INFLUENCE OF BLENDED LEARNING ON OUTCOMES OF STUDENTS IN A RURAL CHEMISTRY CLASS

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Abstract. The merging of several teaching methods and pedagogic tools is a recurrent technique that is geared towards meeting the needs and expectations of students with varying dispositions, learning styles and intelligence styles. This study investigated the effects of blended learning on the outcomes of Ordinary Level students in a rural chemistry classroom in Zimbabwe. The study adopted a quasi-experimental research design with *a* non-equivalent control group. Purposive sampling technique was used to select two intact chemistry classes from two equivalent co-educational secondary schools that were distantly located from each other within rural schools in Gweru district. The main instrument used for the data collection was a Chemistry Achievement Test (CAT). The internal consistency of the instrument was obtained as 0.81 using the Test Retest method to establish the reliability. The researcher also administered survey questionnaire to students to solicit their views regarding blended learning and its implementation. Intact classes were used and in all, 67 students participated in the study (35 in the experimental group taught with the blended learning and 32 in the control group taught using the traditional method). Data collected for the study was analysed using ANCOVA. The obtained results in-

dicated a statistically significant increase in the students' outcomes after being exposed to the blended learning approach. The findings showed positive perceptions of students on the blended learning environment. Recommendations were made that the blended learning strategy should be given more emphasis during teaching and learning of chemistry and be integrated into other related subjects in secondary schools.

Keywords: teaching strategies, e-learning, blended learning strategy, achievement, chemistry

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Introduction

Advances in technology have seen institutions of higher learning consider more attractive and successful models of teaching and learning (Howard et al., 2014). The quest to deliver learning experiences that address societal needs have seen institutions of higher learning offering more online and blended learning (sometimes referred to as hybrid) courses that utilize computer technology and compel more active participation of students (Luna & Winters, 2017). This represents a shift in education from teacher centred instructional strategies (e.g., lecturing) to learner centred instructional strategies (eg, active student engagement) (McLaughlin et al., 2015). As a pedagogical approach, blended learning involves the integration of online learning in a computer mediated environment with face-to-face learning, with the notion being that the elements work together as a single, integrated course. As further noted by Sarabadani & Berenjian (2017), the blended learning approach entails the provision of fundamental course content online for the students to be learned prior to their classroom attendance. The majority of the classroom lecture time will then be devoted to active learning practices and discussions (Gülbahar, 2008). The benefits of blended learning derived from both online-learning and face-to-face teaching environment provides a platform for improved student out-

comes and the acquisition of competencies that may not be achievable otherwise (Gray & Tobin, 2010). In addition to improved student outcomes, blended learning also enhances the development of critical-thinking skills and increases student engagement with the learning process (Persky & McLaughlin, 2017).

Blended learning fits with the constructivist approach to learning, which recognizes the role of the learner in constructing knowledge rather than receiving knowledge passively from the teacher (Lee et al., 2016). This approach entails the provision of a learning environment that is conducive to self-directed learning that fits with the learner's own experience and cognitive ability (Condie & Livingston, 2007). By integrating both on-line and face to face learning, students are provided opportunities to experience the curriculum in a variety of ways; thereby, constructing knowledge in a way that best meets their needs (Shroff & Vogel, 2009).

The provision of learning opportunities that allow students to construct their meaning is a practice based on the theory of constructivism. In the constructivist perspective, knowledge is not seen as a finite and defined body of facts and concepts, but as ever-evolving and dynamically constructed by the learner in interaction with others and with the environment (McLaughlin et al., 2015).In practical terms, the constructivist view of learning fosters use of active learning to absorb students in the learning process through meaningful activities that prompt them to reflect on ideas, self-assess content mastery, gather information, and apply it to solving problems(Michael, 2006; Prince, 2004).

Consistent with blended learning is flipping the classroom sometimes called flipped pedagogy. The flipped classroom (also called reverse, inverse, or backwards classroom) is a pedagogical approach in which basic concepts are provided to students for pre-class learning so that class time can apply and build upon those basic concepts (Persky & McLaughlin, 2017). Providing students with key foundational content prior to class enables students to engage

with content at their own pace, controlling when and how much content they view. Since the students will have already been exposed to the content, it allows for easier application of content while the teacher is present as opposed to the students initially being introduced to the content through a face-to-face lecture (Heinerichs et al., 2016).

In their argument Latchem & Jung (2010) highlight that the flipped classroom helps to motivate student learning and make the purposes of learning more explicit and clear to the learner. By blending e-learning with conventional classroom learning, students could "take advantage of much of the flexibility and convenience of an online course while retaining the benefits of the face-to-face classroom experience (Heinerichs et al., 2016). Moreover, blending the two different learning modes is highly flexible and can be tailored to the specific needs of different learning or subject contexts such that learners can take control and personalize their learning (Condie & Livingston, 2007) in an environment also oriented toward developing their self-regulation and metacognition.

There is limited research to date on how secondary school students construct knowledge using different elements of the blended learning environment as they learn chemistry. The goal of this study is to examine whether blended learning employing a flipped pedagogical approach that is centred on active learning, as compared to traditional lecture, in a rural O' level chemistry class is a more effective learning experience in promoting learning and improving student outcomes. The study attempted to answer the following research question: (1) does blended learning affect the educational performance rural secondary school students in chemistry; (2) what are the views of students on blending learning and its implementation.

The study hypothesised that:

H0: there is no significant difference in the performance of students taught using blended learning technique and conventional method in chemistry.

Methodology

The study was conducted in rural secondary schools in Gweru district. It employed a quasi-experimental design with the pre-test, post-test control group design. The current study involved two groups, one experimental group and one control group. Both the groups were given an achievement pre-test of their baseline knowledge and understanding of the electrochemistry unit content. The experimental group was latter exposed to the blended learning teaching experience consisting of a combination of the face-to-face classes, with access to an e-learning environment while the control group received the usual teaching, which was a face-to-face approach. Differences between the two groups were then identified in terms of achievement.

The population of this study was made up of all rural secondary schools in Gweru district. Two secondary schools with internet facilities were purposively selected and randomly assigned to experimental and control groups. The experimental (blended learning) group had an intact class of 35 students while the control (conventional instruction) group had an intact class of 32 students, making a total of 67 students.

The instrument used in this study for data collection was the Electrochemistry Achievement Test (EAT). The internal consistency of the instrument was obtained as 0.81 using the Test Retest method to establish the reliability. Analysis of Covariance (ANCOVA) was used to test all hypotheses formulated at the 0.05 level of significance. The data were run with a Statistical Package For Social Sciences (SPSS 21.0) windows version. A questionnaire was administered to students at the end of the intervention to determine the views of students on blended learning and its implementation and its effectiveness in their learning. The questionnaire had questions on perceptions in

Section A where responses to these questions were based on a Likert scale (1 strongly disagree to 5 strongly agree). Section B had open ended questions.

Educational materials about electrochemistry in two classes (32 students) were presented as a lecture to the students by the researcher for 2 weeks during six 30-minute weekly sessions. Educational contents were simply presented through PowerPoint slides at each session. In the other group (35 students), educational materials were presented as a combination of lectures and e-learning method. In this group, in addition to teaching the content through lecture, other materials were uploaded onto computers in the computer lab as well as via e-mail. The students were also able to share their comments and questions on a what's app forum with the instructor and other students.

Results

Does blended learning affect the educational performance rural secondary school students in chemistry?

The independent sample t-test was used to measure the mean score difference between achievement scores of the control and the treatment group on pre-test. Examination of Table 1 shows that there is no significant difference between the achievement pre-test scores of the experimental and control group. It means that both groups were on equal level of achievement before intervention. Thus the two groups were suitable for this study.

Table 1. Independent-sample t-test comparing means of students' achievement pre-test scores

Group	*N*	*mean*	*St dev*	*df*	*t*	*P*
Blended learning	35	38.95	3.32	65	0.47	0.672
Conventional instruction	32	38.58	3.13			

Independent-sample t-test was conducted in comparing the chemistry achievements post test scores of the two groups. The post-test means scores of students' chemistry achievement for the experimental group taught by the blended learning approach was 74.98 (sd = 2.98), and that for the control group taught by the conventional teaching it was 48.84 (sd = 2.66). Table 2 shows that the mean for the experimental group was greater than that for the control group. The difference between these two post-test mean scores was significant $t(65) = 38.13$, $p < 0.05$ in favour of the experimental group, which revealed that the performance of experimental group was significantly better than control group. As such, blended learning positively affects students' chemistry achievement.

Table 2. Independent-sample t-test comparing means of students' achievement post test scores

Group	***N***	***mean***	***St dev***	***df***	***t***	***P***
Blended learning	35	74.98	2.98	65	38.13	0.000
Conventional instruction	32	48.84	2.66			

To test the hypothesis of no significant difference in the performance of students taught using blended learning technique and conventional method in chemistry, the covariance analysis technique was used. Table 3 indicates the results of covariance analysis of the impact of using blended learning on the educational performance of students.

The analysis of covariance presented in Table 3 shows that there is a significant difference in the performance of students taught with blended learning technique. Therefore, the hypothesis was rejected. Students taught with the blended learning method performed better than those taught with the conventional instruction method.

Table 3. Result of ANCOVA analysis of the difference in the academic performance of students taught chemistry using blended learning strategy and those taught using conventional method

Source	Type III Sum of Squares	df	Mean Square	F	Sig
Corrected model	5821.112	2	1961.107	43.204	.000
Intercept	10427.021	1	10427.021	238.115	.000
Pretest	2462.115	1	2462.115	52.317	.000
Main Effect	894.867	1	894.867	20.223	.000
Error	2993.402	64	42.324		
Total	266230.000	67			
Correted total	8365.318	66			

What are the views of students on blending learning and its implementation?

The results of the questionnaire show that 91% of the respondents indicated that they are satisfied with the different delivery methods (BL) used in teaching the topic and the overall results are given in Table 4. The average mean for each item is between 3.57 and 4.47 out of 5. The results imply that the use of BL in teaching this topic has positive feedback on students' learning. According to the survey, the majority learners reacted positively to the blended learning initiatives applied in teaching the topic as shown in table 4 with overall satisfaction mean score of 4.05.

As a result of the blended learning activities organised, learners were able to pace their own learning as they had flexible access to the learning resources they required. Since most students do not ask questions in class most probably due to anxiety, the use of blended learning was helpful in that it gave the learners an opportunity to access learning resources, ask questions and receive online feedback easily. Furthermore, learners also concurred that the blended learning initiatives had also improved their accessibility and flexibility

in their learning. This had encouraged learners to learn independently and helped to improve their understanding on the topic. The findings also suggest that generally learners agreed that blended learning activities could motivate them in learning. Moreover, the findings revealed that the activities designed for blended learning were interesting and that learners had the resources and technical ability to cope with online materials and activities. Although most learners had positive experience with blended learning, some were concerned that this approach will increase their preparation time for class. Generally, they still prefer to have teachers delivering information to them directly rather than a flipped classroom model. This is evidenced by the lowest mean score 3.48 obtained in the survey.

Table 4. Students' views on blended learning environment

items	**mean**	**std dev**
Topic easy to learn using blended learning compared to text-book	4.00	0.82
Motivation	3.98	0.72
Self-directed learning	4.42	0.77
Accessibility and flexibility	4.30	0.68
Finding chemistry Content interesting	4.35	0.80
Technical ability	3.93	0.66
Resources (technological tools and access to study)	3.65	0.82
Preparation time	3.97	0.79
Preferences over face-to face instruction	3.48	0.76
Blended learning improves ability to analyse	3.96	0.78
Improves understanding of learning material	4.47	0.72
Satisfaction with Blended Learning Activities	4.05	0.66

Discussion

This examination of the relative effect of using a blended versus a "traditional" approach to delivering course content in an ordinary-level chemistry class revealed that the performance of students taught using blended learning was higher than those taught using the traditional approach. The finding of the study showed that students gained better understanding of electrochemistry

concepts using blended learning technique than with the conventional teaching strategy considering the fact that they had high mean achievement score as compared to their counterparts. This showed that blended learning facilitated students' understanding of the concept of electrochemistry.

This finding is in agreement with the findings of Kiviniemi (2014) who noted that implementing the blended learning approach leads to an increase in student learning as assessed by exam performance and overall course point totals and if well implemented blended learning approaches may have strong potential for improving student learning outcomes in health sciences courses. The finding is also in agreement with Sarabadani & Berenjian (2017) who demonstrated the positive role of blended learning and computer mediated teaching environment on student engagement and academic performance. Bridges et al. (2014) also found that the implementation of a blended learning teaching technique would improve students' learning.

With respect to the views of the blended learning and its implementation, participants of this study perceived that presenting the course in blended format made it easy to follow and enhanced their learning. The content presented was well illustrated and easy to understand. The findings are consistent with the literature reporting that students show greater satisfaction in blended courses than in traditional lectures (Castle & McGuire, 2010).

Interest must be present in the classroom. The satisfaction of an individual's intellectual and personal needs is very critical and is fostered by providing an individual with a variety of educational opportunities that promote his or her involvement. The blended learning environment created in this study was found to help deepen student interest in the subject matter and encourage them to learn. This finding is in agreement with Shantakumari & Sajith (2015) who reported that that when learners are provided with multiple formats of learning materials in blended learning environment it could sustain the students' interest and thereby promote their cognitive engagement

The results of the present study on the application of the blended learning method in a unit of the Ordinary level chemistry curriculum was found to be a promising learning method to enhance the students learning desire and improving their learning outcomes.

Conclusion

Based on the research findings, it can be concluded that implementing blended learning has a significant role in academic performance of students and its application in schools could cause enthusiasm and improvement in students' academic performance and its use should be encouraged in schools. Since blended learning is becoming a predominant classroom component in many institutions of education to actively engage students in the learning process. There is therefore need of integrating online courses with face to face classroom settings in improving student's active learning in the secondary school.

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