Strengthening the Teaching of Scientific Subjects at the Level of High School in Madagascar

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Abstract--**Madagascar is a developing country where the rate of enrolment and quality of education are still weak. At the college level, these problems are still very sensitive since some teachers especially those of scientific topics have difficulty to pass their courses. The situation is worsening in rural areas where teachers lack academic skills and that they do not have adequate educational materials to better explain and engage the attention of students. To address these gaps, the use of media and electronic device for the course is a real solution. This pedagogical innovation allows to modernize learning through visualization of content as well as to limit the possible misinterpretations issued by teachers due for examples to lack of preparation or non-mastery of the lesson. This method consists in filming scientific courses undertaken by experienced teachers then disseminating VCD through institutions in rural areas where science teachers are unsatisfactory or low skilled. The use of such a method helps tremendously on the academic performance as well as on the education quality improvement especially in rural areas.**

I. INTRODUCTION

The teaching - learning of scientific topics presents difficulty for both teachers and students. This problem has occurred a pretty long time ago and it has raised discussions along that time [2]. However, science teaching has become a major issue for the future of human society because of its growing importance in daily lives [2]. This failure is met all over the world [2] but the situation is almost overcome in developed countries. In developing countries, it remains one of the major issues related to education. The case in Madagascar is particularly critical, due to general lack of scientific literacy and basic skills in science, and on the other hand, due to various problems related to the education system: scarce and unqualified teachers, inappropriate teaching materials.

This difficulty leads among others, to the decline of academic achievement and of education quality in general. So is the case of the Secondary School (CEG) Andranonahoatra, in the School District (CISCO) of Atsimondrano Antananarivo and under the Regional Direction of Education (DREN) of Analamanga. Teaching for Physics and Chemistry in the 3rd classes, in preparation of the second official examination called BEPC or First Cycle School Certificate is miserable: Lessons are given such as lecture at the university despite their scientific characteristics. For their part, students face linguistic problems as the lessons are taught in French. Exercises are very essential but they are insufficient. Some technical-scientific vocabularies and concepts are misunderstood and badly assimilated. In addition, Physics and Chemistry does not seem obvious in their daily lives and they lack concentration and attention. Those are the various reasons that push the majority of students to move more to literary topics such as Malagasy, Geography and History which are less demanding and more alive.

This publication provides a study of digital device implementation for which purpose is to develop teaching and learning of Physics-Chemistry in 3rd grade of secondary school. The determination is to produce teaching and courses models on instructional videos that are central for the new generation [3,4]. It aims to demonstrate whether this pedagogic innovation helps strengthen the professional skills of PC teachers in college and encourage students to become interested and to move to scientific domains.

II. MATERIALS AND METHODS

A. Materials:

- Targets

- Teachers

The first material to be mobilized is both Physics and Chemistry teachers: The one as a model teacher and the other as a target teacher. The first would be selected from those experienced teacher who teach at secondary school in the capital city. He should show great educational and academic skills in Physics and Chemistry and also long experience in teaching. He would play the main actor in the scene. Target teacher is the one that would benefit from the educational support. This one could be a non-official teachers (ENF) newly recruited or already an official agent with low academic and pedagogical skills.

- Students

Along with those teachers, there are students from two different third classes: the training class and the target class. Generally those are teenagers between 12-14 years old. The majority have done their studies in primary schools in the surrounding. Their intellectual baggage is relatively low because of the failure of the system since the 6th grade (first grade in the secondary school). They are mostly from middle-class and poor families. Located in suburban, these children are really neither rural nor urban ones.

- Designer Team

This team will be responsible for planning and elaborating curriculum. It is composed of 15 technicians under the 5 Departments of the Ministry that are most affected: Direction of Basic Education, Direction of Secondary education, Direction of Supervision and Pedagogical inspection of Basic

Education ,Direction of Supervision and Pedagogical Inspection of Secondary Education, Direction of Curricula and inputs. They are selected and nominated by their respective directors. These are primarily teachers with substantial teaching experience and strong capabilities in conception (Physics and Chemistry Teachers in the secondary and high school, Pedagogical advisors level II ...).

- Education Authorities

At the Ministry level, the Minister of Education and his staff will be the first responsible for the project. Their roles are mainly to endorse the smooth running of all activities. They also guarantee its implementation by providing their aid and technical support.

At the local level, the Regional Director of Education in Analamanga, Chef CISCO Antananarivo Atsimondrano and the two Directors of the secondary school will be involved from the conception to the implementation of this project. They are responsible for monitoring and control.

- Pedagogic documents and tools

• Physics and chemistry book for 3rd grade

This book defines the general orientation of the teaching in the third grade. It contains the curricula of all subjects to be taught. It also describes the profile of students leaving the secondary school. This document serves to frame the lessons according to the specified time and following general and specific objectives of different themes.

• Pedagogic materials

As far as scientific matter is concerned, teaching Physics and Chemistry requires the use of a variety of teaching materials. For this activity, their use should be well controlled by the model teacher. The aim is to produce clear and rich digital lesson in scientific demonstration to make them more interesting and understandable.

- Production Team

It is a professional team which ensures the completion of footage, editing, processing and multiplication of courses via Video Compact Disc (VCD). This is indeed a well-structured group of technicians who have appropriate human and material resources to respond to the technical and educational requirements of the production.

- Production Technicians

They are in charge of manipulating the equipment and materials during the various stages of production. They shall ensure that the quality of picture and sound is very good. These technicians also ensure the multiplication of these courses on VCD. Therefore, they should be qualified technicians with both audio visual communication capabilities and knowledge in pedagogy. This team must have a leader who is closely monitoring compliance with the standards in all phases of implementation. Definitely this team must have sufficient and competent personnel. (Cameraman, computer technician .....).

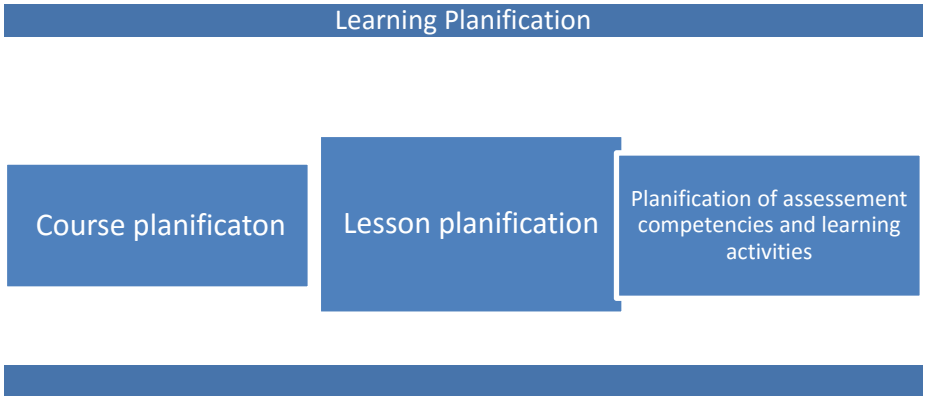
- Production, reproduction and diffusion materials

The production and reproduction materials are of professional quality so as to get good quality products that meet international standards in terms of audio-visual production. The diffusion materials are not necessarily top new and professional, but only in good working condition to avoid improper functioning.

The table below summarizes the technical specificities.

LIST OF MATERIALS AND PRODUCTION EQUIPMENT

	Materials	Technical specifications	Number	Comments
Picture shooting Tool	Camcorder JVC GY-HM 750	with wide angle	1	Institutional Unit
	Camcorder Sony DSR -500	with wide angle	1	
Sound recording Tool	Mixette SQN-4S	portable console	1	Professional Quality
	Professional microphone Shoes		1	
	Ttransceivers		1	With micro tie
	Digital recorder TASCAM DR-100		1	
Studio lighting tool	TOTA LIGHT UNIFLOOD CASELITE	300/800W 300 :650W 55W Fluo 4 Broches	1 1 1	Professional Quality
VIDEO shooting Tool	Video editing	Software specialized in film editing	1	Professional Quality
Reproduction Tools	Computer Equipment Recordable Cd player	with software	1 1 100	Professional Quality
Diffusion tools	Computer Equipment Video Projector VCD player	With VCD reader	1 1	1 In good condition and compatible software



Sequential process teaching approach

B. Methods

The realization process of this research follows an extremely rigorous approach so that the final product has good quality. Thus, three methods have been developed to carry it in a scientific way.

- sequential pedagogic approach

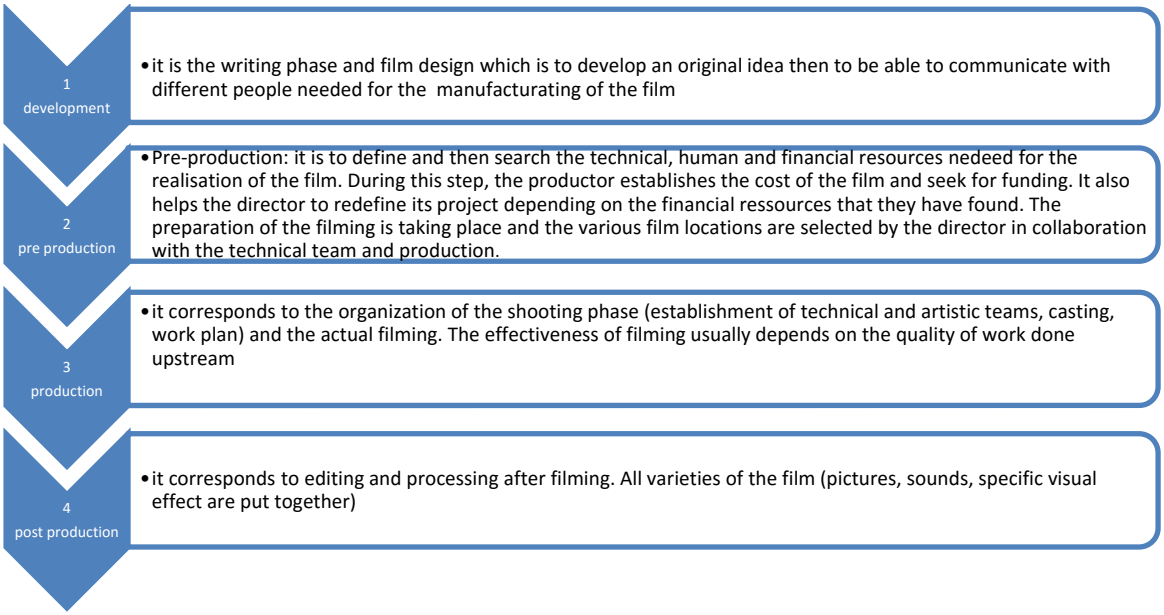
This educational approach consists in planning a course. According to Legendre [2], a course is an organized set of learning activities defined by a curriculum. Planning aims to achieve course objectives or skills. According to Yvon Brunet, this plan has three distinct phases 1]: elaboration of the syllabus, elaboration of the lesson plan and elaboration of competency and learning activities assessment plan. The course outline is built using competency elements described in the Physics and Chemistry schedule book of the 3rd class. The lesson plan is used as planning for teaching and learning activities. It guides the teacher before, during and after each lesson. Finally, the evaluation plan describes the means of assessment of learning activities in the course. This approach is pedagogic and didactic as well.

- Audiovisual technique

Audiovisual means at the same time all materials, techniques and methods of information, communication or teaching involving sound and picture. In Anglo-Saxon countries, in Quebec and France, audiovisual techniques have been used in the service of teaching since 1950 as an educational tool. In Madagascar, its use is still limited for the benefit of private institutions.

The diagram below summarizes the process of producing a film. It shows the four steps of development prior to its release in public.

The production of these courses imitates the production of the film. This comprises four steps:



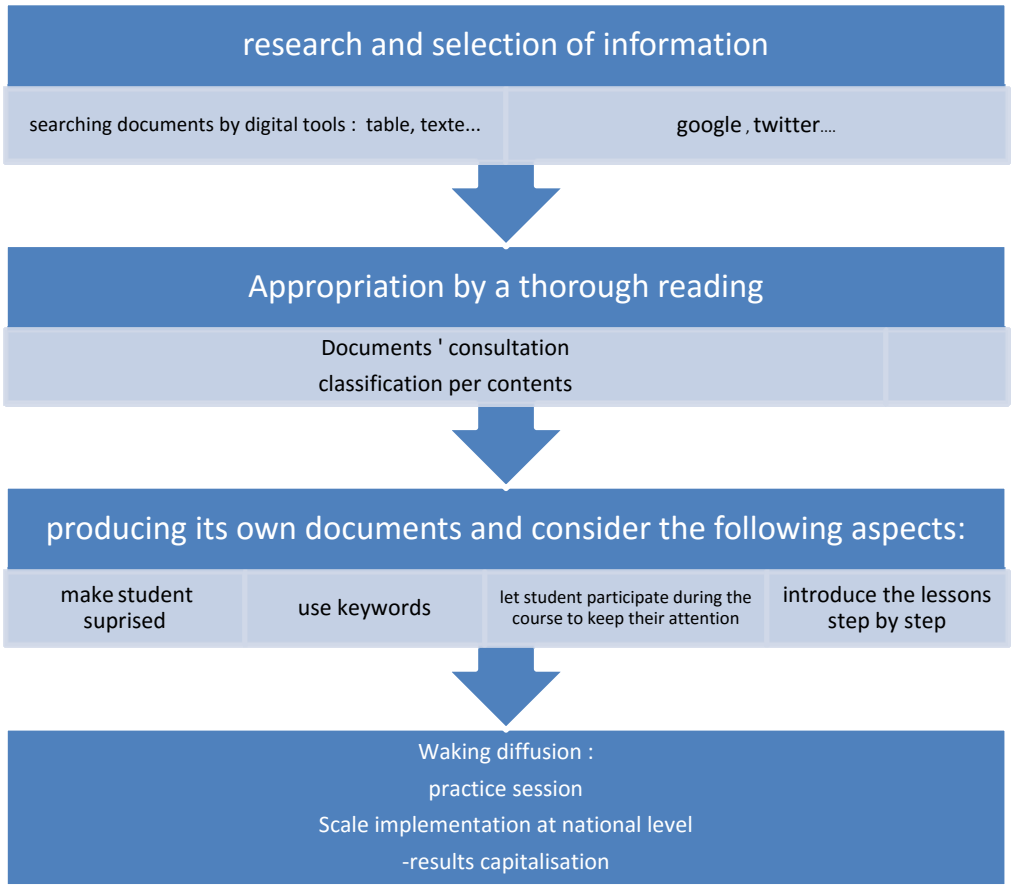
It's only after these steps that the film can be distributed and showed:

- Pedagogical intelligence

The project provides students with well formulated and updated lessons while education system is being modernized;

At this time of technological development, all sectors of activities are turning to the wakening. As far as methodological and technological is concerned, waking methods is very important to build our own knowledge basis. [4] It is valid for the development of these courses.

The powerful pedagogical approach is composed of four steps [5]:



III. RESULTS

The application of this research from the conception phase to the practical courses in 3rd class at the target secondary school allowed us to get the results below:

A. About course and exercise conception

✓ Modeling of courses and exercises development

As it is an interdisciplinary working group, produced courses are totally different from those prepared individually by a teacher. Conceptors contributions and the use of pedagogic intelligence enable the development of a well-proportioned, illustrated and attractive course model. For example, they contain parameters which are encouraging to learning such as:

- Make students surprised by the title of the course or by the scenario. Unexpected questions are inserted to stimulate their curiosity.
- Use well-arranged keywords relating to treated themes.
- Put links that combine new ideas with student achievement and drive slowly to the complexity of the lessons.
- Make the student participate to keep them attentive
- Anchor some visuals by avoiding to remove the visual fields of students to support their memorization process.

✓ *Highlighting the teaching-learning frame*

The courses have become better framed and the teacher could easily follow the logic of learning despite their complexities as scientific topics. The school program has become a reference tool that is binding on all reflections. Several reformulations have been made so that:

- Their contents actually reflect the global and specifics objectives of the curriculum
- They respect the time allocation of each educational stage.

- They contain some knowledge control / assessment exercises in line with their specific objectives

The conception of the course for a theme is an intensive work which last about a week. Thus, they are rich in terms of both content and methodology. In that case, these models are new educational resources to all Physics and Chemistry teachers in 3rd class of secondary school. They are essential to the development of their own preparation sheet and their own course process.

B. Course diffusion

✓ Teaching and Learning modernization

As it is an innovation of the teaching practice in a public institution, the use of audio and visual aids during the learning and teaching of Physics and Chemistry in the target secondary school has an important impact to students. Formerly, the teaching of scientific topics was very archaic and theory-based; then, the teaching materials are too modest and insufficient. With this new approach, they feel at the height of technology. Moreover, the installation and use of materials and equipment in classroom has changed their impression. They see, henceforth, their world greater. During the course diffusion, films break their learning rhythm. The replay of unclear passages is possible. The explanations become more evident owing to several selected illustrations which can be replayed.

For this public school, video is a perfect support to engage education to the media. In addition, during its production, viewing the productions is an immediate and concrete feedback. This innovation induced in students a desire to progress. At a large scale, its implementation would have made revolutions in the education system in Madagascar as far as the learning and teaching of scientific topics in the secondary school is concerned.

✓ Students 'High concentration and involvement

Located in rural areas, students in this secondary school generally have difficulty to focus their interest in scientific topics including Physics and Chemistry. Moreover, they are struggling to stay focused until the end of the sessions especially when the courses seem difficult for them, as it is since they were in the 6th grade and also with teachers having difficulties in teaching as previously. As a new approach, the video brings change to students' behavior. They can watch and listen at the same time the progression of the courses. Their curiosity makes them sit quietly and focus more. In many cases, visualization reinforces memory among the young. Their retaining capacity develops gradually and they become more active and dynamic in classroom.

STUDENTS DEVELOPMENT
BEFORE AND AFTER THE USE OF EDUCATIONAL VIDEO

Number of students		**Number of students that like Physics and Chemistry**		**Average score on a written evaluation**	
		Classic courses	Educational video	Classic courses	Educational video
Boys	22	9	20	8/20	15/20
Girls	31	15	28	6/20	13/20
Total	53	24	48		

In addition, well proportioned and structured content facilitate their understanding. They have a full insurance on how the teacher transmits the lessons. The illustrations allow them to better understand the explanations and reduce difficulties associated with imaginary situations.

IV. DISCUSSIONS

A. A virtually neglected but exploitable period

In Madagascar, students from secondary schools are teenagers of 11-14 years old. For the 3rd class their average age is 13 years old. The four years of study in the secondary school match their psychological development phase where their level of curiosity and risk is quite high. As far as behavior is concerned, they behave like difficult children who lack respect, responsibility and motivation. Contrary to this situation, their intellectual capacity could grow considerably. This phase of transition between childhood and adulthood also corresponds to the exploration phase and acquisition of new unusual experiences. For these teenagers, scientific subjects such as Physics and Chemistry allow them to discover and understand their daily environment as well as to have comprehension and coherent representation of the world. Scientific literacy is based on knowledge of the principles and purpose of reasoning but also on actual practice of scientific approach. It constitutes one of the bases of their adult life by drawing from their earliest ages some guidelines of their personality and their personal and professional reference.

This period is so very favorable to the integration of scientific cultures and to the development of their sense of observation and analysis. Well supervised youth are the future builders of this country.

B. Multiple advantages

✓ Improving the quality of education

The quality of education contributes to the success of education. In Madagascar, the academic success rate is still low in public schools. In 2014, the pass rate in the second official exam called BEPC (highest level in secondary school) was only 38%. Scientific topics are composing certain factors of this low rate.

As far as teacher is concerned, the modernization of education in the Public secondary school can provide Malagasy students quality education. Their scientific competence as teachers generally improved. This skill includes knowledge and expertise both academic and professional. It provides new horizons in education for target teachers and for teaching supervisors involved. Thus, their new knowledge can be used for personal development.

Compared to students, they can enjoy this technological development for basic education. These prefabricated ongoing digital version allows them to have well-framed and measured lessons and added values of their knowledge making their general culture enhanced.

This project, in fact, increase the skill level of students to form new generations of new graduates (BEPC).

✓ Increased learning time

In secondary school (CEG), director still has latitude regarding the organization of administrative and pedagogical nature of their institutions and their teachers. Often their distance from the CISCO leads to lack of systematic control and monitoring. In practice, dead time is often observed. They are, among others, caused by the lack of classrooms and teachers or their occasionally absences. Such cases are common for science teachers who are almost rare especially in rural areas. Accordingly, the hour volumes allocated to these topics are often reduced.

Moreover, dead time accumulates during course time because of the bad-mastery of one or more themes within the topics or because of bad time management.

The implementation of these instructional videos allows largely to resolve this situation. Compared to the inadequacy and lack of teachers, the time allocated to learning can be maintained due to these videos that can replace them temporarily or permanently. In that way, these exam classes no longer suffer from not achieving program and lack of exercise.

Dead time during teaching sequences can also be reduced. Normally the course contents conveyed in videos would be well prepared and proportioned according to the set number of hours (2 or 3 hours) and to the normal learning rythm for the students.

These time savings allow to a normal functioning of the establishment. They will be very helpful to increase the number of exercise and evaluation to control the students adaptation as well as their achievements during the course.

✓ More attractive and accessible learning for students

Diffusing these courses on video can make them more attractive by their content and format.

As from their contents, they are designed to keep the attention of students and stimulate their involvement. In principle, they contain very clear and fun explanations with different vocal rhythms. They also develop varieties of demos that appeal their curiosity.

In addition, it is not only the content of the lessons that influences student learning in this project but also the way the teacher presents the course itself. In traditional education, the adopted pedagogical strategy does not show the current image of science. The manipulation of audio visual equipment allows the mobilization of the whole class attention. Students accustomed to the use of digital media would understand faster and better. Thus, this educational innovation develops their positive attitude about learning especially for scientific topics.

✓ Teaching performance

VCD are digital supports resulting from the development of New Technology of Information and Communication (NTIC) which directly influence the two fundamental missions of the school: transmission of the knowledge and socialization of the young people. [7]. 30 years after the first experiments of its introduction into training, education actors in developed countries could concretely appreciate the transformation that they bring in the daily life of the school system. It is indeed the need for making the teaching contents and competences evolve. Moreover, they provide opportunities for investigations and discoveries [8]. Other than the transformations of teaching supported by the NTIC, they also bring added-values to education making it possible to the teachers to acquire new competences. The "pedagogic intelligence" enables them to adopt favorable behaviors to the profession of teacher by enriching their "knowhow", "know to be" and "know to get":

- Know how
  - • Design and plan learning activities,
  - • Recognize and encourage learning,
  - • Innovate and experiment in braving to launch new activities
  - • Support with teaching resources.
- Know to be
  - • Ability to humor
  - • Ability to transmit scientific culture
  - • Ability to develop a sense of creativity
  - • Ability to develop a sense of analysis
- Know to get
  - • Ability to develop ones vision and that of others
  - • Ability to bring personal development to students
  - • Ability to make changes and innovations

C. The proposed changes during its realization

✓ *Changes similar to other countries*

At first observation, digitization of teaching in the secondary school in Madagascar is an indisputable progress from this innovation. The use of Information, Communication and technology (ICT) in the service of education has already widespread in many countries and we can say that Malagasy students will have the same opportunities as those in other countries. This digitization will have significant impacts: use of modern tools providing

real added value for teachers and for students such as the standardization of course content, continuous research and further information for all actors in education, and the simulation through visualization of the courses.

The valorization of sciences teaching by setting out research and educational innovation is already a global reality that Madagascar could reach through this project. This research is one of the levers of its development. For information, academic and teaching skills of teachers in science and technology fields are developed. At current time of globalization, they can explain, at least, the process of the development of science [9; 10] in the world.

At a large-scale and in medium term, the situation of education in Madagascar could change significantly and progressively. A great part of obstacles related to the lack of qualified teachers and insufficiency of teachers would be mostly solved. The quality of education would be improved over the time. Scientific cultures initiated to the youth would grow and they would form generations of researchers.

This progress could advance the rank of Madagascar in the field of education worldwide (currently 143th), but there is still a long way to run compared to developed countries such as Europe , America , Asia and Africa (France, United States, Canada, Hong Kong, Japan , South Africa, ...) .

✓ *Changes different from those of other countries*

Madagascar is a countries which is still far behind in regard to development of teaching technology. With the material and financial problems to which the current education system is facing, the technical level and the scope of this innovation could be different from other countries, especially with those who are already well advanced. At a national scale, the quality of computer and audiovisual equipment available to institutions in distant areas could nuance the results throughout the country.

D. Limits of the digital device adoption

✓ Difficult technical conditions

- Poor infrastructure and basic facilities of secondary School

Despite overall advances in technology, the education sector especially the public institutions does not benefit fully from this change. Yet this innovating project requires a very suitable framework for its impact to be truly outstanding on students.

- Inappropriate Security

Because of poverty, the problem of insecurity hinders all development projects in Madagascar. The country's socio economic situation creates unmanageable risks.

✓ High Cost of the project

This project is expensive. Apart from the investments allocated to the necessary materials, we must also take into account the various expenses incurred in its implementation. For example the allowances of designers and production engineers' benefit.

E. Proposed solutions

✓ Implementation of a trial period for three consecutive school years

To appreciate the impact of this project, its start-up phase should last three school years. During this period, technical preparations for its implementation and evaluation is processed. Thus, a series of workshops at the Ministry level should take place during this period.

- Preparation workshops: aiming not only the appropriation of project objectives and purpose but also the set-up of the necessary devices.
- Workshops for activities implementation
- Workshops for project monitoring
- Workshop for evaluation of the results
- Workshops for project impacts assessment

The products obtained in this project should be property of the Ministry and should not be subject to any query in terms of its contributor.

✓ Partners seeking

This project requires huge investments particularly for its start-up phase. It is rather judicious that it is directed entirely by the Ministry of National Education. Currently this institution has the potential partners who support it on all levels (physically, financially) to the implementation of its educational policy. This project will provide quality education to Malagasy children and deserves funding from these donors. The various departments at the Ministry of National Education should advocate and argue with fervor for it to be supported.

✓ Mobilization of local education actors

To the question of security, local stakeholders must be actively involved. These officials include the parents, all the teaching and administrative staff of the establishment, local authorities and possibly national or international organizations involved locally. Working meetings should be organized in order to put in place a security plan for the materials.

As usual classrooms are not usually appropriate for diffusing these digital courses, it is also very important to book an adequate and well equipped room. To avoid potential technical risks that could damage equipment, it is best to build or renovate a separate building and ensure that electrical installations are well secured.

V. CONCLUSION

In Madagascar, improving the quality of education requires educational inovations that could overcome all problems impeding the system. This project is part of these inovations. It involves the use of educational videos to enhance the teaching and learning of scientific topics, especially Physics and Chemistry. The study was conducted at the secondary school or CEG Andranonahoatra, Cisco

Atsimondrano Antananarivo, DREN Analamanga where Physics and Chemistry teaching is very weak.

Through the sequential pedagogic approach, educational monitoring and audiovisual technique, we found that this project is a modernizing solution that optimizes the impact of new technologies for the benefit of teaching - learning. The instructional video allows the visualization of course contents that make them more attractive and easier to remember. In terms of results, the level of students has become higher and they adopt positive attitudes towards scientific topics such as scientific cultures promoting the development of research and analysis essence.

In conclusion, the popularization of scientific education can spread basic knowledge in sciences and put it within the reach of non –scientific.

REFERENCES

[1] Brunet,Y. ,« *Planification pédagogique : Fondements généraux»,* 3e Edition, Chenelière Education, 2010.

[2] Legendre, M. F., « *Problématique de l'apprentissage et de l'enseignement des sciences au secondaire : un état de la question* » Revue des sciences de l'éducation, Vol XX, n°4, pp 657-677, 1994

[3] Outrey, Martinez, « Vers *la réalisation de production audiovisuelle en autonomie: de la conception à la diffusion* », Expérimentation art 34, Montpellier, 2015.

[4] Teresa.L.H, Dean.A.Z.,Digital Video, « *Learning Styles, and Students Understanding of Kinematics Graphs* », Journal of SMET Education, August 2000.

[5] Pinte,J.P. , « *Le rôle de la veille pédagogique, 21e siècle, Congrès AIPU, Les technologies éducatives dans l'enseignement supérieur.»,* Marrackech, mai 2004.

[6] Pinte, J.P., « Les outils de la veille *pédagogique* », Revue internationale des technologies en pédagogie universitaire, pp 205, 2005.

[7] Michael, S. Mott, D. A. Chessin, W.J. Sumrall, A.S. Angela.R.V, « *Assessing Student ScientifcExpression Using media: The Media-Enhanced Science presentation Rubric* (MERPR)»Journal of STEM Education, Vol 12, pp 35- 39, Jan –Mar 2011.

[8] Maryline C. Jean François L.M. *« Modélisation et simulation dans l'enseignement scientifique : usages et impacts. »* Aster, p 12, 2006.

[9] Hodson.D. *« Philosophy of Science, Science and Science education »,* Study in Science education, Vol 12, pp 28-30, 1985.

[10] Solomon,.J. *« Teaching about the nature of science in the British National Curriculum*. » Science of education Vol 75 (1). pp 100- 102, 1991.