student's reflection on their learning. In the next section we describe the aims of each block of the WQ.

TOBACCO'S WEBQUEST BLOCKS

Dodge (2001) establishes that a WQ has six essential blocks: introduction, task, process, resources, evaluation and conclusions. These six elements should be integrated in order to promote three different kinds of students' scaffolding: reception, transformation and production.

In the *introduction* students are informed about the topic of the WQ investigation and its aim in order to motivate students. In this case the topic is related to the Spanish Government decisions about the developing and applying of the "Tobacco Law". Previously to this law a statistical investigation about health was done in 2003, which gave some data about the influence of smoking among young people. These data are used in this WQ to solve the statistical problem posed in the introduction *"What is the incidence of smoking among young people?"* The introduction allows students to recognize and to anticipate the task to be done using the WQ.

The *task* is the formal description of something realistic and interesting, and the final product that students should prepare. In this case, students were asked about two different products: a statistical report and a press release

The *process* section includes a clear description of the route learners should go through in accomplishing the task, with specific guided activities. In the case of this WQ there are six different processes related to the investigative cycle:

- *Plan*, identifying the characteristics of the investigation (P1).
- *Data*, identifying the characteristics of the questionnaire (P2).
- *Analysis*, analyzing the relationship between consumption, age and sex (P3), analyzing the relationship between studies done and consumption (P4), analyzing the relationship between the numbers of cigarettes consumed daily and the sex of the smoker (P5).
- *Conclusion*, writing a press release (P6).

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An open-ended *evaluation* system for products was created in concordance with the *GAISE Report: A Pre-K -12 Curriculum Framework* (Franklin et al, 2007). It was introduced as a rubric to allow students to improve their investigation and also to help teachers to regulate the process of teaching and learning.

TEACHING AND LEARNING WITH WEBQUESTS

WQ supports learners' thinking at the levels of analysis, synthesis and evaluation (Dodge, 2001). These capacities are the core of the problem-solving processes. In the case of statistics, this underlying thinking requires students to place themselves in the position of being investigators (Pfannkuch & Wild, 2004). These authors present a four-dimensional framework for statistical thinking in empirical inquiry that describes a nonhierarchical, nonlinear, dynamic way of thinking. It encompasses an investigative cycle, an interrogative cycle, types of thinking and dispositions, all of which are brought to bear in the statistical-problem solving. For Sanchez & Blancarte (2008), the investigative cycle (Problem Plan Data Analysis Conclusion) acquires an important role in the planning of statistical units, because it provides a structure to organize teaching tasks.

The organization of these teaching tasks using a WQ has its foundation in constructivist philosophy. As Lamb & Teclehaimanot (2005) express these are authentic situated learning environments in which the activity is based on using Internet resources to promote the evaluation, analysis and transformation of information. These authentic tasks motivate students' research of an open-ended question and help them to transform newly acquired information into more enriching understanding (March, 2004). From a statistical point of view, students can investigate an open-ended question and the acquired information from the WQ. This, most likely, can help them to formulate new refined questions, to begin a new cycle of investigation and to see richer thematic relationships, in order to reflect on their own meta-cognitive processes (March, 2004). Williams & Gómez-Chacón (2007) introduce a system of categories for assessing the cognitive level that can be promoted by the use of a WQ. This system is related to the different blocks and helps to analyze the motivation and cognition of the task; connection of task with curriculum; clarity, quality, richness of the processes; quality of the resources and clarity in the evaluation. From this wider system of categories we are interested in the cognitive level of the task, the clarity and quality of the process as shown in Table 1.

Table 1. System of categories for WQ's analysis (Williams &Gómez-Chacón, 2007)

	Cognitive level of the task
Level 1	The task is not related with the curriculum.
Level 2	The task is referred to the curriculum, but it is not clearly connected with student's previous knowledge to achieve the objectives.
Level 3	The task is referred to the standards and it is clearly connected with what students should know and could be able to do to achieve the objectives.
	Clarity of the process
Level 1	The process is not clearly stated. Students will not be able to know exactly what to they should do.
Level 2	Some clues are given, but there is missing information. Students could be confused.
Level 3	Each process is stated clearly. Most of the students know exactly in which process they are and what they have to do after.
	Quality of the process
Level 1	The process does not have the strategies and tools of organization needed to obtain the necessary knowledge to end the task.
Level 2	The strategies and tools of organization included in the process are scarce to assure that all students will gain the needed knowledge to end the task.
Level 3	The process gives to the students with different levels of entry strategies and tools of organization to access and to gain the knowledge needed to end the task.

METHODOLOGY OF INVESTIGATION

Twenty-nine Compulsory Secondary Students of Grade 10 took part in this research. It was a long-term WQ, whose aim was extending and refining knowledge learned previously in other years. It was designed as an organizer of the content, activities and evaluation. From a technological point of view it was delivered from a blended learning approach based on didactical criteria of competency-driven learning. This approach evenly balanced the use of face-to-face and online communication activities, which are both individual and cooperative (Serradó, 2009). This previous investigation about the WQ provided information about the use and the quality of the resources used to promote the students' learning.

The aim of this paper is to present the results of the analysis of the affectivity of this WQ based on the meta-cognition expressed by students' reflection on their learning. For this cognitive analysis I used an open-ended questionnaire about what do they think, what they have learned, the difficulties that they have found and the future applications of their learning. The answers of this open-ended questionnaire were analyzed using the system of categories introduced above. Answers were classified as a function of the referenced block, then about the aspects involved in the cognitive level of the task, clarity of the process or quality of the process. Finally was determined the level of each category.

In the next section we introduce some excerpts of the pieces of answers given by the students to highlight their reflections.

STATISTICAL-PROBLEM SOLVING THROUGH TOBACCO'S WQ

Students argue about the efficacy of the introduction in their motivation and their interest in the problem described.

> *M and A: We learn new knowledge about the tobacco consumption about men and women in Andalusia.*

But they do not only argue about their learning about tobacco consumption. They express the connection between the tasks and the syllabus through the objectives that they should know and do.

> *Y and L: We have learned, with the use of the WQ, how to carry out an investigation. And by doing so, we have remembered what a survey is, the meaning of terms such as statistics, population, sample, qualitative and quantitative statistical variables and the process of statistical investigation through the analysis of quotidian situations. In addition, we have analyzed statistical variables through plotting and the computation of the measures of statistical variation by making a critical use of a calculator and Excel software.*
>
> *C and L: We have studied in deep the different kind of variables reflected in a table, selecting and plotting the most adequate graph.*

The students express that the process is generally clear, because it is clearly described.

> *D and A: We have found very few difficulties in this work. We have perfectly understood the questions. The small doubts that appeared have been solved easily with the help of the textbook, class notes or WebPages.*

They express the significance and quality of the resources used to complete the WQ.

> JL and M: *We have enjoyed doing all the process of this work and to have to investigate in different places: National Health Questionnaire, WebQuest, Excel software by making calculations, inserting numbers into formulas and elaborating tables.*

One might think that from a cognitive point of view the tasks included in the processes ask students only to calculate, but they express that the task needs them to synthesize multiple sources of information, take a position, go along with the data and present a creative product.

> *E and J: We have also discovered that mathematics is not only formulas. It is also drawing conclusions.*

As well as concluding with the mathematical and statistical-problem solving, they have interlocked it with the aims of the WQ.

> *V and M: However all these processes, deductions and personal conclusions, that are time consuming, are the basis of the WQ itself. Because we have to process all the previous learned knowledge, to put it into practice and to be able to acquire new knowledge, by*

classifying and generalizing the old knowledge. Hence it will be useful in a universal manner.

JD and M: With the use of the WQ, we have learned to interpret, classify and write down conclusions of the statistical data analysis. We have also improved our use of statistical language, and our capacity to make statistical calculations and interpret results.

CONCLUSIONS

The analysis of the students' answers shows that each process is clearly stated. Most of the students argue that the processes are clear and their quality lets them gain the knowledge and to end the task. The diversity of arguments on the learning of different statistical concepts and capacities involved in the statistical thinking confirms that the processes are clearly related and designed in order to help students to have a higher knowledge about the investigation cycle and about the statistical-problem-solving processes. However the use of this WQ has some limitations for the students' learning. One of them is that it does not let students develop the capacity of formulating their own questions, refine their own conclusions and continue the cycle of inquiry and investigation.

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