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Overcoming Didactic and Epistemological Obstacle to the Learning of Fertilisation Concept and its Applications in High School, Yaounde

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Abstract:
Background: *One of the effective didactic strategy of teaching scientific concept is considering students' misconceptions in view of developing appropriate objective-obstacle to overcome the identified epistemological or didactic obstacles. This gives a positive status to error in a constructivist approach where learning is brought about by conceptual change. The new paradigm education shift in Cameroon to Competency Based Approach with entry through real life problem situation requires teachers to construct problem situation. However, most teachers and authors of official textbooks are unable to build real problem situations to overcome obstacles. More so no research work has been done to identify and overcome the obstacles linked to the teaching and learning of fertilisation concept, and little or no quasi experiment has been carried out to measure the extent of conceptual change. Our work is guided by Vergnaud's Theory of Conceptual Field and the Theory of Didactic Situation by Brousseau.*
Methods: *A cross sectional survey using questionnaires was used to investigate 63 high school students' situated conception of the concept of fertilisation & contraception, aged between 15 & 18 years. The questionnaire were qualitatively analysed to identify epistemological and didactic obstacles, which were then quantified. Objectives-obstacles were developed to overcome the identified obstacles using appropriate problem situations. A one group pre-test, post-test quasi experimental design was used to measure the extent of conceptual change*
Results: *About 65% of students presented several alternative conceptions that served as epistemological and didactic obstacles to acquire scientific knowledge on fertilisation such as the preformist views. Students demonstrate algorithmic knowledge but lack conceptual knowledge in calculating fertile period of a menstrual cycle. They derived a mathematical formula to calculate fertile period not found in their textbooks. The paired sample t-test revealed a significant increase understanding of the fertilisation concept; $t\ (62) = -11.384$, $p = 0.000$, Eta square (η^2) $= 0.676$. ANCOVA results indicate that only didactic strategy significantly influenced the development of learners' competences, $F\ (4,\ 27) = 13.667$, $p = 0.000$. Gender, age, religion, and region of origin had no main or interaction effects on the results.*
Conclusion: *These results have implications in effective teaching the concepts of fertilisation and its application in contraception a socio-scientific issues requiring interdisciplinary approach, and in designing didactic strategy to cognitive change. It will enhance natural family planning techniques accepted by all.*
Key Words: *Fertilisation, Conception, epistemological obstacle, didactic obstacle, Problem situation.*

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I. Introduction

The effective teaching and learning of the fertilisation conception and its application in natural contraception in secondary schools in Cameroon remains problematic as the didactic strategies used do not developed in the learners the expected necessary cognitive competences required for better citizenship. This can be evident by the inability of the Cameroonian youths to make informed and healthy decisions when faced with reproductive health challenges. This assertion is justified by the high prevalence of teenage pregnancy of 7%; and the low prevalence rate of contraceptive use with only 13% of adolescents adopting modern methods of contraception use.

The above observation raises the question on how we can effectively teach the fertilisation concepts in such a way as to empower adolescents with the necessary skills and competences needed to sustain positive sexual health habits as envisage in the UN Sustainable Development Goals 3, 4 and 5. Some authors such as Bury (2001)[1] and Jourdan (2004)[2], have emphasised the use of the complexity paradigm in handling daily problem situation. Manderscheid & Pithon (2000)[3] suggested empowerment of adolescents via learning by problem resolution; socio-cognitive confrontation, amongst other didactic strategies, with the role of teachers as a facilitator.

Given that little or no research has been done in Cameroon to identified students' misconceptions of the fertilisation concept and no quasi experimental research has been carried to investigate the extent to which these didactic strategies can enhance conceptual changes, this study was developed to fill this knowledge gap. Firstly, it seeks to identify students' alternative conceptions related to the scientific notion of fertilisation and contraception based on notion of conception by Clement (2006)[4] as an interaction between knowledge, values and social practices. Secondly, it proposes the development of objectives – obstacle-objectives based on Martinard (1986)[5] model to overcome the identified obstacles. Finally it develops a problem situation to overcome the identified obstacles based on Vergnaud's conceptual field theory. A student's concept of fertilisation (C) is analysed using the formula, "$C_{\text{fertilisation}}$ = f (S, OI, SR)", where the situation (S) is determined by the task that gives meaning to the concept of fertilisation which includes ordering, classifying, categorizing, or comparing; the meaning (OI) given by the operational invariants in the students' scheme about fertilisation; and the signifier (SR), the of symbolic representation about fertilisation and its application that students have (Vergnaud (1991)[6]. This approach uses the steps involved in the construction of a problem situation proposed by Darley (2000)[7] and Orange (2005)[8] to bring about conceptual change. Thus the following research questions guided this study:

1. *What are high school students' conceptions of fertilisation & fertile period in Cameroon, and to what extent do they facilitate or act as obstacles to their acquisition of the expected scientific knowledge?*
2. *To what extent will the proposed problem situation developed enable students to appropriate the cognitive skills to effectively practice natural method of contraception?*

The term conception in this context is defined as common knowledge which student have and use to solve problem daily which could become erroneous and act as obstacles to acquire certain scientific concepts. It could be interchangeable used as misconception, alternative conception or prior knowledge.

II. Methods

Research design

A cross sectional survey using questionnaires was used to measure high school students' situated conception of the concept of fertilisation & its applications. The questionnaire was qualitatively analysed to identify epistemological and didactic obstacles, which were then quantified. Objectives-obstacles-objectives were developed to overcome the identified obstacles using appropriate problem situations. A lessons was then taught using problem based learning (PBL) and argumentation strategies.

Sample Population, technique and size

A co-educational high schools biology class in Yaoundé with 63 students was purposefully selected because it is the class where human reproduction is officially taught according to the Cameroon Biology syllabus for the English-speaking subsystem. Additionally, it is at this level that adolescents aged between 15 and 18 years are found for whom the content is relevant. The school was chosen in Yaoundé because being the capital of Cameroon it was expected that students from diversified socio-cultural and ethnic backgrounds will be met which is representative of Cameroon. The sample size of 63 students for the study were appropriate to have a diversity of conception and for inferential statistical analysis.

Research Instruments

A questionnaire was developed to investigate students' conception of fertilisation and contraception. The instrument was developed by the research team based on some myths and misconceptions identified in literature, research articles and dissertations. The questionnaire was reviewed by National Pedagogic Inspectors for content validity. The Cronbach Alpha value and content validity indices of the questionnaire were acceptable at > 0.70. The questionnaire was self-administered to the participants before and after the two instructional lessons on fertilisation and its application in contraception.

Intervention Process

After analysis of the questionnaire, misconceptions were identified serving as obstacles (epistemological, didactic or psychological) for conceptual change. A lessons of two hours each (Annex 1) was developed according to the socio-constructivist principles of PBL (Fabre & Orange, 2005)[9] and the socio-cognitive conflict theory (Gilly, 1988[10]; Perret-Clemont, 2004[11]), to overcome these obstacles and bring about conceptual changes.

In the lesson, a problem situation was conceive to create cognitive conflict around the epistemological and didactic obstacles on determining the fertile period, which has an implication in the natural family planning methods. Three different menstrual cycles (short, average, and long) were provided for students to look for their

similarities and differences in terms of various phases of the menstrual cycle. These three different cycles were used to enable students appropriate the scientific concept of fertilisation and fertile period which unfortunately, was taught using only an example of a 28-day menstrual cycle in class and in official textbooks (didactic obstacle). Students were guided to appropriate the concept of fertilisation and fertile period, to produce a formula that will be applicable to every menstrual cycle and give meaning to these concept using documentary analysis.
The conceptual field Theory of Vergnaud was used in designing the lessons. A set of didactic situations (various menstrual cycles) were proposed to give meaning to the concept of fertilisation, fertile period and ovulation. Appropriation of this concept required appropriate examples of situations and mobilisation of the required schemas and symbolic representations to create cognitive conflict. The problem situation given read thus:

Three women NJANG, NNAM and CHUO are married to Mr NJUH. After having kept records of their menses for over 12months, they realised that they had a menstrual cycle of respectively 24, 28 and 32 days. Mr NJUH decided to have sexual intercourse with them during the 14th day of each wife's menstrual cycle which he believed was the peak of the fertile period (ovulation day). After a period of 6 months NNAM with a cycle of 28 days got pregnant while NJANG & CHUO didn't. One year later NJANG and CHUO accused NNAM of being a witch responsible for their inability to conceive.

1. As a biology student are these allegation of witchcraft founded?
2. What do you think is responsible for the fact that only Mrs CHUO got pregnant while NJANG and CHUO did not?
3. What are the similarities and differences in the different phases of their menstrual cycle
4. What can you conclude about their fertile period?
5. Derive a formula to enable other couples to exactly determine their fertile period irrespective of the duration of their menstrual cycle.

Data Treatment and Analysis

Data collected from the self-administered questionnaire were coded and quantitatively analysed using SPSS version 23 for descriptive statistics (central tendencies) and inferential statistics (Paired test, ANCOVA and MANOVA). They were analysed qualitatively to identify misconceptions or alternative conceptions. All the statistical assumptions to carry out multivariate analysis was done to show that the conceptual change observed was due to the problem situation used (didactic strategy) and not because influence of other covariate in our Pretest-posttest design.

III. Result

A. Pretest Results.

The respondents were predominantly females (53.6%), between the ages of 16-17years (43%), and Christian (77%). The majority of students (60%) presented epistemological and didactic obstacles which will hinder the understanding of the scientific knowledge of the concept of fertilisation and its application in contraception as analysed item-by-item below:

Table1: Knowledge of female anatomy and physiology

Code	Statement	Vagina	Oviduct	Uterus	ovaries
RS1	Where are the female gametes produced?	21.5 %	29%	14.3%	**35.2%**
RS2	Where does fertilization occur?	9.7%	**20.4%**	22.6%.	47.3%
RS3	Where does the development of embryo / foetus occur?	12.0%	18.3%	**55.9%.**	13.8%

Most respondents have misconceptions as to the source of gametes (RS1) and the site of fertilisation (RS2) as more than 65% gave wrong answers. The function of the oviduct (the site of fertilisation) and ovary (the site of gamete production) were reversed in RS1 and RS2 probably because they have learned in lower classes that in plants, fertilisation occurs in the ovary. This constitutes an **epistemological obstacle** for which conceptual change is required. This is evident as 35% respondents rightly mentioned that gametes are produced in the ovary (RS1), while 47.3% wrongly believed fertilisation occurs in the ovary (RS2). Only 56% rightly know that the embryo develops in the uterus.

Table 2: Knowledge of the role of hormone in the female reproductive system

Code	Statement	FSH	LH	Progesterone	Oestrogen	Do not Know
RS4	Bringing about ovulation	20.4%	**20.4**	19.4%	29.0%	10.8%
RS5	Stimulating development of an egg	**19.4%**	16.1	25.8%	25.8%	12.9%

Less than 21% of respondents know the correct role of hormones in reproduction. This will obviously hinder the understanding of the menstrual cycle controlled by hormones and the use of contraceptive pills as family planning method. Here, we identified a **didactic obstacle** from the structuration of knowledge in the syllabus and textbooks. Th**e** coordinating role of hormone to control menstrual cycle needs to be emphasized especially the concept of negative feedback mechanism of hormones to enhance understanding of contraception.

It may also be as a result of knowledge gap to be filled as most textbooks available to the students before or at this level do not treat feedback mechanism well.

Table 3: Knowledge of Fertile Period on Short 24 days Menstrual Cycle (Natural Family Planning)

S/N	Proposed Answers	Percent (%)	Inference
A	1st -6th day	5.2	Only 32.8 % of respondent selected the right answer B.
B	7th – 13th day	32.8	
C	11th – 17th day	51.7	
D	17th -20th day	10.3	

With respect to the question: A woman has a regular menstruating period of 24 days. When shall her fertile period occur when sexual intercourse will lead to pregnancy? (Circle correct answer), the results on table 3 revealed that:

The, 5.2% who wrongly choose 1st - 6th day are probably those who think menses is accompanied by released of gametes since from experience menstruation ceases during pregnancy. This is an epistemological obstacle to the understanding of the fertilisation concept & fertile period.

The 51.7% who wrongly choose 11th - 17th day, probably applied knowledge that ovulation occurs on the 14th day of a cycle for a normal 28 days cycle treated in most biology textbooks to a short menstrual cycle of 24 days. This is a didactic obstacle as the situation that gave meaning to that calculation is usually not emphasised by teachers or authors of textbooks. This is the effect of overgeneralisation, a source of misconception in biology education. We realised that students demonstrate algorithmic knowledge but lack conceptual knowledge.

Majority of students (67%) do not master the principles underlying the calculation of the ovulation day (presented in most text book using a 28 day cycle as day 14) and the fertilisation period (based on the life span of 2-3 days of an egg and sperms once released). This period can be situated at the beginning, middle or end of the menstrual cycle, based on its length. This is a serious didactic obstacle to overcome.

Table 4: Epistemological view of origin of the baby

S/N	Statement / Misconception	Percentage (Total Acceptance Responses)
EP1	The male and female both provide 50% of the genetic material that make up the baby through their gametes (Epigenesis)	45
EP3	A child pre-exists in the male gametes (sperms) and the female act as receptacle to nourish & protect it in the womb to develop (male preformism).	38.8
EP2	A miniature form of a child is found in the female egg (ovum) and the role of the male is to stimulate growth, or add certain parts (female preformism).	16.2
	SUMMATED TOTAL	100

The results indicate that only 45% had the scientific knowledge about the origin of a baby by epigenesis (EP1). More than half of the students (55%) had misconceptions about baby formation, with dominance of male preformism beliefs (38.8%) over female preformism (16.2%). Most of the respondents believed in preformationism (or preformism) - a formerly-popular theory that organisms develop from miniature versions of themselves instead of assembly from parts. It suggests that all organisms were created at the same time, and that succeeding generations grow from homunculi or animalcules, that have existed since the beginning of creation.

Judging from the 38.8 % acceptance of male preformism (EP3) which claims that a child pre-exist in the male gametes (sperms) and the female act as receptacle to nourish & protect baby in womb to develop, the dominant role is given to the male who puts the child into the female as is claimed in common language, *"he has impregnated a woman"*. The female are seen as passive receptacles to carry the baby. Contrarily to this, female preformism (EP2) is noticed in 16.2 % of respondent who belief a miniature form of a child is found in the female egg (ovum) and the role of the male is to stimulate growth, or add certain parts.

This preformists misconception can act as an epistemological obstacle to the understanding of the process of gametogenesis (gamete production) and the fertilization concept. This misconception is contrary to Epigenesis (or neoformism), the notion that *"each embryo or organism is gradually produced from an undifferentiated mass by a series of steps and stages during which new parts are added."* (Magner 2002)[12]. This word is still used, on the other hand, in a more modern sense, to refer to those aspects of the generation of form during ontogeny that are not strictly genetic, or, in other words, *epigenetic*.

Table 5: Respondents' opinion about fertilisation and twin formation

S/N	Statement / Misconception	Percentage Total

		Responses
FER4	During fertilisation two sperms can fertilise an egg to form twins.	30.7
FER1	Non-identical twins are produced by division of a single fertilised egg into two	24.2
FER 2	Unidentical twins are the product of fertilization of two eggs by a spermatozoan	20.9
FER3	Unidentical twins are the product of fertilization of two eggs by two spermatozoa	*24.2*
	SUMMATED TOTAL	100

Although 45% had the correct scientifically accepted view of epigenesis (EP1), only 24.2% of students rightly applied this concept to explain mechanism of formation of un-identical twins (FER3). The remaining 75.8% had erroneous conceptions about the formation of twins, probably influenced by their epistemological views about the origin of life.
The male preformist view (EP3) could probably have been responsible for the misconceptions held by 30.7 % respondents, that during fertilization two sperms can fertilise an egg to form twins (FER4), or the misconception that unidentical twins are the product of fertilisation of two eggs by a spermatozoan, a concept accepted by 20.9 % of the respondents (FER2).

In a similar manner, the female preformist view (EP2) could equally have been responsible for the misconceptions held by 24.2 % respondents, that Non-identical twins are produced by division of a single fertilised egg into two (FER1). Here it is believed that if two babies are in the egg and its growth is stimulated by the sperms, then it will develop into unidentical twins.

B. Post Test Results After Intervention

There was much change in the scientific concept of fertilisation, fertile period, and contraception after intervention using the Problem based learning and argumentation lesson (appendix 1). Most of the didactic and epistemological obstacles were overcome. For example responses to question on table 3 to determine the fertile period in a 24 day menstrual cycle was as follows

Table 6: Knowledge of Fertile Period of Short 24 days Menstrual Cycle (Natural Family Planning)

S/N	Proposed Answers	Percent %	Inference
A	1^{st} -6^{th} day	2.8%	An improvement from 32.8 % to 70.2% of respondent selected the right answer B in the post test.
B	7^{th} – 13^{th} day	70.2%	
C	14^{th} – 18^{th} day	20.4%	
D	19^{th} -24^{th} day	6.6%	

After getting student to compare various menstrual cycles for “*must have”* characteristics and “*not may have*” characteristics, most could established from documentary analysis that the postovulatory phase was fourteen days in all types of menstrual cycle. It became easier to determine the ovulation day of any cycle (cycle duration minus 14 days) accurately. From the probe questions of the problem situation, most student realised the fact that the sperm cell has a life span of 48 to 72 hours in the female reproductive tract and that the secondary oocyte lives for 24 to 48 hours after evaluation. About half of the student could derived a mathematical formula that holds true for any menstrual cycle which is **N= (X – 14) ± 3 days**. Where N = duration of fertile period, X is the duration of menstrual cycle. Thus for a short cycle of 24 days, ovulation will occur on the 10^{th} day (24 minus 14). Thus fertile period is from 7^{th} to 13^{th} because if the male gametes are deposited on the 7^{th} day they will still be alive to fertilize the secondary oocyte (ovum) by the 10^{th} day when ovulation occurs. Similarly, sperms cell deposited two days after ovulation will till meet the secondary oocyte alive to fertilise. The formula derived by the student from the problem was not found in any of the official textbooks used in Cameroon.

Applying the formula for a very short cycle of 20 days reveal a fertile period between the 3^{th} and 9^{th} day of the cycle, which overlap with days of menstrual flow. It convened those who had the erroneous conception that menses correspond to an egg being release to realise that such was just a specific case and not a general rule.

However, it was realised that the misconception still persisted after the instructional strategy, confirming the difficulty to completely change erroneous conception. All the same the change in conception in the post test revealed significant learning had occurred. It also revealed the student ability to mobilise knowledge from mathematic and other discipline to solve daily life problem which is in line with the definition of competence as the ability to mobilise knowledge, skills and attitude to solve real life situations (Roegiers & Deketele, 2000)[13]

C. Comparison of Pretest and Post Test Results

a. Investigation of Mean Gain Scores on Pre- and Post-Test Intervention

We were interested on the extent of the impact of PBL & Argumentation on the development of Fertilisation Concept, result on the experimental group.

Table 7: Shows the Paired Sample T test comparing different aspects of Pre-test and Post-test results

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% confident interval of the Difference				
				Lower	Upper			
Pair 1. Pretest fertilisation concept – posttest fertilisation concept	-2.3651	1.64906	.20776	-2.78039	-1.94977	-11.384	62	0.000

The results of the paired sample t test were statistically significant for: fertilisation concept; t (62) = -11.384, p = 0.000, Eta square (η^2) = 0.676, indicating that there is a significant increase in mastery of the fertilisation concept after intervention using the PBL& argumentation as didactic strategy from the pre-test (M = 8.87; SD = 1.22, N = 63) to the post-test (M = 11.24; SD =1.24, N = 63). The effect size was large based on Cohen's convention (Cohen 1988) as the Eta Square value (η^2) of 0.676 accounts for 67.6 % of the variance explained in the fertilisation concept. Thus the null hypothesis (Ho) of no difference between group mean was rejected. Cohen (1988)[14] outlined a number of criteria for gauging effect sizes in different metrics, as follows: d: small.> 0.20, medium.> 0.50, large >0.80). The effect size was calculated using the proposed Cohen 1988 formula:

$$\eta^2 = \frac{t^2}{t^2 + N - 1}$$

b. Validation Procedure of Paired T Test Results

First of all the existence of confounders were determined using MANOVA procedures, to test if they statistically influenced the dependent variables (mastery of fertilisation concept). Secondly the assumptions for using the identified confounder in ANCOVA procedures were tested, and finally, the ANCOVA procedures were carried out to measure the influences of the covariate on the paired sample results.

b1. Test for the Presence of Other Covariates that might Influence Effect of Didactic Strategy on Development of Competences Using MANOVA

Multivariate general linear model procedure was used to test the influence of several categorical independent variables (Gender, Age, Religion, Region, and Didactic strategy) on the different dimensions of the dependent variables measured (mastery of fertilisation concept and its application). This procedure investigates the main effect of each of these independent variables as well as the interaction effect of these independent variables. The results are shown on table 8 below.

Table 8: Influence of Gender, Age, Religion, Region, and Didactic strategy on the Mastery of the Fertilisation Concept & its Application.

Multivariate Test (main effect of independent variable)					
Effect	Wilks Lambda	F	Hypothesis (df)	Error df	Sig.
Gender	0.988	0.085	4.000	27.000	0.986
Age	0.836	0.419	12.000	71.727	0.7951
Religion	0.555	1.103	16.000	83.124	0.366
Region	0.394	0.907	32.000	101.166	0.612
Didactic strategy used	**0.331**	**13.667**	**4.000**	**27.000**	**0.000**

The results indicate that only didactic strategy used (PBL & argumentation) had a significant influence on the mastery of fertilisation concept: F (4, 27) = 13.667, p = 0.000. The main effect or interaction effect of gender, age, religion, and region of origin had no effect as read from the Wilk's lambda F values on table 8.

b2. Test for the Influence of Didactic Strategy (IV) on mastery of fertilisation concept (DV) While Controlling for Covariate (Pre-Test Scores)

The objective was to verify the validity of the sample T test results by controlling for protest and measuring any statistically significant difference in post test results between control and experimental group. The results are presented below in table 9 below.

Table 9. ANCOVA Confirmatory Test for effect of PBL on Fertilisation Concept

Tests of Between –Subject Effects						
Dependent Variable: Post-test Fertilisation concept						
Source	Type III Sum of squares	Df	Mean square	F	Sig	Partial Eta Squared
Corrected Model	34.129[a]	2	17.064	11.194	0.000	0.147
Intercept	141.721	1	141.721	92.968	0.000	0.417
Fertilisation concept 1	26.560	1	26.560	17.423	0.000	0.118

Didactic Strategy	*12.398*	*1*	*12.398*	*8.1333*	*0.005*	*0.590*
Error	198.172	130	1.524			
Total	17037.000	122				
Corrected Total	232.301	132				

a. R squared = 0.147 (adjusted R squared = 0.134)

The didactic strategy used is also statistically significant F (1, 130) = 8.133, p = 0 .005, Eta square 0. 590.

Given earlier in table 8 that the result of descriptive statistics shows that the post intervention mean (M=11.24) is higher than the pre intervention mean (M=8.87). We can conclude that after controlling for pre-test score on contraceptive use, there is a statistically significant increase in mean gain post-test scores using the PBL and argumentation compared to lecture method as didactic strategies. This difference in didactic strategy accounts for 59% of the variance in the post test score for mastery of the fertilisation concept from the Eta square values.

This confirms the results using paired sample T test. However, the moderate effect size of 59% when covariate are controlled in ANCOVA is lower than the large effect size of 67.6% when the Sampled T test was used without controlling for covariate (table 70. Thus there is a significant greater difference in conceptual change in student mastery of the fertilisation concept after teaching using Problem-based learning / argumentation compared to the traditional lecture method

IV. Discussion

Our intervention reveals that a true problem situation must be conceived around an identified erroneous conception which act as an obstacles (epistemological or didactic) to the appropriation of a correct scientific conception. It is a learning situation conceived carefully to create disequilibrium, cognitive conflict and divergence between the learners' initial conception of fertilisation and fertile period (based on 28day menstrual cycle for example) and what they realised in reality – the scientific conception (scientific formula derived that works for all types of menstrual cycle in our case).

In line with Vergnaud's theory of conceptual field, "$C_{\text{fertilisation}} = f\,(S, OI, SR)$", our problem situation used several situations (different durations of menstrual cycle) to overcome the didactic obstacles in teaching fertile period based only on the most likely average menstrual cycle of 28 days, so as to give scientific meaning to the concept of fertilisation its application. The schema of the learners reveals the misconception learners have on fertilisation concepts and its application as reveal in the pretest results on table 1 to table 5. The problem situation created a cognitive conflict as learners realised their knowledge of fertile period which worked on a 28 day cycle doesn't hold in all case. Via socio-cognitive conflicts the some learners via argument in groups successfully came out with a formula without the direct intervention of the teacher. The role of the teacher was mainly to validate and institutionalised the newly constructed knowledge by the learners. The learners appropriate the problem situation and proposed a solution based on the didactic and adidactic situation created by the teacher.

The result of the quasi experimental approach reveal the extent to which the use of PBL strategy via problem situation lead to a significant change in conception from common erroneous knowledge to the scientific conception.

Our findings are in harmony with those of Lamour, (2004)[15] and Bantuelle & Demeulemeester, (2008)[16] who proved by experience that interactive programmes founded on social cognitive conflicts and acquisition of competences is much more effective than non-interactive programmes based on knowledge transmission. To Donckèle (2003)[17] and Scallon (2004)[18], PBL is a process of solving authentic, real life problems using old and new competences, and necessitating a profound investigative approach individually and in group. It is a learning approach that challenges students to learn to work in groups to look for solutions to real life problems (Poirier-Proulx, 1999; Galand & Frenay, 2005)[19, 20]. Thus, PBL, as an active (learner - centred), inductive and semi-directive method helps to build autonomy in learners.

V. Conclusion and Perspective

The studies demonstrate how a well-designed problem situation can be used as a didactic strategy to develop cognitive change in learners through the following steps: Establish the didactic contract specifying role and expectation of students and teachers (Appendix 1); Investigating students' prior conception about a lesson to identify epistemological, didactic, psychosocial or ontogenetic obstacles on the object of study; Prepare lesson using complex real life problem situations developed to challenge the obstacles or misconceptions identified; Create appropriate didactic and adidactic situation for learners to overcome these obstacles; and Validate or institutionalise students' findings.

There is need to carry out a purely qualitative study to triangulate the results of this quantitative study by demonstrating how and why these cognitive change are developed in learners when lessons on fertilisation concept and its application in contraceptive concepts are taught using socio-constructivist didactic strategies.

Also we could equally in further studies analysis the psychosocial competences developed by this PBL method such as problem solving skills, communication and negotiation skills required for better citizenship.

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Annex 1: Problem Based Learning & Argumentation Lesson Plan
Lesson Plan 1: Fertilisation concept and menstrual cycle

<table>
<tr><td colspan="5">NAME OF TEACHER: Lawrence NTAM NCHIA</td></tr>
<tr><td>SCHOOL: High School Yaoundé</td><td>CLASS: USS</td><td colspan="3">DATE: October 2020</td></tr>
<tr><td>AGE : 15-18 Years</td><td>TIME: 2 hours</td><td>TOTAL ON ROLL:68</td><td>BOYS:</td><td>GI RLS:</td></tr>
<tr><td colspan="5">THEMES: Use of Contraceptives</td></tr>
<tr><td rowspan="2">CONTEXTUAL FRAMEWORK</td><td colspan="4">FAMILY OF LIFE SITUATIONS: Improving human reproductive health</td></tr>
<tr><td colspan="4">EXAMPLE OF LIFE SITUATION: * Prevalence of Unwanted pregnancy & Abortion</td></tr>
<tr><td rowspan="2">COMPETENCIES</td><td colspan="4">CATEGORY OF ACTIONS: *Preventing unwanted pregnancies and illegal Abortions;</td></tr>
<tr><td colspan="4">ACTIONS: *Avoiding unwanted pregnancies; Awareness and sensitisation.</td></tr>
<tr><td colspan="5">PSYCHOSOCIAL COMPETENCIES TO DEVELOP: *Develop Critical & Creative Thinking; *Relate and Communicate Effectively.</td></tr>
<tr><td colspan="5">LEARNING OBJECTIVES: * Understand the concept of fertilisation, fertile period and Menstrual cycle ; *ability to carry out research to solve problem situation; *Ability to listen to others and respect their points of views;</td></tr>
<tr><td colspan="5">METHODS/TECHNIQUES: Group Work & Buzzing</td></tr>
<tr><td colspan="5">MATERIAL/ TEACHING AIDS:: Biological Science Textbook

Problem situation 1:

Three women NJANG, NNAM and CHUO are married to Mr NJUH. After having kept records of their menses for over 12months realised discovered that they had a menstrual cycle of respectively 24, 28 and 32 days. Mr NJUH decided to have sexual intercourse with them during the 14th day of each wife's menstrual cycle which he believed was the fertile period (ovulation day). After a period of 6 months NNAM with a cycle of 28 days got pregnant while NJANG & CHUO didn't. One year later NJANG and CHUO accused NNAM of being a witch responsible for their inability to conceive.
6. As a biology student are these allegation of witchcraft founded?
7. What do you think is responsible for the fact that only Mrs CHUO got pregnant while NJANG and CHUO did not?
8. What are the similarities and differences in the different phases of their menstrual cycle
9. What can you conclude about their fertile period?
10. Derive a formula to enable other couples to exactly determine their fertile period irrespective of the duration of their menstrual cycle.</td></tr>
</table>

Approach / Procedure	Teachers	Students
Presentation of objectives	1. Teacher present to students the Theme of the lesson and the objectives	A. Students listen
Diagnostic	B. Teacher assures that each student the meaning of contraception by asking the following questions;	2. Students response to questions

activities of student's Preconception	a. *Define Fertilisation?* b. *Define menstrual cycle?* c. *What are the phases of the menstrual cycle and its duration?* d. *What is the life span of an egg and sperm cell after release?*	
Main formative activities	3. Teachers write problem situation on board and ask students to consults their text books and solve it individually for 30 minutes 4. Teacher asks students to form groups of 6 students with at least 2 males or 2 females. Then elect a Coordinator, Secretary & Time Keeper. 5. Teacher instruct each group to deliberate on their answers and present a common response 6. The teacher asks each group secretary to paste and present their chart to the class. He analyses together with the entire class the pertinence of the responses presented in the charts. 7. The teachers ask the entire class to think criticise the appropriateness of the proposed responses and formula. notes the different situations. 8. Teacher assist in validation and institutionalisation of formula to determine fertile period.	3. Students individual resolve problem situation 4. Students form groups and appoint a Coordinator, Secretary & Time Keeper. 5. Each Student discuses his/her response with group, they debates and arrive at a conclusion which the secretary writes down on the charts. 6 The Secretary of each group presents their charts to the class. Each student can comment on the process and decisions presented. 7 Students reflect on proposed formula from each group and ask questions for clarification 8 Students write down validated response.
Synthesis activities	9. Teacher thanks students for their presentation. He points out the various epistemological and didactic obstacles students faced and how it has been overcome. He validates the generally accepted formula produced by the students and write on it on the chalk board	lents listen and jot down conclusion on their notebooks.
Evaluation	Teachers ask them the implication of lesson on natural family planning methods, its advantages and disadvantages.	

Lawrence Ntam Nchia, et. al. "Overcoming Didactic and Epistemological Obstacle to the Learning of Fertilisation Concept and its Applications in High School, Yaounde." *IOSR Journal of Research & Method in Education (IOSR-JRME)*, 11(4), (2021): pp. 01-09.