Effect of Blended Learning using the Station Rotation Model towards Students' Achievement in Learning Chemistry

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ABSTRACT

Modern educational technology is continuously evolving due to the widespread access to internet and advancements in information and communication technology (ICT). Modern educational technology can enhance student-teacher development in learning and solve educational problems by using innovative teaching approaches such as blended learning. This research investigated the effectiveness of the blended learning using station rotation model towards the students' achievement in learning chemistry. This study employed a quantitative research design, utilizing pre-experimental use of one-group pre and post-test design. The sample consisted of 17 Form 4 students who were taking chemistry subject from one school in Johor Bahru. The pre- and post-test were developed to assess students' achievement in learning chemistry. The findings showed there are significance differences in students' achievement after the intervention using Blended Learning type of Station Rotation Model. This shows that there is a positive influence on students after the engaged learning activities. In conclusion, it is expected that this study can assist high school teachers in designing effective blended learning in learning chemistry.

Keywords
Blended Learning, Station Rotation Model, Chemistry, Achievement

Introduction

As reported by Buran & Evseeva (2015), modern educational technology has become a part of the educational system in most countries all over the world. It is undeniable that technology is an effective delivery method and plays an important role in education (Bingimlas, 2009; Hubber & Loong, 2013). Modern educational technology is a revolution due to the widespread reach of the internet along with the information and communication technology (ICT) (Awadh & Higgins, 2013; González et al., 2015; Qingsong, 2012; Serin, 2011). Previous researches indicate that ICT was widely used in education even in these times (Abdel hamid et al., 2013; Ploetzner et al., 2015; Qingsong, 2012; Serin, 2011). By definition, ICT refers to any application that involves the usage of communication devices; this includes radio, television, cellular phone, computer, and a variety of related services such as video conferencing and online learning (Kumar, 2008). The utilization of ICT makes teaching more effective and interesting (Kumar, 2008).

From the perspective of ICT, education can be categorized into three main categories, which are, e-learning, blended learning and distance learning (Kumar, 2008). Among them, blended learning has gained many spotlights in the education sector (Deperlioglu & Kose, 2010; Siew-Eng & Muuk, 2015). Matukhin & Zhitkova (2015) claimed that blended learning is one of the potential applications of ICT in the education sector. Blended learning is specified as the combination of various instructional media, delivery methods and different kinds of pedagogical approaches (Driscoll, 2002; Garrison & Kanuka, 2004). The core of blended learning is the combination of both, offline traditional face-to-face (F2F) learning and online learning (Allen et al., 2007; Bliuc et al., 2007; Garrison & Kanuka, 2004; Kim & Bonk, 2008; Rovai & Jordan, 2004). It is evidently a better move to combine the advantages of offline

traditional F2F learning and online learning in a blended learning environment (Akkoyunlu & Soylu, 2008; Farahiza, 2010; Wang et al., 2009). The blended learning approach is reportedly one of the most effective strategies to implement without ignoring the teachers' role in the classroom.

It is reported that blended learning, if implemented well, is very effective (Verstelle, 2017) because, a teacher does not hold a passive role, but instead acts as a mentor or a coach who gives personalized instructions. Online learning itself cannot solely replace the teacher's role of instructing and teaching students (Verstelle, 2017). More importantly, blended learning can create a Community of Inquiry (CoI) which consists of three presences which are social presence, cognitive presence and teaching presence (Akyol & Garrison, 2010; Akyol et al., 2011). However, for many studies, creating CoI in blended learning was found to be very challenging (Akyol & Garrison, 2009; Colachico, 2007).

Background of The Study

Blended Learning as an Innovative Way to Maximize the Impact of Learning

Garrison & Kanuka (2004) stated that in their definition, blended learning can be both simple and complex. Blended learning is simply the combination of offline traditional F2F learning and online learning (Garrison & Kanuka, 2004). It is supported by Matukhin et al., (2017), who define blended learning as the combination of the benefits of both offline traditional F2F learning and online learning. The complicated part as noted by researches is, how the teachers should integrate the strengths of offline traditional F2F learning and online learning effectively, despite the challenges in their implementation (Garrison & Kanuka, 2004).

One of the main challenges is to combine offline traditional F2F learning and online learning Garrison & Vaughans (2013) despite its challenges to implement. Another challenge is the ability of teachers to integrate and apply blended learning in classrooms (Garrison & Kanuka, 2004). That is why teachers need appropriate guidance on how to design a blended learning classroom. Buran & Evseeva (2015) stated that blended learning is not only about the mix and matches of the right technologies in lessons. It is essentially about redesigning the teaching and learning environment (Garrison & Kanuka, 2004). It should be noted that, only well-prepared teachers will be able to create a successful blended learning classroom. According to Buran & Evseeva (2015), by understanding blended learning, teachers will know how to choose the right materials for the classroom. Blended learning gives flexibility. Some variations include personalized learning, social interaction and direct content learning in the classroom.

In blended learning, the combination of both the learning approaches helps to extend communication via different ways of delivering; which creates opportunities to explore more thoughtful and evident arguments (Vaughan & Garrison, 2005). Even though the preparation of the learning materials takes a significant amount of time; however, it helps teachers to optimize the time and quality in the teaching and learning process (Buran & Evseeva, 2015). An additional benefit is that teachers would be able to keep themselves updated with the latest requirements in the education system. In short, blended learning would be able to assist teachers in solving difficulties in learning by combining both offline traditional F2F learning and online learning.

According to Akyol & Garrison (2008), blended learning was believed to create the community of inquiry (CoI). CoI was a guideline framework that learning occurs in the community through intersection of three core presence, which were social, cognitive and teaching presence (Akyol et al., 2009). However, they also mentioned that it is very challenging to design an effective learning community (Akyol & Garrison, 2009; Colachico, 2007). It is because only well-prepared teachers will be able to create successful blended learning (Garrison & Kanuka, 2004) and lessons need to be planned well to create opportunities for interaction (Garrison & Vaughans, 2008; Akyol & Garrison, 2009).

Blended Learning Helps Educators Solve Difficulties of Learning Among Students

Students feel bored in the classroom when a teacher-centered approach is implemented (Farahiza, 2010; Hendon, 2013). Other than that, it is quite worrying that some students fail to acquire the basic conceptual understanding,

problem-solving and thinking skills, and hence face difficulties in analyzing abstract processes when the offline traditional F2F learning is applied in the teaching and learning process (Hendon, 2013; Seth & Nooridayu, 2010). Students need to understand the concepts in learning rather than just following traditional rote-learning methods (Farahiza, 2010; Zaleha et al., 2014). It makes students less creative, as they end up only memorizing the notes (Farahiza, 2010).

As a result, the National Research Council (2000) stated that, to improve science subjects, a teacher needs to have a high understanding of the content and experiment skills to give effective instructions. It is very crucial to make sure teachers have enough knowledge and mastery to teach science subjects. Therefore, teachers need to apply active learning strategies to help students acquire knowledge. According to Nusir et al., (2013), positive effects will be achieved by using active learning strategies such as blended learning.

Blended learning will help teachers solve the challenges faced in offline traditional F2F learning or online classroom setting among the students (Akyol et al., 2009; Garrison & Kanuka, 2004). Blended learning is not a replacement for offline traditional F2F learning. In fact, blended learning is a useful alternative option when some subjects are not applicable to F2F methods. The National Research Council (2007) reported that teachers are encouraged to find effective ways to help students think deeper when learning. Using technology, Siew-Eng & Muuk (2015) suggested that teachers can combine various parts of their lessons so as to construct the best learning model. Wang et al., (2009) noted that the teachers may have different reasons to blend their lessons.

There are numerous models used in a blended learning environment, some of which are the rotation model, flex model, self-blend model and enriched virtual model (Mohamed Amin et al., 2014; Staker & Horn, 2012). Out of the different models, this research chose the station rotation model in the blended learning environment. The station rotation model allows students to rotate between offline traditional F2F learning and online learning at various stations throughout a classroom or a set of classrooms (Kafer, 2014). Students are given chances to experience rotation which is implemented entirely within the classroom setting (Powell et al., 2015; Staker & Horn, 2012). However, some researchers stated that students also can experience the rotation model within a contained classroom or a group of classrooms (Powell et al., 2015). Within this model, the teacher can set up several stations in the classroom for students to rotate through.

In this study, the station rotation model is used instead of other models due to some reasons. One of the reasons, students rotated in fixed schedule in or outside the classroom according to teacher's desired with the teacher supervision in the classroom (Powell et al., 2015; Staker & Horn, 2012; Verstelle, 2017). Then, the teacher sits at one station to give direct instruction (Kivunja et al., 2006). Other than that, teachers have more flexibility to work with students Truitt (2016), and it lets teachers to have more time with students (Kivunja et al., 2006). The task in the station can also be done individually, in groups or with teacher, and each station consists of different activities, even though it has the same learning objectives (Kivunja et al., 2006). Verstelle (2017) believed that teachers have already mastered the act of rotating between different kinds of learning activities, but what would it became blended learning is the involvement in online learning. The most effective learning community where it allows teachers to spend more time working individually or in small groups with the students. Tucker (2012) suggested one strategy for teacher is by implementing a station rotation model in the blended learning classroom. She also stated that teacher does not necessarily implement station rotation model for each lesson, but this is an easy ways to get advantages from offline traditional F2F learning and online learning to create small learning community.

In addition, Kuo et al., (2014) stated that there are no best model to follow. However, different models may produce different learning experiences among students. It is supported by Moskal et al., (2013) saying that there is no single best model to achieve success. They also mentioned, there is no "one size fits all" approach to make sure the learning successful neither fast result nor slow result, continuous effort still one of the most important part to produce meaningful learning for students.

Applying Blended Learning in Learning Chemistry

Angell et al., (2004) reported that students think science subjects are interesting, but they find them very difficult, and the subjects require high workloads. While the subjects are formal in nature, the theories manage to explain real-world phenomena. In contrast, some researchers have noticed via their study that students think the subject is too difficult, unexciting and unrelated (Aschbacher et al., 2013; Hamidon et al., 2010). Students feel that it is difficult to

learn because it is not just reading the facts but also requires one to possess scientific skills (Hamidon et al., 2010). According to a study, some of the students are interested, but the interest drops suddenly when the topics become growingly difficult (Aschbacher et al., 2013; Fatin et al., 2012). However, the teachers cannot help much to inspire students in learning and to guide them into their careers.

According to the report of science and mathematics in TIMSS (2007), 20% of Malaysian students failed to reach the minimum standard (Osman & Sukor, 2013; Ruddock et al., 2007). This result showed that education in Malaysia is unsuccessful in improving students' academic achievements. Consequently, it is vital to make a positive learning environment in the classroom where students can use scientific knowledge to make sense of the natural world (Demircioglu et al., 2005). The low performance in science subjects in TIMSS (2007) reflects the incompleteness of scientific knowledge among students since young (Osman & Sukor, 2013; Ruddock et al., 2007). The science assessment framework is fully detailed in the TIMSS 2007 Assessment Frameworks based on two dimensions: cognitive and content (Ruddock et al., 2007). The content dimensions listed are biology, chemistry, physics and earth science. The results showed that the distribution of score points in TIMSS (2007) chemistry assessment for the content dimension was only 19%, with a scientific enquiry score of 24 points (Ruddock et al., 2007).

It is identified that chemistry is one of the most challenging subjects in secondary schools because they have a lot of theory, abstract and unseen (Dalacosta et al., 2009; Demircioglu et al., 2005; Hamidon et al., 2010). One of the important topics in chemistry is salt. Seçken (2010) stated that students have difficulties to unite and relate the knowledge about salt in different places and times. However, according to Seçken (2010), there is no specific topic of salt in high school or university level. Salts are indirectly related to many things such as non-metal, semi-metal, metal, chemical reactions, acid and base and much else. Two of these fundamental concepts in chemistry are acids and bases which also related to salts topic (Demircioglu et al., 2005). It is supported by Demircioglu et al., (2005), these concepts are linked to many other chemistry concepts, such as the chemical equilibrium, nature of matter, stoichiometry, chemical reaction, and solutions. A test was made for the students to capture areas of the subject which they might find difficult, and it was found that the students had difficulties on the following topics: dissociation and ionization, definition of Brønsted-Lowry acids and bases, ionic equilibria, neutralization, pH, buffer solutions, and degree of ionization (Demircioglu et al., 2005). All of these topics need a strong basic of knowledge regarding salt topic. Unfortunately, according to the report, many students have difficulties and misconceptions regarding this topic.

To support, one of the aspects that contributed to the low achievement in science subjects was students' misconceptions (Osman & Sukor, 2013; Ruddock et al., 2007). Research on students' understanding of chemistry concepts has noticed that students have lots misconceptions especially in salt topic (Demircioglu et al., 2005). The students sometimes confused when learning basic knowledge and have difficulties in understanding that some concepts are highly related to each other. Misconceptions were always happening among students, scientists and philosophers in the past. The scientists have ever developed their own concepts based on their experiments. These ideas without prior knowledge cannot be considered as incorrect, but can be defined as original or pre-scientific ideas, students' preconceptions or alternative ideas and pre-concepts (Barke et al., 2009). It is supported by Mutlu & Sesen (2015), some students have their own opinions and insufficient interpretations of the scientific phenomena from their experiment in class and own experiences especially in salt topic. Unfortunately, students' opinions on science phenomena differ from scientific acceptable concept and cause learning difficulty to understand the concept (Damanhuri et al., 2016). In school, these misconceptions cannot due to students only, but mainly due to unsuitable teaching approaches and materials or called school-made misconceptions (Barke et al., 2009). That is why appropriate learning strategies such as blended learning may help students to understand science concepts especially salt topic.

In conclusion, blended learning using station rotation model could assist teachers to solve difficulties faced by students, especially in chemistry subjects (Farahiza, 2010). Blended learning helps to design the classroom so that it integrates best element of both offline traditional F2F learning and online learning. While, station rotation model is used to help teachers have more flexibility to work in or outside the classroom with students individually, in groups or with a teacher.

Research Methodology

Research Design

This study employed a quantitative approach using a pre-experimental design which involved one group pre and post-test design. This study was conducted in one of the secondary schools in Johor Bahru, involving 17, Form 4 students. The school was selected by purposive sampling. The researcher chose a school which had a sufficient number of Form 4 students who were studying Chemistry. Other than that, the selected school needed to have a computer lab and internet connectivity in order to be sampled as an experimental group for this study.

Research Procedure

The overall research procedure consisted of 3 phases. Phase 1 consisted of Requirement Analysis and Developing Instrument. After that, Phase 2 was the Implementation of the Station Rotation Model for the process of teaching and learning chemistry. The pre-test was given one week before the intervention (week 1) and the post-test was distributed one week after the intervention (week 6). The last phase was Phase 3 which was, Data Analysis.

Phase 1: Requirement Analysis and Developing Instrument

In this phase, the researcher analysed the topic that students faced difficulties learning. Then, the researcher designed the Schoology that contained all the learning content of that topic. For this purpose, the researcher used a learning management system (LMS) website called Schoology to design the online learning activities during the intervention. The researcher used Schoology as a platform of online learning in (Station B): online learning. Other instruments were developed such as pre-test and post-test assessments. After all the instruments were developed, a pilot study had been carried out to obtain the validity and reliability of the instruments.

Phase 2: Implementation of Blended Learning Approach (Station Rotation Model)

In phase 2, the implementation of the station rotation model was categorised into three categories, which were, before intervention, during intervention and after intervention. The implementation of this model was done in a month, not including the pre-test and post-test assessments. The pre-test assessment was given one week before the intervention (week 1) and post-test assessments were distributed a week after the intervention (weak 6). These three categorizations will be discussed in detail below.

Before Intervention

Before the intervention, the students needed to sign up and register an account on Schoology. The researcher approved the students first before they could enter the course. Then, they were given a unique password each, in order to access the learning materials.

At first, the students were given the pre-test assessment to evaluate their pre-knowledge on the topic of salts. Salts is the chosen topic because students are known to have learning difficulties and misconceptions when learning this topic (Damanhuri et al., 2016; Seçken, 2010). The question papers had two sections, namely section A and B. Section A consisted of ten objective-type questions and section B had one structured questions. The duration between pre-test assessment and the implementation of the blended learning approach was one week. The students needed to answer the pre-test assessment in one hour.

During Intervention

During the intervention, students had to rotate between the fixed schedules according to the researcher. This intervention was conducted in four weeks. Each week, students were required to rotate between different stations which were, offline traditional F2F learning (week 2 and week 4) and online learning (week 3 and week 5). The flow of this research is shown in Figure 1. Therefore, students rotated through each station to complete the learning process.

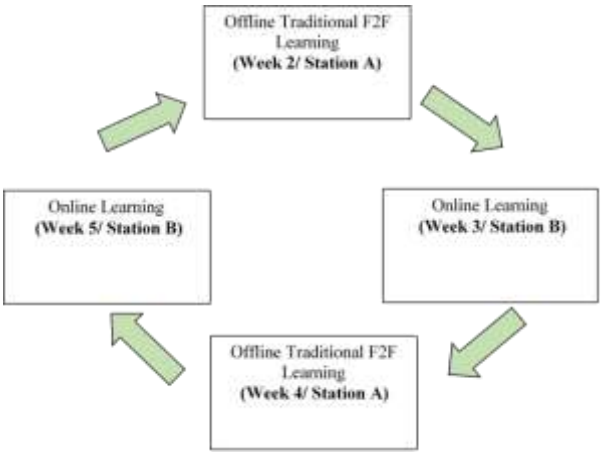

Figure 1. Station Rotation Model

After Intervention

One week after the intervention, students were given a post-test assessment based on the salts topic. The questions were identical to the pre-test assessment; however, the sequence of the questions was shuffled. They were given one hour to answer all the questions.

Phase 3: Data Analysis

The researcher analysed the frequency, percentage, descriptive statistic and inferential statistic for the pre-test and post-test assessments.

Results and Discussions

To measure the achievement of students during blended learning classroom, pre-test and post-test assessments were used as instruments. In pre-test and post-test assessments, their descriptive and inferential analysis were both analysed using SPSS software. Analysis on the students' achievements can be seen by comparing the achievement scores obtained by students before and after the intervention in the blended learning classroom. Table 1 shows the descriptive analysis for pre-test and post-test assessments.

Table 1. Descriptive Analysis for Pre-test and Post-test Assessments

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test	17	35	80	62.65	12.762
Post-test	17	40	85	69.41	14.457

From the table, it can be seen that students' achievements after intervention was at mean = 69.41, while before the intervention it was at mean = 62.65. It can be concluded that the mean of achievement after post-test assessment was

higher than pre-test assessment. A Wilcoxon Signed Rank was used to analysed the pre and post- test. Table 2 showed the results obtained of rank test for pre-test and post-test assessments using SPSS.

For descriptive analysis, the students' achievement score after the intervention was at a mean of 69.41, while before the intervention, it was at a mean of 62.65. It can be seen here that the mean achievement in post-test assessments was higher compared to pre-test assessments. Smith & Suzuki (2015) reported, students in the treatment group showed higher scores in Algebra II than the control group. 80 % students preferred blended learning (screen capture technology) over offline traditional F2F learning (live lecturers) when learning math. During offline traditional F2F learning (live lecture), the mean achievement in pre-test assessment was 26.46 and in post-test assessment was 70.63. While, during blended learning (screen capture technology), the mean achievement in pre-test assessment was 20.47 and in post-test assessments was 81.56. Obviously, it showed students preferred blended learning over offline traditional F2F learning (Smith & Suzuki, 2015).

Table 2. Rank Test of Pre-test and Post-test Assessments

Pre-test and post-test	N	Mean Rank	Sum of Ranks
Negative Ranks	4^a	6.75	27.00
Positive Ranks	12^b	9.08	109.00
Ties	1^c		
Total	17		

a. Post-test < Pre-test
b. Post-test > Pre-test
c. Post-test = Pre-test

From the table above, it can be concluded that, 4 students were at negative ranks with mean 6.75, and 12 students at positive ranks with mean 9.08. Overall, the mean score before and after the intervention only had high differences with each other. Table 3 shows the Wilcoxon signed-rank test for pre-test and post-test assessments.

Table 3. Wilcoxon Signed-Rank test for Pre-test and Post-test Assessments

	Posttest – Pretest
Z	-2.143^b
Asymp. Sig. (2-tailed)	.032
Exact Sig. (2-tailed)	.030
Exact Sig. (1-tailed)	.015
Point Probability	.002

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Based on Table 3, there was significant difference between pre-test and post-test assessments before and after the intervention ($Z = - 2.143$, $p < .05$). It was concluded that there was significant difference between pre-test and post-test assessments before and after the intervention in this research. To support, many researchers reported there was significance difference of blended learning classroom on students' achievements (Alsalhi et al., 2019; Arina, 2018; Ceylan, 2017; Eddeen et al., 2014; Khader, 2016; Oweis, 2018; Salajegheh et al., 2016; Utami, 2018).

Therefore, the blended learning using station rotation model influence students' achievements in positive ways. Even though the achievements of students were higher after the intervention, many students got problems and struggle to solve all the questions given in time provided. It was due to the fact that the salt topic was a very difficult topic and as such, misconceptions among students were hard to prevent; it was also related to many other topics such as matter, acids and base, oxidation, chemical equilibrium and others. Students were very familiar with some examples of salt. Seçken (2010) believed that there were difficulties and misconceptions regarding the salt topic among students.

Conclusion, Limitations and Future Studies

In conclusion, the blended learning classroom using station rotation model helps students to learn with fun in learning Chemistry. There are significant differences towards students' achievements and that post-test assessment are higher than pre-test assessment results. Additionally, the term 'blended learning' already existed a long time ago. However, how the teachers blend and design their classrooms becomes an issue in today's education landscape. The proposed design on how to teach the salt topic in Chemistry will give new knowledge and guidelines to all teachers in education and all researchers in educational technology.

There are some challenges and limitations in the implementation of this method in developing countries, which should be considered in future studies. Firstly, the participants involved in this study were not from random sampling (purposive sampling). The participants were Form 4 students who were taking the chemistry subject. The findings of this study had to be interpreted carefully because these findings cannot be generalized to other populations. Moreover, it may also lead to different results regarding the level of critical thinking of the students when other subjects are investigated.

Secondly, this study was done in natural settings, and as such other factors may influence the learning of students during the treatment. The students may use other learning materials to increase the knowledge and content of the subject such as their own notes rather than discussions on Schoology. The instructors do not have control over these situations. However, the instructor was monitored based on a blended learning classroom using offline traditional F2F learning and online learning.

Thirdly, in this blended learning classroom, students had limited time to finish all their tasks. This was due to the fact that, in blended learning, students had to do all the tasks in the classroom. More classrooms were needed to help students complete the tasks, especially the online learning tasks. Students needed more facilitation from teachers so that they would not get distracted and start browsing other unnecessary websites. More research is required to be done to learn the salt topic in the Chemistry subject, because this topic is quite difficult to score.

For suggestions, it is suggested that future studies be done in different settings and for different subjects, to determine whether the same results are obtained in pre-test and post-test assessments. This study can also be expanded and used for other subjects such as mathematics, languages and others. This research is only limited to the salt topic in the chemistry subject. As a result, it is really hard to generalize the findings for all the subjects. The blended learning classroom theory suggests that this treatment should be implemented for at least a full semester in future studies, to observe findings for a long period of time according to each presence. It is also to determine whether the same results would be obtained if the period of time was different. For achieving better results for projects, the time period should be lengthened.

Collaboration with other teachers could be carried out to design a better blended learning classroom which would lead to students' high performances in assessments. Different teachers may have different methods to design good teaching and learning process, especially on the salt topic. Teachers can also make a collaboration with some of the salt factories to explain the concept of salt easily. Other than that, teachers can suggest field trips to salt factories or beaches, so that the students can feel and observe the real phenomena, before explaining the concepts. Collaboration with other universities could also be carried out which could lead to different results and interactions.

The present study only reported on the pre-test and post-test assessments. It is recommended that future studies assess discussions on online posting for online learning. Besides that, other types of more efficient, usable social media tools could be used. The researchers can also use any other social media tools as per convenience, such as WhatsApp or Telegram.

Lastly, research should be conducted using bigger samples and including different student achievements. If the findings show significant differences, the generalization can be made to make teaching and learning processes more organized. Students also have a lack of IT skills and hence need more practice to use all the learning tools in Schoology. Instructors should prepare handouts or pictures to help students by making it easier for them to use Schoology.

All the problems and challenges mentioned herein are expected to help other researchers who want to do this kind of research, so that they can consider all these things in future. From research findings, the researcher hopes that this intervention will be spread and implemented to all schools, especially to secondary school. Besides, this intervention can be a guideline to all teachers to create better teaching and learning tools in future, so that the student achievements become higher, they learn in a fun environment and lastly, they get to create all presences in the community of inquiry (CoI).

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