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Implementation of the Skill-Based Approach in the Teaching of Chemistry in the 5th Grade of the French Education System

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Abstract

Based on the skill-based approach, the teaching of chemistry in the 5th grade in the French educational system follows a program where the notions to be learnt are organized by theme. Using this form of teaching, we studied the acquisition process and proficiency level for students of the 5th grade at the LycéeFrançais de Tamatave during two trimesters of the school year 2016-2017, through the themes of Health and Sport. The contextualization of the activities gives rise to the motivation of the students, and the collaboration makes it possible to optimize their proficiency level; the skill-based approach gives students a feeling of ability to succeed, and the teacher's assistance has a considerable importance. However, good students complain that they have resulted far from their expectations when working in groups, preferring to work alone instead of helping their peers to progress. Gaps are also identified in the acquisition of disciplinary notions, as the skill-based approach does not require students to master the content of the lesson. In addition, it would be better to optimize the use of school time which should be used for skills development activities.

Subject Areas

Education

Keywords

Skill-Based Approach, Collaboration, Motivation, Acquisition Process, Proficiency Level

1. Introduction

Despite its great success, the concept of competence still is neither clear nor distinct. In the French education system, the concept of competence is defined as the ability to mobilize and reinvest knowledge, skills and abilities in order to achieve a given objective in a complex situation. Focusing on the notion of competences thus allows for increased attention to learning processes, how the student learns and uses his or her knowledge, and ultimately to the cognitive functioning of individuals [1].

Many authors [2] [3] [4] [5] [6] emphasize the dynamic nature of competence and invite refocusing on the learning processes of the student rather than on the content of instruction, on the relationship between knowledge acquisition, skills development, and the adoption of attitudes. They also emphasize the process of contextualization that subordinates the acquisition of knowledge to the mobilization of resources in new situations.

In this context, the curricula of the French education system were reformed and defined, not in terms of content, but in terms of skills that pupils should acquire during their schooling [1]. The introduction of logic of skills in the teaching of chemistry in the French education system led us to consider carefully the requirements of this method of education and training, its conditions of application and the relative limits to its implementation.

Improving the application of a pedagogical approach needs a permanent review from practisers. This paper aims to highlight the impact of the use of the skill-based approach in the learning process of chemistry. Indeed, we wanted to analyze the process of acquisition of skills by students during the learning of chemistry in 5th grade. Therefore, we implemented a skill-based approach to identify the inputs and gaps in this method in the learning of the discipline. The objective is to show that despite the good intentions associated with the skill-based approach, its implementation does not always produce the expected effects of the program designers, and therefore requires adjustments to improve the learning framework students.

2. Research Methodology

During the academic year 2016-2017, we conducted our study in the physical sciences course of 5th grade of the Lycée Français de Tamatave, which included 26 students. So, we based our study on the chemistry program of the general and technological 5th grade of the French educational system to define the skills to be acquired in chemistry, and more specifically we focused on the skills that can be acquired within the framework of the theme Health and Sport [7]. Our study began in January, when the second trimester began, and ended with the end of the program in May. Indeed, the first trimester was used to familiarize students with working methods and to identify the intellectual potential of each student in order to balance the composition of the working groups.

2.1. Activities

Various activities were proposed to the pupils, during which they were placed in a situation of permanent evaluation [8], and whose level of demand is relative to the progression of learning:

1) The practical work was the main part of the activities carried out; indeed, experimental skills were combined with other types of skills, and evaluated instantaneously because experimental activity can perform only once [9] [10];

2) Documentary studies also contributed to the investigation, the acquisition of knowledge and the construction of skills;

3) The lessons summarized the essential notions to be learned [11];

4) The exercises to be carried out outside the classroom and corrected in class were used to train pupils to mobilize acquired skills;

5) Resolving scientific problems was to mobilize a set of skills and to use provided information in order to answer a research question;

6) Individual assessments evaluate skills' acquisition.

The activities of acquiring a set of skills divided into two or three areas, depending on their nature, are practical work and documentary studies, and those which were used to reinvest them are individual assessments and problem solving. We limited the number of engaged and evaluated skills in each activity. For practical reasons (organization of laboratory equipment, small room with possibility of communication between the students), most activities were carried out by group, except for individual assessments. The teacher imposed the composition of each group in order to have a relative homogeneity, notably in terms of skills and level of performance. Indeed, each group is composed as much as possible of a student with high scientific potential, a pupil who is able to bring a useful transversal expertise during the activity and a student with shown difficulty.

2.2. Evaluated Skills

Based on the defined skills in the program and their classification by area as described by IGEN [10], we classified the evaluated skills during each activity by area in the "Analyze", "Realize" and "Validate" areas, as it is presented in the **Table 1**.

2.3. Modalities of Evaluation

The evaluation of the activities was based on skills in accordance with the program guidelines [7]. The mobilization of a skill is evaluated in relation to the other skills of the same area [8] [9]. For each group of students during the group work, and for each student during individual assessment, the proficiency level is assigned to each of the identified skills' areas during the activity, according to 4 levels:

1) the group or the pupil demonstrated mastery of the skills in the area by performing all the requested work satisfactorily according to the specified criteria or with one or two interventions of the teacher, concerning difficulties identified and explained by pupil, and to which he answers by himself;

Table 1. Engaged skills in each activity.

Activities	Skills' areas	Engaged skills
Preparation of solution by dissolution	Analyze	Distinguish the solute from the solvent Determine the concentration of the solution to be prepared Calculate the mass of the required solute Draft a dissolution protocol
	Realize	Take a quantity of material of a given chemical species Implement a protocol of dissolution
Formulation of a drug	Analyze	Characterize a drug Recognize a drug Recognize a generic drug Differentiate drugs
	Validate	Recognize a drug Prescribe a drug
Preparation of a solution by dilution	Analyze	To know and to exploit the expressions of the mass and molar concentrations of a dissolved molecular species Calculate a molar mass from the atomic molar masses Calculate a quantity of material Develop a dilution protocol
	Realize	Prepare a solution by dilution
	Validate	Determine the concentration of the solution by the comparison method
Interaction with the environment	Analyze	Determine the different forms of an active ingredient Develop a protocol to check the acidity of a solution Develop a protocol to simulate the action of a drug on the body
	Realize	Measure the pH of a solution Implement a protocol to simulate the action of a drug on the body
	Validate	Conclude on the parameters influencing the choice of drugs
Thin-layer chromatography	Analyze	Analyze drug formulation Develop a protocol for the thin-layer chromatography
	Realize	Realize thin-layer chromatography
	Validate	Interpret thin-layer chromatography
Individual assessment on drugs	Analyze	Analyser la formulation d'un médicament Repérer la présence de groupes caractéristiques dans une formule développée
	Realize	Calculate a molecular molar mass from atomic molar masses Determine an amount of material to the mass of a solid Determine the mass of a sample from its density To know and to exploit the expression of the mass and molar concentrations of a dissolved molecular species
Hydrodistillation	Analyze	Explain the principle of hydrodistillation Explain the principle of solvent extraction
	Realize	Use a heater under safety conditions Use a separating funnel Implement a hydro-distillation protocol Implement a solvent extraction protocol
Problem solving on drugs	Analyze	Know that a raw formula can correspond to several semi-developed formulas Know that the concentration of a solution in dissolved species can be expressed in g/L or in mol/L

Continued

	Realize	Calculate a molecular molar mass from atomic molar masses Know and exploit the expression of the mass and molar concentrations of a dissolved species
	Validate	Solve a problem
Synthesis of aspirin	Analyze	Describe a chemical system and its evolution Write the equation of the chemical reaction with the correct stoichiometric numbers Determine the mass of a sample from its density Determine an amount of material known to the mass of a solid Propose a protocol to identify a molecule
	Realize	Use a heater under safety conditions Implement an experimental protocol to carry out the synthesis of a molecule
Individual assessment on experiences analysis	Analyze	Mobilize your knowledge Search, retrieve and organize useful information Implementing a reasoning
Problem solving on doping	Analyze	Mobilize your knowledge Search, retrieve and organize useful information Implement a reasoning
	Realize	know and exploit the expression of the mass and molar concentrations of a dissolved molecular species
	Validate	Solve a problem
Thermal effect of chemical transformation	Analyze	Describe a chemical system and its evolution
	Realize	Implement an experimental protocol to demonstrate the thermal effect of a chemical transformation
	Validate	Calculate the released energy during a chemical transformation

2) The group or the student performed all the requested work satisfactorily according to the criteria specified by one or two interventions of the teacher concerning difficulties or errors not identified but resolved by the student;

3) The group or the student does not finish performing the requested work, thus showing a fragile proficiency of skills;

4) The group or the pupil is unable to carry out the work requested despite the help given by the teacher, thus showing insufficient proficiency in the required skills.

During our study, we measured the levels of acquisition in the areas of skills in each activity for each student or group of students.

3. Results

Throughout the implemented activities in our teaching, we observed the attitude of students in the classroom. We evaluated the students according to the proficiency level they achieved on the expected skills for each activity.

3.1. Observing Students in Act

During activities, as groups are trained to have students with different levels in chemistry, students having high proficiency level do not appreciate group work. Indeed, as other students in the same group often have difficulties, good students are supposed to help them and motivate them in the task; Paradoxically, they prefer to do the work alone; they do not manage to involve the other students and feel they are the only ones working, despite the role of leader assigned to them. On the other hand, moderately good students and those with difficulties appreciate group work: they take responsibilities corresponding to their skills, and experience the ability to succeed by being helped by their classmates; for them, mutual help and sharing are essential to better understand what they have to do.

Some lecture sessions were conducted after the investigation activities, in order to summarize the essential notions to remember. In order to facilitate the taking of notes, copies of the lessons with text with holes were distributed to the students, who filled them as the course progressed. Not to copy the lessons in an integral way allowed the students to focus on the teacher's explanation; the texts with holes led them to think about the course and to reflect on what should complete the lesson in order to have logic sense.

Students often request help from the teacher when certain points of the course are not understood or when they encounter difficulties in carrying out the tasks. Generally, homework is facilitated by anticipation through investigation and access to the lesson. Of all the activities we have done, the individual assessments are the least appreciated by the students.

3.2. Proficiency Level

At the end of each activity, we noted proficiency level achieved by each student in each area of skills, and we calculated the percentage of students who reached each proficiency level.

Above, we presented in the **Table 2** percentages corresponding to each proficiency level for each activity we implemented during the period of our study, and in the **Table 3**, we showed the means of percentages of each proficiency level obtained on all activities, classified by skills' area.

Despite a majority of students with a good level of acquisition in the "Analyze" area, we found that activities related to this area of skills are not interesting to most students. The part preceding the experiments often involves an analytical task which consists in answering questions which prepare the pupils for the realization of the experiments. In this section, students are asked to use the accompanying documents and propose protocols. The observation during sessions shows that students do not take the time to read the documents, they struggle to think and use the different tools available to them, and they find it difficult to extract the relevant information.

During a first problem-solving session, including skills related to the notions of molecule and mole, the students had difficulty in appropriating the documents that were made available to them for the activity. An individual assessment on analyzing chemical extraction and synthesis experiments was also disappointing

Table 2. Percentages of proficiency levels for each activity.

Activities	Skills' areas	Proficiency levels			
		A	B	C	D
Preparation of solution by dissolution	Analyze	20.83%	62.5%	16.66%	0%
	Realize	62.5%	37.5%	0%	0%
Formulation of a drug	Analyze	47.36%	42.10%	10.54%	0%
	Validate	23.07%	34.61%	19.23%	23.07%
Preparation of a solution by dilution	Analyze	46.15%	38.46%	15.39%	0%
	Realize	23.07%	38.46%	11.53%	26.92%
	Validate	0%	0%	23.07%	76.93%
Interaction with the environment	Analyze	41.67%	37.5%	20.83%	0%
	Realize	37.5%	37.5%	25%	0%
	Validate	58.33%	37.5%	0%	4.17%
Thin-layer chromatography	Analyze	76%	8%	16%	0%
	Realize	84%	16%	0%	0%
	Validate	0%	60%	40%	0%
Individual assessment on drugs	Analyze	23.07%	50%	26.93%	0%
	Realize	11.53%	42.3%	26.93%	19.4%
Hydrodistillation	Analyze	36%	64%	0%	0%
	Realize	28%	60%	12%	0%
Problem solving on drugs	Analyze	0%	40%	48%	12%
	Realize	0%	24%	64%	12%
	Validate	0%	0%	36%	64%
Synthesis of aspirin	Analyze	0%	24%	64%	12%
	Realize	48%	28%	24%	0%
Individual assessment on experiences analysis	Analyze	0%	28%	60%	12%
Problem solving on doping	Analyze	50%	12.5%	25%	12.5%
	Realize	50%	25%	12.5%	12.5%
	Validate	37.5%	37.5%	12.5%	12.5%
Thermal effect of chemical transformation	Analyze	21.74%	26 .09%	13.04%	39.13%
	Realize	52.18%	13.04%	34.78%	0%
	Validate	13.04%	26.09%	13.04%	47.83%

Table 3. Assessment of skills' areas.

Areas	Mastery's level			
	A	B	C	D
Analyze	30.27%	36.08%	26.35%	7.30%
Realize	33.24%	29.87%	20.93%	15.96%
Validate	18.85%	27.95%	20.54%	32.66%

in terms of results. Indeed, this activity show that when they are evaluated individually, a large majority of students have difficulty in mobilizing analytical skills, which have been fundamental because the activity which consists in extracting information from documents, and explaining the progress of the experiments, using the knowledge acquired during the course and the practical work on the topics. The second problem solving allowed students to better grasp the approach to be followed and applied better to demonstrate the skills of the "Analyze" area.

The results show that the majority of the pupils have a good proficiency level in the "Realize" skills area. The observations of the pupils in action and the apprehensions expressed by the pupils confirm this statement. Indeed, we noticed that the students, both good and bad, are motivated to get involved when it comes to carrying out experiments in practical work, resulting in a fairly good level of self-skills. On the other hand, there are always a proportion of students showing a lack of interest in experimental activities.

Among the skills of the "Realize" area which were evaluated during the individual assessment and problem solving on drugs, we included the mobilization of formulas on mass and molar concentrations and relations between masses, molar masses, volumes and quantities of material which were seen during practical work on dissolution and dilution, which were then given in progress and the use was the subject of various training exercises, as well as the calculation of the molar masses of molecules; it is therefore both a matter of restoring knowledge and using it to answer questions of evaluation. The results show that not only the students have difficulty in performing the corresponding calculations, but some of the pupils cannot reproduce the formulas. At the end of the problem-solving sessions, we observed that even students who are generally good cannot use the notions which were tackled and repeatedly used to answer an open-ended question; this type of activities also show students' shortcomings in implementing reasoning.

The "Validate" skills area is the one where the students have the most difficulty to mobilize. Indeed, being in the course of chemistry, they consider that the validation and the communication are not essential. They often neglect to answer the problem, although the objective of each activity is explained in an introductory part reserved for contextualization. Students do not understand that the skills and knowledge they will acquire during an investigative process, which may be a documentary study or an experimental activity, are used to solve problems that can common. During training exercises, they do not realize that the concepts tackled in the course serve as tools to answer concrete questions. They do not understand the importance of mobilizing skills and using knowledge in individual assessments and problem solving. In spite of well-explained situations, students have difficulty in contextualising tackled disciplinary concepts, leading them to a lack of understanding of what should be done during validation.

The analysis of the copies of pupils shows that the "Communicate" skills area does not appear in their written traces. In practical work reports and problem solving, the pupils are unable to produce a satisfactory conclusion that answers the problem, or to associate the obtained results with the objective of the requested work. The analysis of the given answers in the correction of training exercises and individual assessments highlight the difficulty of students to correctly write an assessment of chemistry, sometimes omitting formulas or calculation steps, or forgetting to specify the purpose of the question to be answered.

The observation of the students during the activities allows saying that out of the 26 students, 14 demonstrate the qualities to validate the skills of the "Being autonomous" area. As the groups are trained to have a heterogeneous level of the students who compose them, we found that good students do not appreciate group work and progress better by working alone. Indeed, during group work, student with high proficiency level performs a large part of the requested task, while the others follow his instructions; good student of the group is the one who takes initiatives during an activity, and decides the resolution process to follow; usually he is the one who demonstrates proficiency of experimental skills, and achieves good results in individual assessments.

4. Discussions

On the one hand, the strong commitment of the pupils in the realization of the complex tasks means that they were particularly interested in the practical sessions. On the other hand, the analysis of the copies and the results obtained for the "Validate" area of skills show a difficulty in linking the activities with their contexts, and the pupils do not always answer the problem. The finding also shows that students have difficulty in developing autonomy in carrying out activities. Moreover, students do not usually do their homework, and do not feel comfortable in individual assessments, precisely because of the lack of motivation for these activities which are often decontextualized.

Students are aware of the need to learn lessons. As lessons have been summarized, they have been useful in solving training exercises and preparing individual assessments. For students, having access to the lesson and learning it is a learning habit. Furthermore, among the implemented activities, the lecture is the type of activities that requires the least effort from them.

The students understood that the activities helped them acquire skills. Practical work is the type of activity in which students express the most interest: they place a great deal of importance on practice, and manipulation motivates them and gives them a feeling of capacity for success. Since documentary studies are also part of the investigation process, students can demonstrate their cross-curricular skills and often succeed in them.

Generally, students appreciate group work. The pooling of individual knowledge and the use of personal skills are assets to solve a complex task. Thus, collaboration gives them the feeling that they are able to carry out the requested work, because they are helped by their classmates. However, good students prefer to work alone; they find that they take up an important part of the work, while the others devote themselves to the easiest parts of the activity.

Among activities we have done, the individual assessments are the least appreciated by the students. Indeed, it is the type of activities in which they are led to work alone, and therefore have no access to any help. As a result, individual assessments are not very enthusiastic and cause the fear of failure among most students. On the other hand, pupils with high proficiency level are comfortable and give good results, because the individual assessments allow them to show their full potential and to be evaluated individually.

The students' difficulty in mobilizing skills in solving complex tasks is due to lack of training. Problem solving activities are incentives for students to find a solution to a problem that can be encountered on a daily context or in the practice of a profession. They are done by implementing various skills in chemistry. However, it is often difficult for students to identify the different steps to follow. The school time allocated over the year did not allow students to become accustomed to methods of resolution.

For students, teacher's explanation is essential to be able to understand the lesson and to appropriate the problems of the activities. Having been accustomed to lectures in previous classes, students appreciate that the teacher provides a detailed explanation of the lesson, and is always available to answer their questions. Adapting learning to give access to the lesson without having to copy it allows students to focus on explaining and appropriating the content of the course. This approach reduces the work of students at home, who no longer need to deepen the understanding of the lesson outside of school time.

During activities, students need to be placed in confidence by the teacher. At each step of the work, they often challenge the teacher to validate the progress of their work, or question their approach and identify errors. When they grasp their mistakes, they try to remedy them by themselves, thus improving deepening and analysis. In case of persistent difficulty, the availability of the teacher and the help he brings ensure them to be able to reach the solution.

5. Conclusion

The research we carried out allows showing two aspects of the skill-based approach. On the one hand, the skill-based learning of chemistry motivates the students, particularly through the contextualization of the activities. On the other hand, the mobilization of disciplinary skills in a school context such as training exercises and individual assessments does not arouse the enthusiasm of the pupils.

A skill-based approach does not require students to appropriate the disciplinary concepts which are specified in the curriculum. A reinvestment of skills does not necessarily imply a capacity for restoring the prescribed contents. When learning focuses on the acquisition of skills rather than knowledge, students are no longer required to acquire the knowledge that is the subject of instruction in the discipline.

In the context of skill-based learning in chemistry, complex tasks presented in different forms lead students to design and carry out a scientific approach to solve a problem. Students learn how to formulate scientific explanations using experience to prove their hypotheses, to exploit and communicate their results by explaining their approach. They learn to extract and exploit the useful information to answer questions that lead them to answer a contextualized problem.

With this approach, students demonstrate initiative, critical thinking, curiosity and creativity. They feel empowered and, therefore, more involved in the work they are asked to do and in their learning. This type of practice allows mobilizing skills that can be reinvested in new situations similar to those that have allowed them to be mastered and transferred to other disciplines. In this context, the teacher must fully play his role as an accompanist in the process of acquiring skills, during which the student needs to be placed in confidence and encouraged to exploit his potential.

In order to satisfy all students, it is essential to differentiate teaching. Indeed, the role of accompanist implies the necessity to meet the needs of each student according to his level of difficulty. Students with special needs need ongoing help from the teacher to encourage them to progress, to help them identify and use their abilities in order to improve the learning process. For pupils demonstrating a high proficiency level, the teacher must provide an organization that allows them to acquire skills at their own pace, and provide for extension and deepening activities which will be carried out in addition to the common learning required by the program.

In order to increase learner autonomy in a new situation requiring a reinvestment of skills, activities involving the same skills must be varied. The school time allocated to the discipline is a parameter which the teacher must manage in his annual planning and programming. Indeed, if the aim is to improve the proficiency of different skills, training through the diversification of scenarios is the best way to implement the skill-based approach. In the absence of being able to act on the hourly volume allocated to the discipline, the teacher must seek new methods of learning in order to optimize the use of school time, and make him available to the pupils as much as possible in order to better to accompany.

Since school time is reserved for activities to implement skills, it is essential to give pupils the means to appropriate the disciplinary contents that make up the specificity of the discipline and the object of the teaching of the subject.

References

[1] IGEN (2007) Les livrets de compétences : nouveaux outils pour l'évaluation des acquis (Rapport n. 2007-048). [Skillsbooklets: New Tools for as Sessment (Report n. 2007-048).] Ministère de l'Education Nationale, Paris (France).

[2] Meirieu, P. (1989) Apprendre… oui mais comment ? [To Learn... Yes, but How?] Editions Sans Frontières, Paris (France).

[3] Le Boterf, G. (1994) De la compétence. Essai sur unattracteur étrange. [About Skill.

Essay on a Strangeattractor.] Éditions d'organisation, Paris (France).

[4] Romainville, M., *et al.* (1998) Réformes: A ceux qui s'interrogent sur les compétences et leur évaluation. [Reforms: To Those Who Question on Skills and Their Evaluation.] Forum pédagogie, 21-27.

[5] Perrenoud, P. (1999) Construire des compétences dès l'école. [Building Skills from Elementary School.] Editions Sans Frontières, Paris (France).

[6] Tardif, J. (2006) L'évaluation des compétences: De lanécessité de documenter un parcours de formation. [Assessment of Skills: About the Need to Document a Training Path.] Chenelière Education, Montréal (Québec).

[7] Bulletin Official Special n.4 du 29 avril 2010. [Special Official Bulletin n. 4 on April 29th, 2010.]

[8] Boumahmaza, M., Khyati, A. and Talbi, M. (2013) Former à l'évaluation des apprentissages en physique et chimie.Actes du 25ème colloque de l'ADMEE-Europe Fribourg 2013: Evaluation et autoévaluation, quels espaces de formation. [Training on the Evaluation of Learning in Physics and Chemistry. Proceedings of the 25th Colloquium of ADMEE-Europe Friborg 2013: Evaluation and Self-Evaluation, Which Training Area.]

[9] DGESCO (2010) Former et évaluer par compétences dans le cadre des activités expérimentales. [Training and Evaluating Skills in Experimental Activities.] Ministère de l'Education Nationale, Paris (France).

[10] IGEN (2011) Activités expérimentales en physique-chimie: Enjeux de formation (Rapport n.2011-111). [Experimental Activities in Physics : Training Issues (Report n. 2011-111).] Ministère de l'Education Nationale, Paris (France).

[11] Rey, B. (2015) Guide pour la construction d'une leçon selon l'approche par compétences. ULB-UNICEF, Bruxelles (Belgique).