



Charateristcs, roles and times of use of examples by a university physics teacher in a course of kinematics

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Abstract:

In this research, we analyze the effective practices of the teacher, using the dual didactic and ergonomic approach in physics. The reconstitution of the logic of its action makes it possible to infer the characteristics, the roles and the moments of use of the examples. We find that the teacher uses a lot of examples which are essentially concrete, simple and anticipated and of which the majorities are motivational and cognitive. The majority of choices of these examples are explained by the desire of the teacher to involve, to help to understand and to arouse the interest of the students.

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1. Introduction

For several years, university higher education has been a subject of study by many researchers (Clanet, 2001; Altet, 2004; Endrizi, 2011; Duguet & Morlaix, 2012). However, "didactic research on teaching practices in a university discipline is still rare" (Houart & al., 2010).

In this context our research focuses on the effective practices of a Tunisian university physics teacher in a kinematics course of the material point for a first year class of fundamental physics.

We are interested in the use of examples in the teacher's speech because "the example is omnipresent in everyday discourse as a scientist and seems intrinsic to the discourse of any teacher" (Delserieys & Martin, 2016). Particularly in physics, according to Cécile de Hosson and al (2016), in order to explain natural phenomena, the teacher must adopt a modeling and law-making process with many possibilities of using examples. Also research work on the use of examples at university in different disciplines is still new. For France, according to Isabelle Kermen (2016) "The way in which chemistry teachers use examples in their teaching at university has not been published to date".

Indeed, the few works that have appeared in France, such as the review research in education (2016), are based on the declarative, they "questioned the didactic choices of university teachers when they use examples in their courses. Drawing on the perspectives of teacher-researchers from a variety of disciplines:

physics, chemistry, mathematics, etc." (Alice Delserieys & Perrine Martin, 2016). This work showed the importance given by the French university teacher to the use of examples in university teaching. As confirmed by Cécile de Hosson and al (2016), "the use of examples in the teaching of physics at university appears to be an essential practice". Knowing that in this research (Cécile de Hosson & al, 2016) the qualitative analysis of the teachers' declared practices on the use of examples in the physics course revealed, according to all the teacher-researchers interviewed: the nature and identity of the example. Also, the timing, attributes, roles and functions of the examples.

This allowed researchers to identify the relationship between the identities of researcher and teacher in the teaching of physics at the university through the use of examples. But the new in our research is the identification of the characteristics, roles and moments of use of the examples from the analysis of the effective practices of the teacher by reconstructing the logic of his action using as theoretical framework the dual didactic and ergonomic approach (DDEA) developed by Robert and Rogalski (2002) to analyze the practices of the teacher from his action in the class. We find that in a logic of action to make student understand, attract attention and arouse interest, the examples used are motivational, cognitive, conclusive and sometimes within the course, anticipated, simple and concrete. And the way in which the examples are used and chosen clearly reveal the impact of the different dimensions of the practices (cognitive,

mediative, personal, social and institutional).

2. Theoretical framework

In this part we mobilize some concepts that seem important to us in our research. We begin with an explanation of some research in science didactics dealing with the use of examples in teaching and learning. After, we give the characteristics and roles of the examples based on the work of some researchers in didactics (Chie & al, 1989; Cécile de Hosson and al, 2016; Isabelle Kermen, 2016....) what it will serve as a theoretical reference in our work. Then we present the theoretical framework the double didactic and ergonomic approach (DDEA) that we will use to analyze the practices of the teacher in an effective teaching situation.

2.1 Use of examples in teaching and learning

The use of examples in learning is not new and this form of learning has made one of the research topics for many years. The first works were placed in a paradigm the learning-by-example paradigm, where it used various of examples with the same principle: the illustration of a target concept. This allowed, according to Atkinson & al (2000), to know how to select, organize, present...an example.

After, Chi and al. (1989) showed that learning by example is effective when learners are able to generalize from examples addressing the same concept or

from a single example that represents an instantiation of a studied principle. But finding indicators of the illustrative function is a difficult task for these learners, so "only learners with a high academic level can do it" (Chi & al., 1989).

But other works such as those of John Clément and David Brown (1989) and those of Brown (1992) have led to a slightly different result. Because reasoning by analogy in the absence of evidence of a link between the problems is not easy.

Goldenberg.P and Masson.J (2008) consider that the notion of example can concern many disciplines, and can form a common point concerning the "game between abstraction and the empirical world". So from examples it is possible to generalize and understand the mechanisms of certain objects and to apprehend certain concepts. And conversely the example can give meaning to abstract definitions. This gives the consideration of examples as "mediation tools" between learner and concept. Similarly, the example is a "communication tool" between the actors of the teaching-learning act to assimilate the concepts.

2.2 Characteristics and roles of examples

According to Grégory Cormann and Céline Letawe (2011), the example is intimately linked to the issues of learning and education. But, according to Badir (2011) the example, as a concept, it is difficult to define. Although it is considered by Kermen (2016) as a case corresponding to what is shown and by Delcambre (1997) as a model to imitate. In addition, according to (Damblon, 2014) the example relates to a

practice for exposition, demonstration and argument.

According to Fossion and Faulx (2015), the example has different pedagogical characteristics depending on whether it is developed (long) or small. Also the pedagogical nature of the example appears when it is a question of "making the students work" (Isabelle Kermen, 2016). Similarly, the pedagogical aspect appears by the presence or not of an explanation of the link between the example and the concept and the degree of preparation: improvised or anticipated (prepared in advance). And the example "is supposed to be pedagogically effective if it is concrete, if it relates to everyday life, to the familiar" (Cécile de Hosson & al, 2016). For Kermen (2016) the concrete example is a digital application, an example of daily life, a laboratory experiment. Also according to Vezin & vezin (1984) the example can be simple when it does not disperse the attention of the students on irrelevant attributes and allows to apply what has been done in class.

The example is considered classic when it refers to "examples that must be known, those used by the teacher as a reference to recall a definition, a method of resolution" (Kermen, 2016).

The example may be real, but according to Cécile de Hosson and al (2016) the realism somewhat contradicts the simplicity. Because in a real example we can find too many dimensions that mix and too many ideas.

The example can have the role of showing, illustrating, making concrete the taught content. The example "can make it possible to enrich the theoretical aspects by

nuancing them or by showing their limits" (C.Leininger-Frézal, N.Douay & M.Cohen, 2016). According to Denhière and Richard (1990), examples can be used to argue, to make people understand, to attract the attention of students, to help them memorize. And "we do not consider examples without assigning them a function. These functions can be of various orders, socio-affective, communicational, motivational, social, cognitive and depend on the intended interlocutors"(Provenzano, 2011). Knowing that "the role of example is cognitive when it is a question of student's understanding, explicitly or not, of the difficulties they may find, of the appropriation that they may derive from the use of the example" (Isabelle Kermen, 2016). Also for Fossion and Faulx (2015), the example has a cognitive role when it helps memorization, understanding, integration...

Similarly, the example has a cognitive role when it is illustrative where illustration by example consists in showing that the general rule actually works. According to Oliveira & Brown (2016) the illustrative function of an example serves to clarify a point, which can evoke the simplicity of the example compared to the general statement and aim for conceptual understanding. Also according to this same researcher, the example has a function of argumentation to convince which again gives a cognitive role.

On the other hand, the example can "do a motivational role when it comes to arousing interest of the student to the taught concepts, maintaining attention for the activity in progress to do, even to make student want to study" (Venturini, 2007).

Again "example has a motivational role when it is part of everyday life" (Isabelle Kermen, 2016).

And example has a meditative role when it is used to "accompany students who are sometimes in great difficulty" (Isabelle Kermen, 2016). And according to Isabelle Kermen (2016), the example has a meditative role when it is from daily life, it can encourage the student to ask questions and help him to approach different situations with a critical mind.

2.3 Framework for the analysis of teacher practices

We use the dual didactic and ergonomic approach DDEA (Robert & Rogalski, 2002) as a framework for analyzing teaching practices in physics. This analytical framework is "in line with activity theories" (Rogalski, 2003) and proposes "the study of teaching practices by examining the activities in an observed session to reconstruct the didactic and pedagogical choices of the teacher, his representations of the profession, his institutional relations with the institution, his epistemic relations with knowledge" (Robert, 2006).

This is why, from the perspective of the DDEA, the research carried out in the didactics of mathematics and chemistry (Robert, 2012; Kermen and Barroso, 2013) is based on a methodology that takes into account "the potential learning of pupils (didactic aspect) and the work of the teacher (ergonomic aspect)" (Kermen and Barroso, 2013). Because according to (Robert et al., 2007) within the framework of the (DDEA) studies on teaching practices take into consideration, alongside the didactic aspect, determinants linked to the exercise of the profession in an

ergonomic perspective. And according to the dual approach, a teacher's teaching practices include "everything he thinks, says or does not says, does or does not do, over a long period of time, before, during and after class" (Robert, 2008b). It should be noted that within the framework of the (DDEA) "The tasks of the teacher are defined and prescribed by the institution in which he works, the effective tasks are inferred from the activity of the teacher and result from the representation that he has about tasks to accomplish" (Rogalski, 2003). Because each teacher will read the prescriptions in his own way and make a unique representation. So the effective task depends on the state of the teacher during the act of teaching, on these personal points of view on the contents which he must teach according to the program, on his knowledge in physics, on the students who are in front of him... Hence the teacher of the dual approach is considered singular and therefore not generic.

For the DDEA, learning is not assessed "we infer possible learning, through the tasks proposed by the teacher and the activity developed by the students" (Robert & Rogalski, 2002). According to the DDEA, the practices of teachers are analyzed from:

- A didactic point of view linked on the one hand to the scientific content which can show that the practices, at least in part, are aimed at the learning of the pupils (cognitive dimension) and on the other hand to the ways of putting them into operation and to the activities used when the teacher establishes the cognitive itinerary of his pupils and the projects of the sessions (mediative dimension).

- An ergonomic point of view based on the characteristics of the profession as being an activity with personal (knowledge, conceptions, experience..) social (work collective, professional habits) and institutional (program, resources..) dimensions, subjecting the teacher to constraints. This point of view is based on ergonomic psychology which assumes that "the teacher exercises his profession by managing an open dynamic environment" (Rogalski, 2003). And as a result, the analysis of teaching practices retains certain elements external to the classroom in order to grasp and interpret what is happening in the classroom.

In our research, the analysis will be made according to the five dimensions (cognitive, mediative, personal, social and institutional) to reconstitute the logic of action of the teacher.

3. Problematic

The question of the evolution of teaching practices at university is "increasingly at the heart of debates" (Alice Delserieys, 2016), but works "in the context of research in the didactics of disciplines are rare" (Cécile de Hosson & al, 2016).

On the other hand, "research on the use of example in a teaching situation mainly concerns secondary education" (Caroline Leininger-Frézal, 2016). But at university, the use of examples is "little explored in didactics research" (Alice Delserieys & Perrine Martin, 2016). Among the few studies on the use of examples at university, we cite research on the use of examples in the lecture course of physics (Cécile de

Hosson & al, 2016), according to declared practices.

In this work the researchers have shown that according to French university teachers the use of examples is unavoidable and can be a revealer of the professional identity of the university teacher. This work incites us to explore the use of examples by a Tunisian university physics teacher in course of physics according to effective practices.

Because "in terms of teaching, the declarative is often differed from effective practices" (Robert, 2012) and "there is no obvious relation between what is said by the teacher and what is effectively done in class" (Cross, 2010).

In our work we analyze the practices of the teacher to infer the logic of his action to answer the question: What are the characteristics, the roles and the moments of use of the examples used in his course of kinematics during an effective session of teaching?

4. Methodology

4.1 Context of the study

We observe a session of course of mechanics of the first year of fundamental license in physics at the Faculty of Sciences of Gabes. This session is a continuation of the course of chapter 2: kinematics of a material point. (Velocity and acceleration in different coordinate systems). The university teacher has 24 years of experience.

The session is filmed by a single camera directed at the board to record what is said and written by the teacher.

4.2 Data collection

We make an audio-visual recording, an interview after the session.

After the video recording is transcribed word for word and cut into episodes (each episode corresponds to the achievement of a task).

Examples are identified from oral signaling by lexico-semantic markers such as: "for example, imagine that, like saying, such as..." (Coltier, 1988) or when it's about "an analogy, a thought experiment, an exercise,..." (Cécile de Hosson & al, 2016).

4.3 Method of data analysis

We use the double didactic and ergonomic approach (DDEA) for physics as (Kermen, 2013) for chemistry.

We carry out an a priori analysis of the tasks, an analysis of the progress and an analysis of the interviews. Then we cross the results of the analyzes to reconstruct the logic of action of the teacher.

The analysis of progress concerns: The chronology, the interventions, the reconstruction of the cognitive itinerary and the identification of examples and types of context in relation to the difficulties of the students.

5. ANALYSIS AND RESULTS

5.1 Progress: episode structure and chronology

Table1. episode structure and chronology

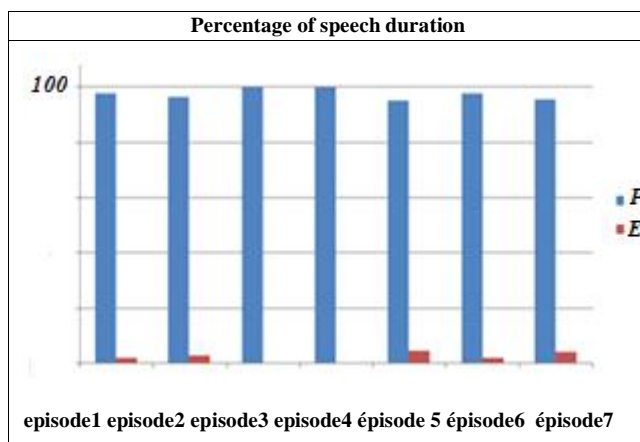
Episode	Nature and mode of work	Duration
Episode1	Introduction and reminder of the work of the first part of the chapter treated the last session.	1mn42
Episode2	Determination of the components of the velocity vector in	5mn12

Episode	Nature and mode of work	Duration
	spherical coordinates with succession of questions and short answers.	
Episode3	Definition of acceleration in the form of a teacher's monologue and use of an example.	2mn51
Episode4	Determination of acceleration in Cartesian coordinates in the form of a teacher's monologue.	1mn18
Episode5	Determination of the acceleration in cylindrical coordinates with a succession of questions and short answers, with the use of an example.	11mn47
Episode6	Determination of the acceleration in the frenet trihedron with a succession of questions and short answers, with the use of an example.	17mn0
Episode7	Application of the course by dealing with examples of simple movements: the rectilinear movement (uniform and uniformly varied) and the uniform circular movement with a succession of questions and short answers and the passage of a student at the blackboard.	15mn0

5.2 Chronology: Percentage of speech durations and percentage of the number of speaking turns for each speaker

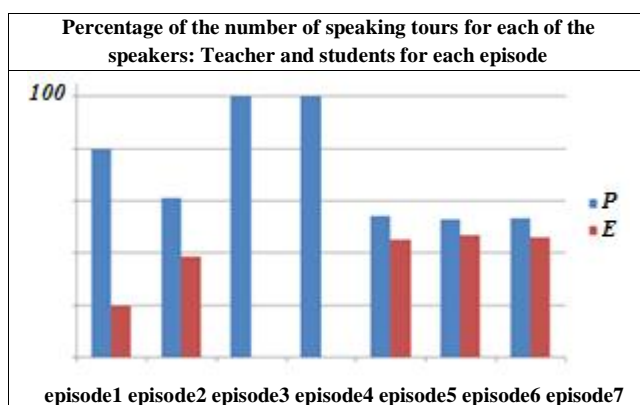
-Percentage of speech durations for each speaker: Teacher and students for each episode. We note the percentage of the duration of the speech of the teacher: P and of the students: E

Fig.1. Percentage of speech duration



-Percentage of the number of speaking tours for each of the speakers: Teacher and students for each episode
We note percentage of speaking turns of the teacher: P and of the students: E

Fig.2. Percentage of speech duration



For the seven episodes, the dominant speaker in the teacher-student discourse is the teacher, something expected in a lecture course that is generally asymmetrical. But for the number of speaking tours, the results obtained show the absence of asymmetry for episodes 2, 5, 6 and 7. This shows the existence of a strong interaction between the teacher and the students. But we note that the number of speaking tours in a lecture course cannot provide information on the duration of the speech of each of the speakers.

5.3 Analysis of practices according to the DDEA

- Practices from the didactic point of view: the cognitive and mediative components.
 - Identification of the knowledge involved: The teacher provides some repere points (Verification of formulas by the units of quantities...), gives 9 examples and in addition to writing on the blackboard, he repeats the conclusions.
 - Enrollment of students in the task: The student is asked to participate and he seems involved in the realization of the task ("What did we do the last time?" (round 1); "... once we have done the speed we are going to do the acceleration..." (round 26)... etc.)
 - The aids provided: The teacher reformulates the questions ("ur is a function of what?" (round16) "What is the expression of the vector ur? ...) and attracts the attention
"... I give you something that can help you..." (round 44) "...Let's start again..." (round 38) "...Here be careful..." (round 32)

Practices from an ergonomic point of view:

- Personal component: The teacher highlights his professional experience "...as i always say...", he gives a lot of examples and sometimes goes beyond the course "...so as i always say...we will see that in dynamics...we connect acceleration to force" (round 79).

- Institutional component: The teacher declares that he went quickly during the session because he is in a hurry for the date of the test. He wants to do everything that is asked in the program.

- Social component: The teacher makes applications in the course, participates with his colleagues in the choice of tutorial exercises.

• The logic of action of the teacher:

From the previous analysis we infer the logic of action of the teacher:

- He solicits the participation of the students by asking and reformulating the questions (according to the teacher "...ensuring the physical and mental presence of the student...").

- It attracts attention to the important points of the course.

- It helps understanding by recalling definitions and methods and by linking the old to the new. Also the teacher does repetitions and reformulations and gives many examples.

5.3 Characteristics, roles and moments of use of the examples used during the session

According to the logic of action of the teacher we find a variety of forms, implementations and roles of the examples.

There are the "small example" to arouse interest (Delserieys & Martin, 2016, p.11) and the "extended example" to apply the concepts and understand the course.

For the degree of preparation and with the help of the statements of the teacher, there are improvised examples and anticipated examples.

For the moments of use, we distinguish the introductory example (example 3 to define the curvilinear abscisse), the example used "inside the course" such as examples (1, 2 and 4) to approach the knowledge to students and help understanding and conclusive example to apply the laws of the course as the examples (8 and 9). This proves that the place of the example differs according to the role assigned to it by the teacher.

For the assigned roles and in the logic of attracting the attention and arousing the interest of the students, the teacher uses the examples "to motivate the students, hook them, show them the usefulness of the concepts that they teach them" (Delserieys and Martin, 2016). As for the example 1.

The teacher considers the use of the example as a "cognitive intervention strategy in the service of understanding the terminology of a discipline" (Nonnon, 1993), what is according to (Denhière and Richard, 1990; Van Lehn, 1996), a way of learning, making students understand, encouraging the acquisition and integration of new knowledge.

For most of the examples used during the lesson, the teacher assigned the function of "arousing interest" aimed at understanding and memorization, which will give the examples a cognitive role, as confirmed by Fossion and Faulx (2015).

We find in the teacher's discourse words and phrases to awaken and arouse the student's interest, as in (round 26) of episode 3 devoted to defining acceleration, the teacher uses the word "attention" also he uses the phrase "it's a very important parameter" and before giving the example adds "...I'll give you an example if you want to feel what the acceleration is...". So the teacher consider that the use of example can arouse interest and therefore help to fix the course in the mind of the student.

However, keeping students' attention and motivating them through the use of examples requires, among others, a choice of simple examples from daily life or concrete examples (example 1) as postulated by Viau (2007) in his model where he considers that for a teaching practice to arouse and maintain the motivation of a student, it must be linked to reality.

Similarly, Vezin and Vezin (1984) affirm that the proximity between the example chosen and what students see in reality have a positive role at the cognitive level. As shown by "research in cognitive science and neuroscience has shown that the individual engages more significantly and has facilitated cognitive processing when what is communicated to him resonates with an analogous coded experience in memory " (Clément, 2014).

Also the cognitive role of the example appears when the teacher illustrates a general idea as in example 5. After having expressed the acceleration in the trihedron of Frenet, the teacher gives an example allowing the student to check the result found "... for example in a_N (equals v^2/R) you have $(m.s^{-1})^2 / m$ which is equal to

$m^2.s^{-2}/m$ equals to $m.s^{-2}$..this is the unit of an acceleration..". Here the example has a demonstrative value, it functions as a confirmation, a proof in the service of the teacher's discourse. Knowing that "Illustration has a particularly important status in the process of managing student learning. It awakens the attention and mobilizes the student's study activity" (Liliane Vezin, 1986).

And in order to make the students understand, the teacher uses generally simple examples (does not disperse the attention on irrelevant attributes...) and concrete (from daily life...) like example 1 and sometimes classic (referring to the examples you need to know...) such as example 8 and 9 where it deals with simple movements (rectilinear movement and circular movement).

This analysis allows us to present the properties of the examples which are numbered from 1 to 9 as follows:

- Moments of use:

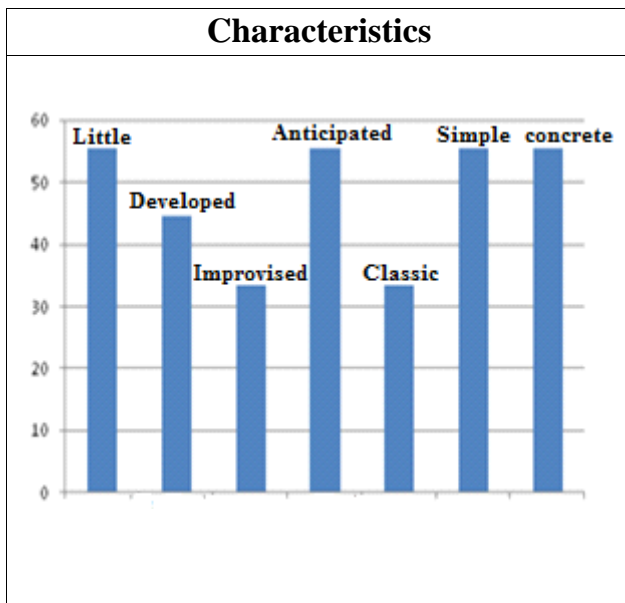
Table2. Moments of use

Example N°	Moments of use
1	introductory
3;4	inside the course
2;7;8;9	conclusive

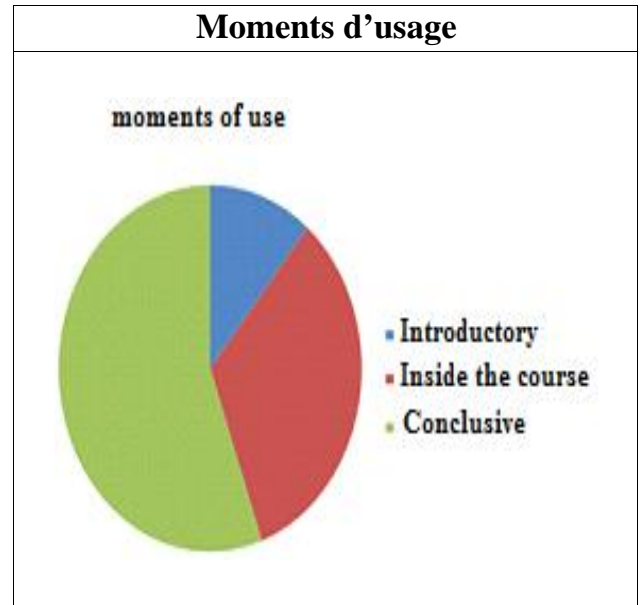
Fig3. Moments of use

- Characteristics:

Table3. Characteristics



Example N°	Characteristics
1	little ; improvised ; concrete ; simple
2	little ; anticipated ; classic ; simple
3	little ; anticipated ; concrete ; simple
4	little ; improvised ; concrete ; simple
5	little ; improvised ; classic ; simple
6	anticipated ; developed ; concrete
7	anticipated ; developed ; simple
8	anticipated ; developed ; classic



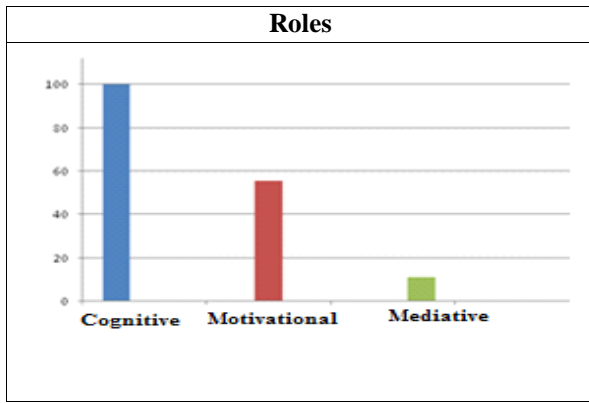
Example N°	Roles
1	cognitive; mediative; motivational
2	cognitive; motivational
3	cognitive
4	cognitive
5	cognitive
6	cognitive; motivational
7	cognitive; motivational
8	cognitive; motivational
9	cognitive

Fig4. Characteristics

- Roles:

Table4. Roles

Fig5. Roles



6. SYNTHESIS

The exploration of the use of examples by a Tunisian university physics teacher during a course in mechanics (kinematics of a material point), through a methodology based on the framework of the dual didactic and ergonomic approach (DDEA), allowed us to analyze these effective practices and reconstruct the logic of his action. So we can categorize the examples used from the point of view of characteristics, roles and moments of use.

This gives the following figure linking the logic of action of the teacher and the properties of examples:

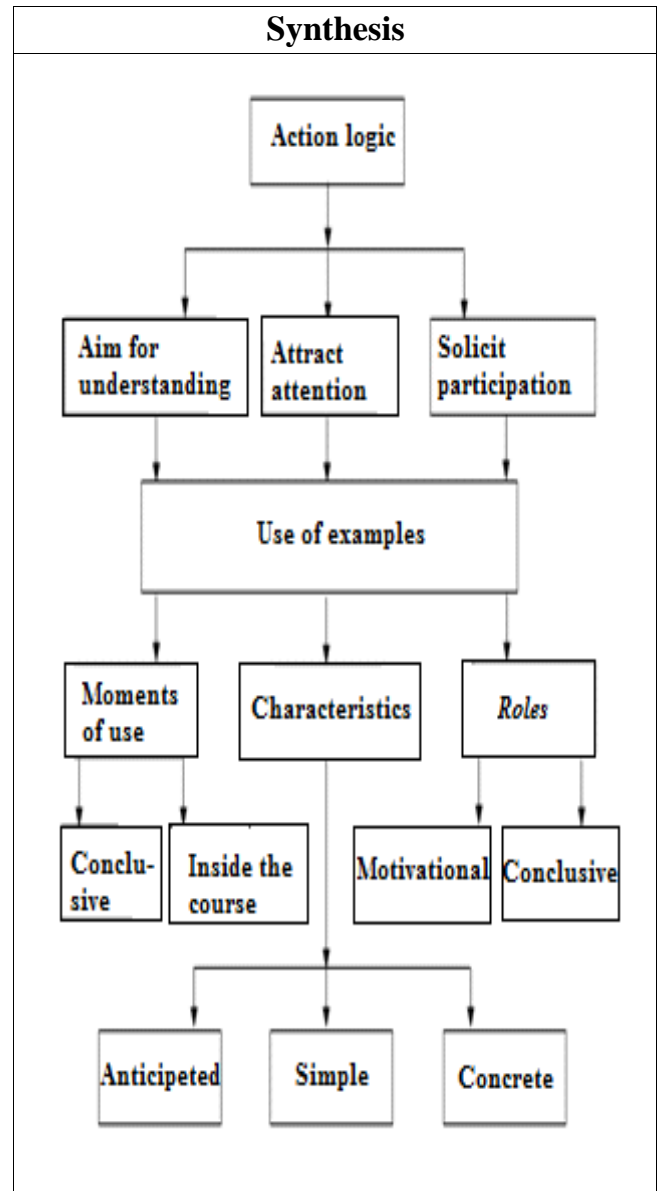


Table6. Synthesis

7. CONCLUSION

In our research we find that the teacher gives a lot of importance to the use of examples. He considers the example as a possible tool to motivate and make the course understood. The teacher considers that the pedagogical efficiency of the example is greater when it is concrete and relates to daily life, because physics deals with many natural phenomena.

Also we find that because of the mathematical aspect of kinematics, the

teacher uses examples to show that physics is an experimental science. And it is by giving examples such as (bus in motion, movement in a bend, etc.) with the aim displayed by the teacher "to feel the acceleration by forces or disturbances because of the variation of the speed ..." and by insisting in the course that "Acceleration is more a physical quantity than a mathematical one..".

This allows us to say that these choices and the way of mobilizing examples by the teacher can depend on the way he considers physics and the way of teaching it.

We identify in the teacher the desire to get his message across, which explains the high number of examples used.

And the choices of these examples are explained in large part by the need to involve the students by providing the necessary accompaniment and by motivating to arouse the interest to understand the course.

So the examples are chosen by the teacher in order to respond to a logic of action aimed at the participation, attention and understanding of the students.

This shows the impact of the personal dimension of the teacher's practices, especially his experience in teaching.

And we find that most of the examples are anticipated, this proves that the teacher before giving the course to the students chooses and prepares the examples and knows which example, what will be used for and when will it be used? Because it is possible that the teacher and the student do not share the same meanings of the example when it is not well prepared. This shows the impact of the cognitive, mediative and even social dimension of the practices.

These dimensions are also revealed by the importance of the number of concrete and simple examples used during the course.

Finally we find that the teacher used the examples that can satisfy the logic of his action and his point of view on physics and his teaching.

We note that our work is a case study so we should not generalize. But this research may encourage didactics researchers to explore the use of examples by university teachers of physics. This will help to access possible training paths for beginner teachers in higher education.

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