International Journal of Computer and Information Technology (ISSN: 2279 – 0764)
Volume 03 – Issue 05, September 2014

Affordances of ICT in Learning Physics Electricity Concepts: A Study Conducted in Nablus City Palestine

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Abstract—**Information and Communication Technologies (ICT) in teaching and learning physics is a very active field of research and innovation, where learning is understood to be meaningful and grasping multiple linked representation rather than rote memorization, a great amount of literature offering a wide range of theories, learning approaches, methodologies and interpretations, are generally stressing the potentialities for teaching and learning using ICT. Despite the utilization of new learning approaches with ICT, students experience difficulties in learning concepts relevant to understanding electricity concepts, much remains unclear about the relationship between the computer environment, the activities it might support, and the knowledge that might emerge from such activities. Many questions that might arise in this regard: to what extent does the use of ICT help students in the process of understanding and solving tasks or problems? Is it possible to identify what aspects or features of students' electricity concepts learning can be enhanced by the use of technology? This paper will highlight the interest of the integration of information and communication technologies (ICT) into the teaching and learning of electricity concepts, it aims to investigate the effect of three instructional methods (blended self-based learning (BSBL), blended collaborative learning (BCL), and usual learning on students' acquiring electricity concepts. Results reveal that acquiring electricity concepts evolve as students engage with ICT – rich environments and learn cooperatively.**

Keywords-educational technology; learning physics concepts; ICT; blended learning; collaborative learning

I. INTRODUCTION

Information and Communication Technologies (ICT) in teaching and learning physics is a very active field of research and innovation, where learning is understood to be meaningful and grasping multiple linked representation rather than rote memorization, a great amount of literature offering a wide range of theories, learning approaches, methodologies and interpretations, are generally stressing the potentialities for teaching and learning using ICT [1], [2], [3], [4], [13], and its potential to play a significant part in approaching more effective, in the sense of more profound and more persistent learning process [15].

Learning physics is often considered by teachers and students to be difficult pursuit, cognitive theories have challenged the common belief that thinking is an important issue in learning, and the associated activities with learning are vital to student's perception and understanding [7], [8], [12].

Blended learning (BL) is well-thought-out to be one of the top trends to emerge in the knowledge delivery industry [16]. Recently, the rapid advances in using BL have acted as a catalyst for educational transformation, many researchers define BL as a combination of face-to-face and online instruction [16], Hanefar et. al. (2011) define it as "a flexible approach to course design that supports the blending of different times and places for learning, offering some of the conveniences of fully online courses without the complete loss of face-to-face contact" [17]. Garrison and Kanuka (2004: 99) argue that "blended learning (BL) is not just finding the right mix of technologies or increasing access to learning. Blended learning inherently is about rethinking and redesigning the teaching and learning relationship." A thoughtful redesign in order to integrate the strength of the face-to-face and the computerized program. This integration may engage the teachers and students in reflection, continuous learning and construction of knowledge [14]. Some researchers considered using BL as an appropriate approach to a better engagement in the learning process, "taking into account the need to be pedagogically grounded and their design should take into account not only the target learners and their immediate implementation environment but also systemic constraints and affordances" [18]. Lee and Tsai (2011) reported positive effects of collaboration using ICT include a better engagement in the learning process, and student's perception.

Despite the utilization of new learning approaches with ICT, students experience difficulties in learning physics relevant to understanding electricity concepts, much remains unclear about the relationship between the computer environment, the activities it might support, and the knowledge that might emerge from such activities [6], [9], [10], [11]. Many questions that arise in this regard: to what extent does the use of ICT help students in the process of understanding electricity concept? What is the role of teachers in an enhanced technology class ? Is it possible to identify what aspects or features of students' learning can be enhanced by the use of technology?

The work presented in this paper is offered as a contribution to understanding the relationship between affordances of ICT learning environment and the acquisition of electricity concepts that may develop as a result of interactions with the learning environment. This study focused on the effect of different learning approaches in learning electricity concepts. It is part of a more comprehensive study pursuing the goals: (1) to study the role of visualization in the learning process of electricity concepts; (2) to examine the contribution of different learning approaches in the visualization process to the students' understanding of electricity concepts; and (3) to examine the effect of the type of engagement (individualize vs. cooperative) on the student's learning.

II. METHOD

A. Subjects

Participants were 90 students (ages ranging from 14 to 15 years old both male and female) composed of three 9^{th} grade sections from two private schools (intentional sampling with proper ICT infrastructure that meets research objectives) in Nablus city in Palestine. The three sections were divided according to the way of learning into: (1) Blended self-based learning (BSBL), (2) Blended collaborative learning (BCL), and (3) Usual learning. Table I shows the distribution of participants according to the way of learning.

TABLE I. STUDENTS' DISTRIBUTION ACCORDING TO THE WAY OF LEARNING

Way of Learning	**School**	
	Saint Joseph	**Al-Rawda**
Blended Self - Based Learning (**BSBL**)	30	
Blended Collaborative Learning (**BCL**)	30	
Usual Learning (**face to face - F2F**)		30

B. Research instruments

(a) One of the most difficult challenges in science education is to design professional development programs, which can lead to fundamental changes in the learners practices as well as teachers, to accomplish this the researcher developed a learning environment involving a computerized program that was given to several evaluators to review material and make independent judgments and interpretations, i.e., inter-rater reliability) comprising three components: (1) The learning material (four chapters, sixteen lessons that are presented using videos, macromedia flash, 3ds max software covering modeling, animations and rendering, and educational games), (2) Formative evaluation tests that are applied after the lessons completion, and (3) Summative evaluation tests that are applied at the end of each chapter. Fig. 1 explains the different stages in the learning environment and how they are connected.

(b) Data collection tools included: (1) pre-test comprising general background to evaluate students' prior knowledge about electricity concepts; (2) structured observation and data forms, (3) acquiring electricity concepts test consisting of 31 multiple choice questions (see Table V), to ensure content validity the test was given to several evaluators to review material and make independent judgments and interpretations, reliability of the data is needed for authenticity. A test-retest reliability coefficient of 0.85 where obtained from a pilot study, and this reliability coefficient is significantly suitable for this study.

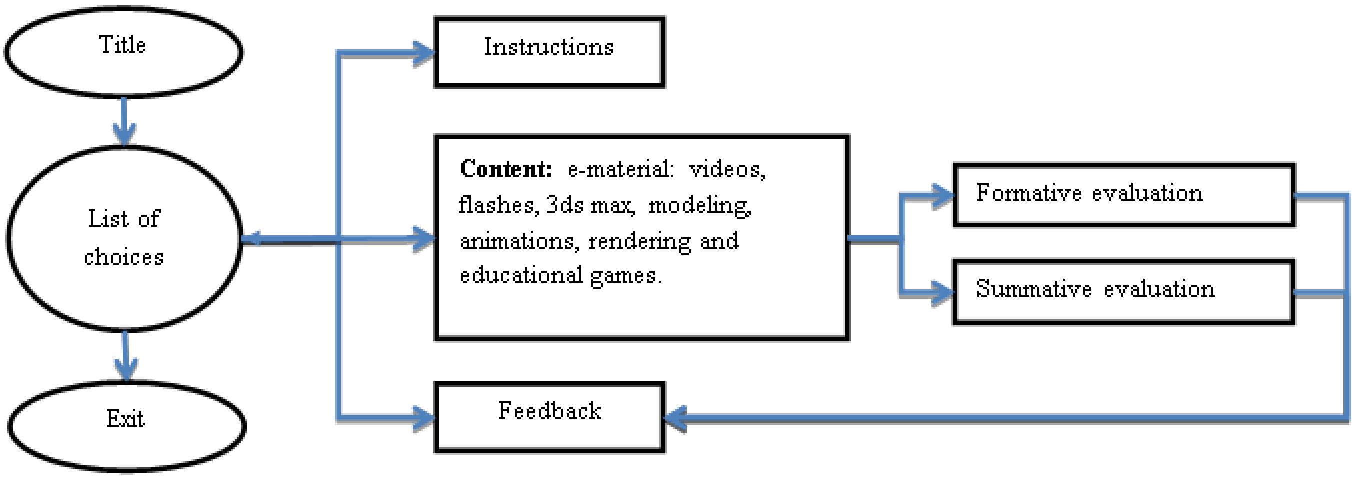


Figure 1. Flowchart that explains the different stages in the learning environment and how they are connected.

C. Procedure

The study was carried in the following stages: (a) Training teachers by the researcher how to use the learning environment when teaching using the approaches (Blended Self - Based Learning and Blended Collaborative Learning), (b) Training students by the researcher how to use the learning environment when learning using the approaches (Blended Self - Based Learning and Blended Collaborative Learning), (c) Pre-test, (d) Treatment in three different approaches as follows: (1) Blended Self - Based Learning (BSBL): students were engaged separately with the learning environment (16 lessons), (2) Blended Collaborative Learning (BCL): the collaborative technique suggests that students learned in small groups (2-4 students) (see [5]: 287), each group were engaged with the learning environment (16 lessons), and (3) Usual Learning (face to face - F2F): students were engaged in a face to face lessons (16 lessons).

III. RESULTS AND DISCUSSIONS

In order to investigate the effect of three instructional methods (blended self-based learning (BSBL), blended collaborative learning (BCL), and usual learning (F2F) on students' acquiring electricity concepts, several statistical measures and tests where done using SPSS software, Table II and Figure 2 show the mean scores on acquiring electricity concepts test, results found to be in favor to the BIL learning approach followed by the BSBL learning approach.

TABLE II. MEAN SCORES AND STANDARD DEVIATION ON ACQUIRING ELECTRICITY CONCEPTS FOR THE DIFFERENT GROUPS

Groups	**Mean**	**Standard deviation**	**N**
Usual Learning	18.23	5.49	30
Blended Collaborative Learning	24.26	6.082	30
Blended Self Based Learning	25.3	3.37	30
Total	22.6	5.93	90

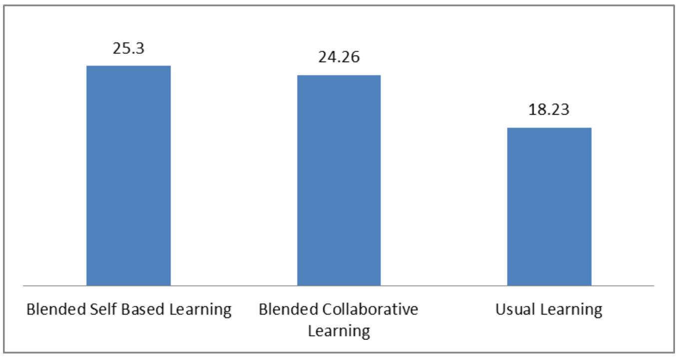


Figure 2. Acquiring electricity concepts mean scores

We analyzed data through the examination between the different instructional approaches of learning on the acquisition of electricity concepts test (see Table III) An analysis of covariance (ANCOVA) where done (Table III) showing a significant differences between approaches (F (2, 86) = 17.153, $p < 0.01$).

TABLE III. ANCOVA TEST DUE TO THE THREE LEARNING APPROACHES ON ACQUISITION OF ELECTRICITY CONCEPTS

Source	**Sum of squares**	**df**	**Mean squares**	**F**	**Sig.**
Treatment	891.010	2	445.500	17.153	0.0
Error	2233.696	86	25.937		
Total	3124.706	88			

A Post Hoc (LSD) analysis was done (Table IV) showing that: (a) significant differences between the F2F learning approach and the BSBL learning approach ($p < 0.01$), in examining Table II, it shows that the BSBL learning approach got the highest scores on the acquisition of electricity concepts test, (b) significant differences between the F2F learning approach and the BCL learning approach ($p < 0.01$), in examining Table II, it shows that the BCL learning approach got the highest scores on the acquisition of electricity concepts test, (c) there were no significant differences between the BCL learning approach and the BSBL learning approach (p = 0.498).

TABLE IV. POST HOC ANALYSIS BETWEEN THE THREE LEARNING APPROACHES ON THE ACQUISITION OF ELECTRICITY CONCEPTS TEST

Group 1	**Group 2**	**Mean Difference (1-2)**	**Std. Error**	**Sig.**
F2F	BSBL	7.096	1.316	0.0
	BCL	6.197	1.326	0.0
BSBL	F2F	7.096	1.316	0.0
	BCL	0.900	1.323	0.498
BCL	F2F	6.197	1.326	0.0
	BSBL	0.900	1.323	0.498

IV. CONCLUSIONS

In this work we have used different learning approaches using ICT, models, videos, flashes, animations and rendering that were used by students in their learning were very useful in understanding electricity concepts; results reveal that acquiring electricity concepts evolve as students engage with ICT – rich environments and learn cooperatively.

This paper reports an analysis of how affordances of ICT – rich environments can support students in learning physics in schools within proposed pedagogical practices in physics learning during the acquisition of electricity concepts using different learning approaches, there are many concepts that we never directly experience or that violate our intuitions and challenges of our cognitive and meta-cognitive resources. The implementation of such an instructional approaches in the curriculum would have many benefits for learners, such as new ways of thinking, exploration of tools to think with.

By introducing this new perspective in learning using computerized learning environments through BCL and BSBL, concepts learning in physics will be more motivational and truthful, more inclusive and accessible to the great majority of students, the use of the ICT allows effective reasoning about concepts learning in physics, its potential to play a significant part in approaching more effective, in the sense of more profound and more persistent learning process, in addition, this study's results have clear implications for the design of learning environments that can support learning about physics.

ACKNOWLEDGMENT

We would like to thank Mrs. Hala Bakeer and Mrs. Dina Dawani for their genuine support and valuable assistance during the time this work was conducted.

REFERENCES

[1] A. K. Bingimlas, "Barriers to the Successful Integration of ICT in Teaching and Learning Environments: A Review of the Literature," *Eurasia Journal of Mathematics, Science and Technology Education*, vol. 5, no. 3, pp. 235-245, 2009.

[2] A. D. Schliemann and D. W. Carraher, "The Evolution of Mathematical Reasoning: Everyday vesus Idealized Understandings," *Developmental Review*, vol. 22, pp. 242-266, 2002.

[3] N. Zanamwe, T. Rupere and O. Kufandirimbwa, "Use of Social Networking Technologies in Higher Education in Zimbabwe: A learners' perspective," *International Journal of Computer and Information Technology (IJCIT)*, vol. 2, no. 2, pp. 8-18, 2013.

[4] B. Çavas, B. Karaoglan and P. Çavaa, "The Use of Information Communication Technologies in Primary Science Education: A New Teaching and Learning Approach," *Turkish Science Education*, pp. 35-46, 2004.

[5] U. J. Wilensky, Connected Mathematics - Building Concrete Relationships with Mathematical Knowledge, Massachusetts Institute of Technology, 1993.

[6] J. Gobert, "Harnessing technology to support on-line model building and peer collaboration," 2003. [Online]. Available: http://www.slideee.com/slide/gobert-poster. [Accessed May 2014].

[7] S. D. Johnson and S. A. Aragon, "An instructional strategy framework for online learning environments," in *Facilitating Learning in Online Environments, New Directions for Adult and Continuing Education*, S. A. Argon, (Ed.), San Francisco, Jossey-Bass, 2003, pp. 31-44.

[8] J. L. Brown, A. Collins and P. Duguid, "Situated cognition and the culture of learning," *Educational Researcher*, vol. 18, no. 1, pp. 32-42, 1989.

[9] X. Liu, "Socio-cultural context for online learning: a case study viewed from activity theory perspective," in *The Association for Educational Communications and Technology Conference*, Chicago, IL, 2004.

[10] D. Reynolds, D. Treharne and H. Tripp, "ICT-the hopes and reality," *British Journal of Educational Technology*, vol. 34, no. 2, pp. 151-167, 2003.

[11] J. Underwood, "Research into information and communications technologies: where now?," *Technology, Pedagogy and Education*, vol. 13, no. 2, pp. 135-145, 2004.

[12] F. Marton and S. Booth, Learning and Awareness, New Jersey: Lawrence Erlbaum Assoc, Publishers, 1997.

[13] K. Hashem and I. Arman, "Integration of ICT in Mathematical Understanding Using Modeling," *International Journal of Computer and Information Technology*, vol. 2, no. 2, pp. 330-335, 2013.

[14] D. R. Garrison and H. Kanuka, "Blended learning: Uncovering its transformative potential in higher education," *The Internet and Higher Education*, vol. 7, pp. 95-105, 2004.

[15] R. Motsching-Pitrick and A. Holzinger, "Student-centered teaching meets new media: concept and case study," *Journal of Educational Technology and Society*, vol. 5, no. 4, pp. 160-172, 2002.

[16] C. R. Graham, "Blended learning systems: definitions, current trends and future directions," *in Handbook of blended learning: Global Perspectives, local designs*, C. J. Bonk and C. R. Graham, (Eds.), San Francisco, CA: Pfeiffer Publishing, 2005, pp. 3-21.

[17] S. B. M. Hanefar, W. L. Shing and C. C. C. Tik, "The Effectiveness of Reciprocal Peer Tutoring in Supporting Blended Learning in both Online and Offline Modes," *Proceedings of the 3rd International Conference of Teaching and Learning (ICTL 2011)*, INTI International University, Malaysia, 2011.

[18] B. Boitshwarelo, "Exploring Blended Learning for Science Teacher Professional Development in an African Context," *The International Review in Open and Distance Learning*, vol. 10, no. 4, 2009.

[19] S. W. Lee and C. Tsai, "Students' perceptions of collaboration, self-regulated learning, and information seeking in the context of internet-based learning and traditional learning," *Computers in Human Behavior*, vol. 27, pp. 905-914, 2011.

TABLE V. **AQUIRING ELECTRICITY CONCEPTS TEST (31 QUESTIONS)**

Please read questions and then put circle around the correct answer:

1. Physical unit of charges is:

   A. AMPS. B. Coulomb

   B. Volte C. Watt

2. Wood and plastic classified in terms of conductivity:

   A. Conductive B. Isolate

   C. Semiconducting D. Answer (A+b)

3. If metallic cable touch Scouts electric, what do you expect to happen:

   A. Inflate both papers to Scouts electric. B. do not inflate both papers to Scouts electric

   C. inflates on paper to Scouts electric. D. brightness the wire

4. If electric current was value (0.02) AMPS pass in two minute on metallic wire, what do you expect the value of charges on metallic wire:

   A. (3) Coulomb B. (2.4) Coulomb

   C. (5) Coulomb C. (6) Coulomb

5. The a mount of charges passes on connecter through unit of time is ………….

   A. Power B. Volts

   C. electric current D. electric resister

6. Electric current proportion with electric resister is:

A. Direct proportion B. Reverse proportion

C. Form proportion D. No effects

7. The device is using to calculate value of electric currents is:

A. Voltmeter B. Clock

C. Galvanometer D. Meter

8. If two bodies have different charges touch each other, what do you expect results:

A. Electric current B. New charges

C. Voltage D. Electric resister

9. The device is using to measure value of voltage is:

A. Ammeter B. Clock

B. Galvanometer D. Barometer

10. The ship using to rejection passes electric current is:

A. Wire B. electric resisters

C. Lamb D. Battery

11. The symbol (Ω) is mean:

A. AMPS B. Volt

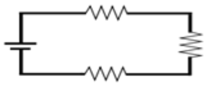
C. Ohm's D. Watt

12. The electric circuits can connect through:

A. Parallel connecting B. Respectively connecting

C. Equivalent connecting D. Answer (A+B)

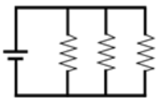
13. This figure is express on connecting circuit through:



A. Parallel connecting B. Respectively connecting

C. Equivalent connecting D. Answer (A+B).

14. This figure is express on connecting circuit through:



A. Parallel connecting B. Respectively connecting

C. Equivalent connecting D. Answer (A+B)

15. Resistance Equivalent to two resisters connect on parallel method is mean through symbol:

A. $R^E = 1/R1 + 1/R2$ B. $R^E = 1/R1 - 1/R2$

C. $R^E = R1 \times R2$ D. $R^E = R1 + R2$.

16. Resistance Equivalent to two resisters connect on respectively method is mean through symbol:

A. $R^E = 1/R1 + 1/R2$ B. $R^E = 1/R1 - 1/R2$

C. $R^E = R1 \times R2$ D. $R^E = R1 + R2$.

17. The methods to calculate value of electric resistors is:

A. Colors B. DMM

B. Voltmeter C. Answer (A + B).

18. Trade name to electric pole is:

A. Resistors B. Battery

C. Power D. Wire.

19. The types of electric pole are:

A. Cathode B. Columns dry

C. Accumulators D. Answer (B+C).

20. In the dry columns classified elevator according to:

A. Cathode B. Anode

C. Counting D. Accumulators.

21. Dry column consist from Internal resistance is (0.8) OHM'S, electric force is (3) Volt, and external resister is (2.4) OHM'S, calculate the value of electric current in this circuit:

A. (0.93) AMP. B. (1) AMP.

C. (0.5)AMP. D. (0.2) AMP.

22. The value of internal resistors is:

A. Equal B. Unequal

C. Variable D. Stable

23. The electric energy in electric fireplace is converted to:

A. Thermal energy B. Pneumatic energy

C. Nuclear energy D. Chemical energy.

24. The electric energy in electric fan is converted to:

A. Thermal energy B. Pneumatic energy

C. Nuclear energy D. Chemical energy.

25. The electric energy in electric lamb is converted to:

A. Thermal energy B. Pneumatic energy

C. Nuclear energy D. Optical energy.

26. Hair dryer is wire resistor (500) OHM'S, and voltage (200) Volt, calculate converter energy through time is (2) hours ,hence the electric current is (0.5)AMP:

A. 9500 Joule B. 5005 Joule

B. 4500 Joule D. 6000 Joule.

27. The physical law to calculate electric power is:

A. Power= Volt/ electric current B. Power= Volt × electric current

C. Power= electric current +Volt D. Power= electric current × resister.

28. The method of safety from electricity risk is:

A. Grounder B. Electrical separation

C. Ammeter D. Answer (A+B).

29. The physical symbol of (W) is short to:

A. Ampere B. Ohms

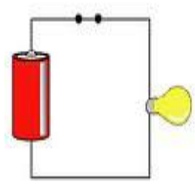
C. Watt D. Joule.

30. Electric fireplace work on (220) Volt, (0.5) AMP, and it work every day two hours, calculate the price of converter energy in one month, hence the value of Kilowatt is (0.6) NIS:

A. (50) NIS B. (66) NIS

V. (33) NIS D. (40) NIS

31. In this figure the dry column using to:



A. Resister B. Optical

B. Thermal D. Grounder