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Problems of Teaching and Learning Wave Phenomena and Electromagnetic Induction Phenomena: Case of Three Public High Schools in Madagascar

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Abstract: Scientific study is included in the experimental sciences. In sciences physics, the resolution of problems and exercises follow-up of an experience has an important place in the teaching / training and the assessment of the acquirements. Several research showed that the pupils find some difficulties in resolution of physics problems is to the phenomenological level or the theoretical level. The investigation with several pupils and teachers within three big high schools in Madagascar (Laurent Botokeky Tulear, High school Jean Joseph Rabearivelo Antananarivo, and High school Zafy Abert Antsiranana) permitted us to note that they feel real difficulties to fear the scientific matters, the absence of the experimental sciences.

The teaching of the experimental sciences as the physical sciences, mathematics and the sciences of life and the earth drive the pupil to a good understanding or committed a construction of the knowledge among the pupils. To this effect, one intends in our work to analyze the difficulties of the pupils, to localize and to identify the obstacles to clear in the different stages of the resolution of Physics problems. For it, we elaborated a survey as several "investigates." The collects, the analysis and the exploitation of the results of him investigated showed that the pupils in difficulty need of the following helps: the experimental survey, explanation of the physical phenomenon, presentation of a summary of a recall of courses and formulas, use of the didactic material adapted to the society and supported by the TIC

Keywords: *Resolution of Problems, Training, Difficulties, Experience, Didactic Material, Exploitation of the TIC.*

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I. INTRODUCTION

In the new school system reforms in Madagascar, particularly the Education Sector Plan (PSE), scientific study plays a very important role in these curriculum reforms. Our survey of several students and teachers revealed that they experience real difficulties in grasping scientific subjects such as electricity and wave phenomena.

The teaching of experimental sciences (Physical Sciences, Mathematics, Life and Earth Sciences) leads the student to a good understanding or initiates a construction of knowledge in the students.

It presents the main steps of the various working methods, including observation, description, hypothesis formulation, experimentation, simulation, model building, law formulation, and theory development. It also addresses, with the help of computer tools among other things, different aspects of scientific language such as drawings, diagrams, graphs, and mathematical models.

Experimental sciences are, for students, one of the reference systems that helps them understand the diversity, complexity, and limitations of knowledge, appreciate beauty and harmony, and develop their comprehension skills by awakening their curiosity about natural phenomena. They encourage students to personally enrich their scientific and technical knowledge through the consultation of documents.

Finally, experimental sciences require students to have clear, precise, and correct language in both oral and written expression.

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Our article aims to present the context of students' difficulties in physical sciences. In the first part, we will analyze educational systems and the situation of these difficulties, and subsequently, the second part of our article will consist of presenting proposed support measures for struggling students.

II. THEORETICAL FRAMEWORK

Numerous research studies have shown that learners encounter serious difficulties in the teaching/learning of physics in general and in problem solving in particular (Reif, 1983; DumasCarré, Gil-Perez & Goffard, 1990; Goffard, 1994; Proulx, 1999), because learning situations in physics are characterized by particular difficulties given the complexity of certain phenomena and the underlying formalism, notably the wave phenomenon (Maurines, 1986; Mazouze, 2011; Mazouze & Lounis, 2012).

The concept of a wave is not easy to grasp, because its genesis, its intrinsic structure, and its functioning are inextricably linked to the implementation of an elaborate mathematical formalism. In this sense, Gil-Perez (1993, p. 51) states that: “It is certain that a large number of central scientific concepts are quite difficult for the majority, if not all, of adolescents and even university-aged adults to construct.” The work we present here falls within the field of research concerning the processes involved in problem-solving tasks related to wave phenomena and electricity.

The didactic concepts we adopt in this study revolve around didactic or pedagogical obstacles and problem-solving (Astolfi & Develay, 1989; McDermott, 1998). The didactic consideration of obstacles and their "overcoming" by learners now plays a crucial role in any curriculum design or the development of learning activities. Problem-solving is often considered a learning objective, a skill to be acquired, but it is also conceived as a means of learning.

III. PROBLEM STATEMENT AND METHODOLOGY

Problem-solving plays a crucial role in recent educational reforms in Madagascar (PSE). Students consider it fundamental and decisive, as it is the measure of success in the current assessment system, a pivotal event in a **student's** academic journey. However, many students struggle to understand the course material and often encounter obstacles in problem-solving activities, unsure how to overcome them.

Our research objective is divided into two parts. The first part focuses on the experiences of high school teachers regarding the difficulties students encounter in learning about physical phenomena in general (wave phenomena and electromagnetic induction). The second part presents the results of research and analysis on the difficulties students face in understanding physical phenomena and the obstacles they encounter in solving physics problems.

To this end, we plan in this work to investigate the causes of difficulties in the teaching and learning of physical sciences, as well as the obstacles that prevent students from successfully completing problem-solving tasks. This leads us to ask the following questions:

- What difficulties do students encounter in learning about physical phenomena?
- Why are some students unable to even begin solving a problem?

These questions lead us to adopt the following research hypothesis: "Students experience difficulties in understanding the wave/electromagnetic phenomenon, and in using mathematical and graphical tools to solve problems."

We used a five-choice questionnaire with the following format:

- TF: Very Easy: that is, the question is simple and presents no difficulty for the student;
- F: Easy: the question is less simple than the previous one;
- D: Difficult: the student encounters difficulties;
- TD: Very Difficult: the student encounters greater difficulties than the previous ones;
- SR: No answer: the student did not answer.

Thus, candidates are asked to tick the box that suits them and we have asked them to justify their choices by citing the causes of the different difficulties.

IV. PRESENTATION OF THE SURVEY RESULTS AND INTERPRETATION

We present the results of the survey in the tables below with explanatory and interpretive texts to facilitate reading and following the work.

- *A. 1 - Teacher Survey in the Three High Schools: (N=21, 21 Teachers):*

Table 1 Number of Physics Teachers in the Three High Schools.

High school	Number of Teachers
Zafy Ambilobe High School	06
Laurent Botokeky High School	05
Jean Joseph Rabearivelo High School	10
Total	21

ISSN No: -2456-2165 https://doi.org/10.38124/ijisrt/26may366

Table 2 Overall Results of the Teacher Survey by Number

Overall Survey Results (Teachers) **TF:** Very Easy**, F:** Easy, **D:** Difficult, **TD:** Very Difficult, **SR:** No Response						
Questions		**Responses in Numbers (Teachers, *N=21*)**				
		TF	**F**	**D**	**TD**	**SR**
E_1	Course comprehension	00	14	07	00	00
E_2	Insufficient course simulation time	3	5	4	2	7
E_3	The existence of gaps in mathematics	1	2	4	7	7
E_4	Difficulties related to the complexity of the physical phenomenon	2	2	10	3	4
E_5	Inadequacy of the problem-solving methods	2	3	5	1	10
E_6	The professor's method	4	11	4	00	2
E_7	The formulas are difficult	2	7	4	2	6
E_8	Lack of mastery of mathematical concepts	2	2	8	4	5
E_9	The lack of practical work	2	4	6	4	5
E_{10}	The lack of exercises on the different types	1	8	6	3	3
E_{11}	Few exercises are covered in class	2	8	3	4	4
E_{12}	Insufficient use of technology (programmable calculator, recorder, etc.)		2	5	8	6
E_{13}	Use of ICT and ICT	1	3	3	10	4
E_{14}	Use of teaching materials	2	6	5	6	2
E_{15}	Use of educational resources	3	7	3	5	3

Table 3 Overall Results of the Teacher Survey in Percentage

Overall Survey Results (Teachers) **TF:** Very Easy, **F:** Easy, **D:** Difficult, **TD:** Very Difficult, **SR:** No Response						
Questions		**Responses as a Percentage (Teachers, *N=21*)**				
		TF	**F**	**D**	**TD**	**SR**
E_1	Course comprehension	0	66,66	33,33	0	0
E_2	Insufficient course simulation time	14,28	23,80	19,04	9,50	33,33
E_3	The existence of gaps in mathematics	4,75	9,50	19,04	33,33	33,33
E_4	Difficulties related to the complexity of the physical phenomenon	9,50	9,50	47,61	14,28	19,04
E_5	Inadequacy of the problem-solving methods	9,50	14,28	23,80	4,75	47,61
E_6	The professor's method	19,04	52,38	19,04	0	9,5
E_7	The formulas are difficult	9,5	33,33	19,04	9,5	28,57
E_8	Lack of mastery of mathematical concepts	9,5	9,50	38,05	19,04	23,80
E_9	The lack of practical work	9,5	19,04	28,57	19,04	23,80
E_{10}	The lack of exercises on the different types	4,75	38,05	28,57	14,28	14,28
E_{11}	Few exercises are covered in class	9,50	38,05	14,28	19,04	19,04
E_{12}	Insufficient use of technology (programmable calculator, recorder, etc.)	0	9,5	23,80	38,05	28,57
E_{13}	Use of ICT and ICT	4,75	14,28	14,28	47,61	19,04
E_{14}	Use of teaching materials	9,50	28 ,57	23,80	28,57	9,50
E_{15}	Use of educational resources	14,28	33,33	14,80	23,80	14,28

➢ *B. 1 - Student Survey in the Three High Schools: (N=181 Students):*

Table 4 Number of Students in Second Year (2nd) in the Three High Schools.

High school	**Number of students**
Lycée Zafy Albert High school	48
Lycée Laurent Botokeky High school	82
Lycée Jean Joseph Rabearivelo High school	51
Total	181

Overall, the majority of teachers, nearly 50% (47.61% average percentages), observe that students have great difficulties in understanding the wave phenomenon and the phenomenon of electromagnetic induction, in addition to the use of mathematical tools and the insufficient use of didactic, pedagogical materials, ICT and ICTE and the laboratory.

In this section (student survey), we will divide our survey into two stages. The first analyzes the students' learning difficulties, and the second concerns the forms and

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needs for support requested by students experiencing difficulties.

➢ *B. 2 - Results of the student survey: Difficulties and Obstacles: (N = 181):*

The following two tables (Tables 5 and 6) present the overall results of the student survey. The detailed results, in numbers and percentages per high school, were recorded on the survey forms.

Student survey results: Zafy Albert High School, Laurent BOTOKEKY High School and Jean Joseph Rabearivelo High School: that is to say the overall results of the student survey for the three high schools in percentage (%).

Table 5 Overall Results of the Student Survey as a Percentage: In All Three High Schools for Difficulties and Obstacles

***Difficulties and Obstacles:* Overall Results of the Student Survey** **TF:** Very easy, **F:** Easy**, D:** Difficult, **TD:** Very difficult, **SR:** No response						
Questions		**Responses as a Percentage Students, *N=181***				
		TF	**F**	**D**	**TD**	**SR**
E_1	Course comprehension		2	52	13	33
E_2	Insufficient course simulation time					
E_3	The existence of gaps in mathematics		8	62	10	20
E_4	Difficulties related to the complexity of the physical phenomenon				57	43
E_5	Inadequacy of the problem-solving methods	4	8	34	28	26
E_6	The professor's method		1	40	4	55
E_7	The formulas are difficult		9	33	16	42
E_8	Lack of mastery of mathematical concepts			35	45	20
E_9	The lack of practical work				75	25
E_{10}	The lack of exercises on the different types					
E_{11}	Few exercises are covered in class					
E_{12}	Insufficient use of technology (programmable calculator, recorder, etc.)		8	27	59	6
E_{13}	Use of ICT and ICT		40	1	51	8
E_{14}	Use of teaching materials		20		48	32
E_{15}	Use of educational resources				54	46

➢ *B. 3 - Results of the student survey: Needs and Forms of Support for Students in Difficulty (N= 181):*

Table 6 shows the statistics of students who need support, categorized by type. These overall results are presented as percentages (%).

Table 6 Overall Results of the Student Survey as a Percentage in the Three High Schools Regarding Proposed Assistance

QUESTIONNAIRE RESULTS ***Needs and Forms of Support: Overall Results of the Student Survey*** **A: No Preference** **B: Not Desirable** **C: Desirable** **D: Highly Desirable** **SR: No Response**						
Forms of Assistance Offered		**Responses as Percentage (%) Students *N=181***				
		A	**B**	**C**	**D**	**SR**
Q_1	A review of the concepts learned in mathematics	17	10	45,50	12,50	15
Q_2	A reminder of the lesson	5	35	5	55	0
Q_3	A reminder of the formulas studied		32,5	52	14	1,50
Q_4	An explanation of the physical phenomenon studied	3,5			51,5	45
Q_5	Don't go too fast in the courses			20	73	7
Q_6	A practical experience in everyday life or simulation			56		44
Q_7	The use of practical exercises corresponds to the course		10	47		43
Q_8	A limited number of exercises are presented, along with detailed and in-depth solutions.				78	22

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Q_9	A large number of exercises with very brief solutions.			30	68	2
Q_{10}	Use of ICT and information technology (CDs, internet, etc.)		58	10		32
Q_{11}	Working in a group	50		17		33
Q_{12}	Work individually					
Q_{13}	Using tutoring services (private lessons, etc.)	3	13		74	10
Q_{14}	Use of bilingualism or multilingualism (dialect)		8	68	15	9
Q_{15}	Application of different calculation methods and solution methods.		52			48
Q_{16}	Use of traditional teaching materials (rulers, set squares, springs, etc.)		15	67		18
Q_{17}	Use of ICT-supported teaching materials	40				60

V. CONCLUSION AND DISCUSSION

We have developed two surveys with the same question: the first is posed to physical science teachers at Laurent Botokeky High School, Jean Joseph Rabearivelo High School and Zafy Abert High School and the second survey for students at these high schools.

The objective of this work is to identify the difficulties that students encounter in understanding the physical phenomenon (wave, electromagnetic induction, resonance), the use of mathematical tools, and the use of educational, didactic and technological materials (ICT and ICTE).

Using the same questionnaire, we surveyed two types of samples separately: teachers and students. In the three high schools, a total of 202 individuals were surveyed, including 21 high school physics and chemistry teachers and 181 students in the second year of high school.

The analysis of the survey results made it possible to identify the causes on which students encounter the most difficulties in learning about the wave phenomenon and in solving scientific problems.

➢ *These Results can be Summarized as Follows:*

- R_1 - difficulties in understanding the phenomenon of electromagnetic induction;
- R_2 - difficulty in mobilizing previously acquired mathematical concepts;
- R_3 - lack of mastery of mathematics;
- R_4 - the lack of practical work;
- R_5 - Insufficient use of teaching and learning materials;
- R_6 - Insufficient use of ICT and ICT

Based on these results, we can propose and develop some avenues for improvement and remediation.

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