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Effect of ICT on Students' Achievements and Motivation in Life and Earth Sciences Subject

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Abstract

As contemporary society evolves, technological revolutions are increasingly forcing academic and secondary institutions to adopt innovative strategies rather than traditional instruction. Therefore, the use of ICT in teaching is an active teaching method with proven effectiveness on learning outcomes and student motivation in life and earth sciences.

Our study aims to examine the impact of ICT integration on student learning and motivational outcomes in science education. In order to do that, we used three tests, the knowledge test, the achievement of objectives test and the motivation test. The control group consisted of 30 students compared with 30 students in the experimental group, and the experiment lasted for 8 weeks. Also, we used a motivation questionnaire for students in the experimental group as a pre-test at the beginning, followed by a post-test at the end of the study to measure the degree of student motivation after using ICT, these last one were used as data collection tools, and all statistical analysis were performed using SPSS version 23.

The results obtained showed a very particular statistical increase ($p<0.0001$) in the results and the degree of motivation of the students in the experimental group. According to our results, the integration of ICTE could be an effective way to improve students' learning and increase their motivation for teaching life and earth sciences.

Keywords: motivation, life and earth sciences subject, information and communications technology, control group, experimental group,

Introduction

All The general unease of teachers, learners and students, and parents, expressed informally (and sometimes formally) in the media, meetings, etc., with regard to the teaching of life and earth sciences in Morocco. This observation is well corroborated in a scientific and rigorous manner by researchers in education sciences and science didactics (Kaddari, 2005; El Hajjami, 2009) as well as by the Higher Education Council (CSE). Indeed, the latter has clearly shown that despite the efforts made during the multiple reforms, the results remain well below expectations. Thus, in its first report on the state and prospects of the education and training system in Morocco in 2008, the CSE pointed out:

- The small number of laboratories, some secondary schools (junior school and high school) has no laboratories, and even if they do exist, they do not meet the standards.
- The lack of scientific equipment and when it exists it is poorly maintained;
- Lack of qualified laboratory personnel;
- Teacher training gives priority to theoretical presentations;
- The limited financial means available for the development of experimental practices;
- The size of secondary classes, which is often very large (often more than 35), means that working methods and the organization of premises and experimental equipment have to be adapted to this situation.

It should be noted, however, that the problems of teaching and learning science are far from being a Moroccan particularity. Indeed, international studies (TIMSS, 2015; PASEC, 2011; ...) have clearly shown a deficiency in learners' achievements on an international scale. These international findings have made research on difficulties in the life sciences an ever-present focus and the issue is increasingly attracting the interest of researchers.

In this sense, in the first stage of the research we tried to identify the difficulties and obstacles of the learners in learning the teaching sequences "The Nervous System" and "Immunology".

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In today's learning environments, there are many teaching strategies that have the advantage of incorporating technology. One of these new strategies is the integration of ICT into the learning/teaching process.

In this sense, to address the difficulties and obstacles of students in life and earth sciences, we used digital resources provided by the Moroccan Ministry of Education within the framework of the GENIE program (The program of generalization of ICT in the Moroccan educational system). This study aims to investigate the impact of these digitals resources on the learning outcomes and motivation of secondary school students in life and earth sciences. The study involved 60 students divided into two classes. The first class used the traditional lecture while the second class used digital resources. The research data was obtained through the life and earth science concept test, motivational questionnaire. It was found that the students in the experimental group scored higher than the students in the control group. An increase in motivation and autonomy of the students in the experimental group was identified.

General Context

Science education in general has become a strategic and societal issue, which aims at developing the scientific spirit in learners. This objective must be aimed at from the first years of schooling and consolidated as the learner progresses in his studies.

In this sense, Morocco has made considerable efforts to improve the quality of education and ensure its generalization. Major reform projects have been initiated since 1999, including the national charter of education and training, the emergency plan 2009-2013 and the vision 2015-2030 which aimed essentially at the generalization of education, the improvement of its quality including that of the pedagogical content and the restructuring of the education cycles, without forgetting the program GENIE 2009-2013 whose objective is the generalization of information and communication technologies (ICT) in order to integrate them into the education and training system. However, despite the efforts made during the multiple reforms, the Higher Education Council (CSE) has shown that the results remain well below expectations. There is also no consensus on how to reduce the difficulties of science students. By analyzing many reasons, researchers have been able to develop, implement, and evaluate new teaching strategies to address this problem. Innovation in science education can help create a supportive learning environment in schools.

By adopting innovative teaching strategies according to the nature of the subject, a teacher can create a supportive classroom environment, which facilitates the learners' subsequent learning.

This is in line with what was stated in the National Charter for Education and Training "the new national school is working to become: a living school, through a pedagogical approach based on active learning, not passive reception; cooperation, discussion and collective effort, not individual work alone."

Active learning classrooms (ALCs) are learner-centered, formal learning spaces designed to promote interaction and engagement. They are designed to minimize the barrier between teacher and learner, facilitate collaborative learning activities, and enhance teaching practices (Baepler, & Walker, 2014; Carpenter, 2013; Pundak, & Rozner, 2008). Active learning classrooms can be viewed as rich active learning environments that involve dynamic, interdisciplinary, and generative learning activities with the goal of achieving higher order thinking and building complex knowledge (Grabinger, & Dunlap, 1995; Kovalchick & Dawson, 2004). While active learning pedagogies, such as peer learning, team learning, cooperative learning, flipped classroom, etc., can certainly be applied in traditional classrooms with fixed seating (Deslauriers, Schelew, & Wieman, 2011; Lyon, & Lagowski, 2008; Mazur, 2009), a better space for these pedagogies would be an active learning classroom designed specifically for learner interaction and engagement.

Active learning is broadly defined to include any pedagogical method that involves students actively working on learning tasks and reflecting on their work, apart from observing, listening and taking notes (Bonwell, & Eison, 1991). Active learning has emerged as a normative pedagogical practice in educational institutions from kindergarten through higher education. Recent studies, such as the 2014 meta-analysis linking active learning pedagogies to dramatically reduced junior school failure rates (Freeman, & al., 2014), have established that active learning promotes learner learning and engagement across disciplines, grade levels, and demographics.

Practical Work and the Teaching of Life and Earth Sciences

Many research results seem to show that traditional practical work does not achieve the objectives assigned to it (Najoui, & Alami, 2017). According to the survey conducted by Mukhtar Boulal (Mokhta, 2021), experimental activities are reduced to course experiments where the teacher manipulates and exploits the results. The objectives assigned to these experiments generally aim at the acquisition of conceptual knowledge by the learners through the experiments. According to Jean-Yves Cariou (Cariou, 2015), the role of experiments in experimental sciences in general and in life and earth sciences specifically taught is often reduced to the illustration of concepts taught dogmatically to learners.

In the Moroccan context, experimental activities are reduced to course experiments where it is mainly the teacher who manipulates and exploits the results. In this context, learners rarely have the opportunity to manipulate.

Research in science didactics has often focused on "problem solving" as a deficit skill that hinders effective understanding of science in general and life and earth sciences in particular. Indeed, several works have shown that learners have a lot of difficulties in problem solving situation in life and earth sciences (Orange, 2007); (Chalak, 2012); (Maouni, & al. 2019)

Problem solving, the process of identifying and implementing a solution, has been recognized by cognitive psychologists and cognitive scientists as a context for analyzing thought processes. It has been analyzed through three main stages: description and analysis of the problem, construction of a solution and control of the solution (Reif, 1983).

The analysis of these stages showed that the components of problem solving are too complex to be learned from examples and practice. Indeed, the ability to solve problems depends not only on learning procedures, but also on the ability to draw on appropriate ancillary knowledge (Eastes, 2013). It requires the mobilization of a certain number of means in an appropriate order and therefore to call upon: concepts, strategies, attitudes, compatible with the problem in question.

In the hope of overcoming these obstacles and improving Science Teaching/Learning, researchers have turned to ICT in recent decades. For example, in order to monitor common representations on an individual basis, computerized exercises have been developed that allow for the rapid collection of sufficiently relevant data and thus automatically detect the conceptions held by learners when answering a given question (Coppens, 2007). Knowing that the knowledge of conceptions is of paramount importance in the development of effective teaching strategies, the ICTE offers in this case, a real help to teachers who have neither the time nor the didactic skills to detect the conceptions of each learner.

Researchers and teachers assume that the potentialities offered by ICT allow the development of teaching/learning strategies (Al-Hammouri, & al. 2020).

Indeed, in this frenzy towards ICT, digital resources are presented as an alternative and a means to innovate and improve the learning of life and earth sciences.

ICT in Life and Earth Science Education

In their concern to innovate and to offer an education in line with the demands of contemporary society, all education systems preach for a school that allows mastery of new technologies and work to integrate the computer tool into school habits. It can be said that the emphasis placed on ICT in teaching and education has been so strong for a long time that one might think that it is the only means of innovation (Janati-Idrissi, 2000).

Currently, no one can ignore that the dizzying evolution of ICT has metamorphosed the world of education. The metamorphosis has been felt at all levels: tools, methods, teaching practices, expectations and aptitudes of learners, etc. There is even talk of "a real pedagogical revolution with digital technology".

The teacher is therefore obliged to respond to the expectations and standards of the digital natives that are today's learners.

"*ICT is ubiquitous in the lives of learners and students...: they use it continuously for entertainment, to communicate with their friends or to do their homework. In fact, ICT is everywhere... except in the classroom!*" (CEFRIO, 2011, p. 6)

Through the use of ICT, the teacher seeks conformity with the experience of today's learners who are immersed in the virtual and digital world. He must therefore take advantage of their passion for technology and the potentialities offered by ICTE to enable them to build their knowledge.

However, contrary to the beliefs of some speakers, pedagogical innovation should not be limited to the use of computer gadgets and the integration of ICTE in pedagogical practices and should not be an objective in itself but just a means or a working tool to be adapted to specific situations.

"*.... their ability to produce improved learning has now reached a level where it is taken for granted, provided, however, that these technologies are paired with quality content and effective teaching methods*" (Ring, & Mathieux, 2002).

Problematic

Contemporary society values scientific and technological training as the main factor of adaptation and social integration (Legendre, 1994). However, despite the efforts made by the world to improve training, a massive failure has been noted (Walberg, 1991). Indeed, based on a number of tests on knowledge in science and mathematics in about 41 countries, the International Association for the Evaluation of Educational Achievement (IEA) has shown a significant conceptual deficit among learners. The deficiency in scientific knowledge, which is very pronounced in developing countries, has been confirmed by other international surveys such as TIMSS, PASEC (TIMSS, 2015); (PASEC, 2011). This observation has been corroborated by research in science didactics which for several decades has made (and continues to make) the problem of Teaching/Learning of science an object of investigation. In fact, many researchers have shown that basic scientific concepts present multiple obstacles that are difficult to overcome by learners at all school levels (Tiberghien, 1976); (Astolfi, 1978); (Giordan, 1987); (Clément, 2006).

The analysis of the difficulties generated by the Teaching/Learning of sciences refers to several poles: didactic, epistemological, psychological,...In life and earth sciences, more particularly, the complex and multidimensional character of this problem is even more sensed, that is what we want to illustrate by this research.

Teaching-learning problems in life and earth sciences

Life and earth sciences seem very complex and difficult. They are even considered as a "cut-off" discipline, in other words a discipline that leads to the most failures in the exams in the scientific fields (Venturini, 2004). The failure is also manifested by:

- The inability to transfer school knowledge to the extracurricular domain (Giordan, 1987) and the knowledge taught does not play an integrating role in the sense that it cannot be reinvested in an extracurricular context (non-functional and non-operational knowledge on the scale of daily and professional life)
- Demotivation towards the subject, (Giordan, 1987)
- The loss of scientific knowledge, (Giordan, 1987)
- The lack of scientific spirit in spite of prolonged education, (Venturini, 2004); (Grignon, 2008)

As already mentioned the sources of these problems are many and varied: the nature of knowledge itself, implicit models of science, the gap between learned knowledge and taught knowledge. Generally speaking, the synthesis of the various research studies allows us to summarize these difficulties and to classify them into three fields: alternative conceptions, practical work and problem solving. (Orange, 2005); (Hamdani, & al, 2019); (Chalak, 2014).

- In this context, can introducing digital resources be an alternative and a way to innovate and improve learning in life and earth sciences?
- Will teaching life and earth sciences using digital resources have an effect on learner motivation?

Accordingly, the two hypotheses are formulated as follows:

- H0: "The use of digital resources has no effect on students' achievement in Earth science."
- H01: "The use of digital resources have effects on student outcomes in the sciences of the and earth".
- H1: "The use of digital resources does not have an effect on student motivation in earth sciences".
- H11: "The use of digital resources have effects on students' motivation in the sciences of the and earth"

Method

To study the impact of using digital resources in the teaching/learning process in the subject of life and earth science, we chose the students of the third year of secondary school. The sample studied consists of 60 students, who attend school in 2 classes (30 students by class) of two different junior schools of the provincial direction of the province of Tetouan in north of Morocco. We divided these students into two groups, the first group will be a control group, and it will follow the course in a traditional way, which generally consists of using only the blackboard and the books by the teacher, except for the experiments which are done with provided material which may be insufficient to cover in detail all the desired aspects. The second group is an experimental group; it will follow the course with the use of digital resources provided by the Minister of National Education within the framework of program GENIE in addition to the traditional method. At the end of the course both groups will take a test to reach the objectives. The lessons chosen are "The Nervous System" and "Immunology" of the third year of secondary school. Also a "SCIENCE MOTIVATION QUESTIONNAIRE II" © 2011 Shawn M. Glynn is essential to study the effect of using digital resources on student motivation in life and earth sciences.

Type of study

This is an experimental correlational prospective quantitative study that took place from the 2020/2021 school year to verify the correlation between the use of ICT and the improvement of students' academic performance in life and earth sciences subject.

Research Design

The research design is presented in the table below. In the year 2020/2021, the "life and earth science knowledge test" was administered to the control group before and after the course taught by traditional methods; the same test was administered to the experimental group. Then "motivation test" was given to the same group. These two tests were given before and after the experiment (teaching with digital resources). We then proceeded to compare the results obtained by these students, using recognized statistical methods such as averages and the t-student test.

Table 1. Research design

Group	*Number of students*	*Pre-test*	*Application*	*Post-test*
Experimental group	30 students	- Test of knowledge in life and earth sciences - Motivation questionnaire.	Digital resources	- Test of achievement of objectives - Motivation questionnaire.
Control group	30 students	- Test of knowledge in life and earth sciences	Traditional method	- Test of achievement of objectives

Test of achievement of objectives in life and earth sciences

In order to identify the effect of teaching with digital resources on student achievement, a "Knowledge Test in Life and Earth Sciences" consisting of 20 multiple-choice questions was prepared by the subject teachers and used as a diagnostic assessment (pre-test).

- Pre-test: This knowledge test was used as a pre-test to determine the knowledge levels and prerequisites of the groups (control and experimental).
- post-test: 8 weeks later (with an hourly volume of 16 hours / 2 hours per week), in order to identify the level of progress of the students in the two groups in relation to the knowledge taught in life and earth sciences, a post-test was applied to the students of the two groups (control group and experimental group) in qualitative studies, study group should be preferred instead of sample since such studies are conducted with few individuals or units. The individuals or units forming the study group should be introduced with all relevant characteristics. Information regarding the context of the study group should also be explained here.

Motivation test

In order to identify the effect of flipped classroom instruction on student motivation, a motivational questionnaire developed by Glynn, Taasoobshirazi and Brickman (2009) was used and adapted to fit the context of the study and the knowledge to be taught. This questionnaire consists of 24 questions and was used as a pre-test and post-test for the experimental group during this study.

Data collection and statistical analysis

A life and earth science knowledge test and a motivational questionnaire were used as data collection tools. Baseline variables were calculated using descriptive statistics, including tests of arithmetic means and standard deviation. The violation of the normality assumption was revealed by Cronbach's alpha test approved the reliability of the test (Yener, Gülaçti, & Kandemir, 2006) (See Table 2). Therefore, a non-parametric test was performed. The comparison of variables was done by student's T-test.

The statistical analyses were performed using SPSS Version 23 with a significance level set at 5% or an alpha level of 0 .05 that means a significant level ofprecision in the results.

Results

In this section, the results of the data analysis are presented below.

Effect of the applied method on student's results

The "Life and Earth Science Knowledge Test" was used as a post-test to determine if there was a significant difference in the students' knowledge level. The results are presented in Table 3.

The results obtained show that the average scores of the students in the experimental group are almost equal to those in the control group with a difference of about 0.0023. This shows that the level of knowledge of the students before the start of the experiment is the same.

Table 2. Reliability statistics

Cronbach's Alpha[a]	*Cronbach's Alpha based on standardised items*[a]	*Number of items*
0,602	0,560	30

Table 3. Control and experimental group statistics+

Grouping		*N*	*Average*	*Standard deviation*	*Average standard error*
Knowledge_scores	Controle	30	17.0000	0.83045	0.15162
	EX	30	17.0023	0.41523	0.07581

Table 4. Independent T-student test of students' "Test of achievement» pre-test and post-test

		Levene's test for equality of variances		*t-test for equality of means*						
		F	Sig.	t	ddl	Sig. (bilateral)	Average difference	Difference in standard error	Confidence interval of the difference at 95%.	
								Lower	Superior	
The_scores	Assumption of equal variances	0.000	0.989	-3.296	54	0.002	-3.57143	1.08370	-5.74412	-1.39873
	Assumption of unequal variances			-3.296	53.768	0.002	-3.57143	1.08370	-5.74434	-1.39852

So we will proceed to the verification of the null hypothesis ''H0'', for that we used the test ''T-student'' (Zimmerman, 1987).

From Table 4, the "T-student" at a value of -3.296 and the p-value (Sig=0.002) is less than 0.05. Therefore, we reject the H0 hypothesis and accept the H01 hypothesis: "The use of digital resources has effects on students' achievement in the life and earth sciences" (Zimmerman, 1987). Thus, we find that teaching this subject using digital resources has a more positive effect on student outcomes compared to teaching the course using traditional methods.

Effect of the applied method on student motivation

The results of the motivational questionnaire distributed to students before and after the "life and earth science" instruction for the experimental group are presented in Table 5.

According to the above table, we found that the average of motivation test was increased from 2.0473 to 4.3633; this result confirms that there is a motivation of students after the use of ICT in the learning process of life and earth science.

According to Table 6, the p-value<0.0001 (Sig=0.000), i.e. less than 0.05, this difference is highly significant at 95%. This allows us to reject hypothesis H1 and accept hypothesis H11: "The use of digital resources have effects on students' motivation in science of the and earth".

This result indicates that students' motivation for the knowledge taught increased with the use of digital resources.

For the motivation questionnaire, the following five items showed the greatest increase: For the item "If I fail to learn science, I try to understand why," the mean score on the pretest was X = 1.79, while the mean score on the posttest was X = 4.43. For the item "The science I learn is more important to me than the grade I receive," the mean pretest score was X = 1.46, while the mean posttest score increased to X = 4.43. Also for the item "I like to do better than other students on science tests", the mean score on the pretest was X= 1.86, while the mean score on the posttest was determined as X= 4.36. Similarly, for the item "I use strategies that ensure that I learn science well," the mean pretest score was X = 1.86, while the mean posttest score was determined as X = 4.32. Similarly, for the item "I am confident that I will do well on science tests," the mean pretest score was X = 1.96, while the mean posttest score was determined to be X = 4.25.

Table 5. Group statistics

Z		*N*	*Average*	*Standard deviation*	*Mean standard error*
X	CONTROL	30	2.0473	0.21492	0.03924
	EXPERIMENTAL	30	4.3633	0.06945	0.01268

Discussion

This study was conducted to identify the use of digital resources on the learning outcomes and motivation of students in the courses of "Nervous Systems" and "Immunology". Regarding the results of the post-test questionnaire of the "Objectives Achievement Test", we found a statistically very significant increase in the students' results. In this regard, we can say that teaching these life and earth science courses through the use of digital resources has a more positive effect on student achievement. Our results are in agreement with other international studies. Indeed, the literature suggests that using digital resources can improve student performance (Nafidi, Alami, & Zaki, 2018; Bruillard, & al., 2011; Michaut, & Roche, 2017; Tarichen, Zerhane, & Janati-Idrissi, 2017). We found in the same sense, the results obtained showed adaptive motivational profiles before and after the intervention of ICT in the learning process (Valdez, 2022; Komar, & al. 2022).

There are several reasons that could explain this increase in students' level of knowledge mastery through the use of digital resources. Among others, the use of the quiz (pre-test) at the beginning of the course may have helped students to recall knowledge acquired before the course. Prior knowledge has long been considered an important factor influencing learning

Table 6. Pre-test and post-test independent T-student Test of "motivation" of students.

Independent samples test

		Levene's test for equality of variances		*t-test for equality of means*						
F		*Sig.*	*t*	*ddl*	*Sig. (bilateral)*	*Average difference*	*Difference in standard error*	*Confidence interval of the difference at 95%.*		
								Lower	*Superior*	
X	Hypothe of equal variances	25.970	0.000	-56.163	58	0.000	-2.31600	0.04124	-2.39855	-2.23345
	Hypothe of unequal variances			-56.163	34.990	0.000	-2.31600	0.04124	-2.39972	-2.23228

(Zerhane, & al., 2002; Hailikari, Katajavuori, & Lindblom-Ylanne, 2008; Merrill, 2012). Therefore, stimulating recall of prior knowledge helps students better understand new information by connecting it to something they already know. Additionally, retrieving information from memory makes the path to that information in memory stronger; therefore, it allows the information to be more easily retrieved by the student at the next opportunity (Dirkx, Kester, & Kirschner, 2014).

Another reason that could have positively influenced learners' results is the short duration of our research, which was spread over a semester (almost 4 months). Indeed, Clark (2015) recognized that a novelty effect could lead to short-term improvements in student performance when new technologies are introduced.

As for the 2nd important result of the study, we observed a highly significant increase ($p < 0.001$) in the post-test of learners' motivation towards teaching life and earth science with the use of digital resources. This result indicates that students' motivation increased with this method. This result supports the idea that students' motivation level increases under active learning conditions (Aubenas, 2015); (Khalil, 2008); (Berrado, & al., 2009). It is also consistent with other findings internationally (Xie, & Reider, 2014).

Indeed, there are several reasons for our finding. First of all, generally in junior and high schools with the lack of teaching materials and the time constraint of the session, courses are taught in a traditional approach, which has a negative impact on the students' engagement and attitude during the course.

Another explanation that could interpret the positive effect of ICTE integration on learners' motivation is the small sample size, since students' participation is much better in small classes where each student finds the opportunity to manipulate the applications, experiment with digital resources, and have the method levels of teaching exploited (Labioui, & al., 2015), and this is what was achieved in our study. Regarding the five items of the motivation questionnaire that showed the highest significance are respectively, "If I fail to learn science, I try to understand why", this significance aligns with the results of a study conducted by Bryan, Glynn, and Kittleson, (2011).

For the item "The science I learn is more important to me than the grade I receive," this recorded meaning could be due to the fact that the integration of ICT involves the student in his or her own learning process, unlike traditional teaching methods (Khiari, & Siafa, 2016).

Finally, we emphasize that the choice of these courses is not random, we have conducted a study on the grades of students in junior school in the subject of life sciences and earth and we found that there is a decline in the averages in the continuous control of these courses in addition we refer to a survey conducted in December 2008 "The job of teaching ELS in junior school" SNES-FSU survey, and also the analytical report of "national program of assessment of student achievement in the 6th year of elementary school and 3rd year of junior school" PNEA 2019.

Conclusion

This work, although it aims at the example and not the generalization, is a pilot study, which we intend to generalize on all the junior and high school levels of the province in the coming years, on a greater number of students. The results of this work have highlighted the positive effect of ICT in general and of the digital resources provided by the Minister in a specific way on the grades of the students of the third year of secondary school in the subject of life and earth science, and their motivation to teach this subject. Thus, our study adds to the literature to suggest that the use of this method adds value to the class session. Also, it could remedy the shortcomings of teaching materials for conducting experiments. Since the content of these courses "immunology" and "nervous systems" are very difficult to explain and also they continents of complicated notions to teach to the student in an abstract way.

Therefore, further studies should be conducted to apply ICT to other courses to be taught and to other subjects. To be able to compare the results and propose other pedagogical scenarios.

Suggestion

The originality of this experiment lies in the fact that it involves implementing digital ministerial resources and studying the effect of these on student performance and motivation in life and earth science for third year of junior school students. The use of these resources was more effective than traditional courses and also the use of them improves students' knowledge scores and motivation.

Theoretical knowledge scores are relatively objective and reliable in determining the effectiveness of ICTE compared to the traditional method.

Limitation

Since this study was conducted on a small sample, we suggest further studies on a larger sample. We also suggest applying this approach to other science subjects to be taught, especially physical sciences. In addition the digital resources provided by the Minister remain insufficient and they need updating and improvement (Tarichen, Zerhane, & Janati-Idrissi, 2017), and also there are several challenges noted on the integration of ICTE in life and earth sciences in Morocco addressed by Nafidi, & al. (2018), and integration barrier studied by Mastafi (2014).

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