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Lessons Learned and Strategies Used While Teaching Core-Curriculum Science Courses To English Language Learners At A Middle Eastern University.

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ABSTRACT

This article describes a reflection on teaching strategies used and lessons learned by two western, expatriate university professors teaching core-curriculum science courses at a middle eastern university, where the native language is Arabic and the language of instruction is English. Descriptions of effective strategies used and the benefits and limitations of each are provided. No rigorous quantitative data were collected on the efficacy of the interventions. However, the authors did note a marked increase in student engagement and active learning, critical thinking, student self-confidence, science self-efficacy and student performance over five semesters. As more of the pedagogical techniques were employed instructors noticed an improvement in instructor evaluation scores and an increase in positive student comments.

Keywords: Science Teaching Strategies; Arabic ELLs; Science Education; Mind Maps; Science Drawings.

INTRODUCTION

In Fall 2012 I was employed to teach core-curriculum science courses at a local university in the United Arab Emirates (UAE). In FALL 2013 my colleague joined the faculty in the same department. We had both previously taught at the same university and between us had over 30 years of science teaching experience.

In our home country the official language is English, although there is a dialect (called Patois), which is spoken by the majority of the population. Patois has a vocabulary that is largely English but differs enough in the phonology, morphology and syntax to be unintelligible to non-local English listeners (Craig, 1983). It is not uncommon to find students incorporating Patois in the Standard English used for academic writing and both my colleague and I were accustomed to making accommodations for this. However, in our new environment we were teaching native Arabic students.

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The Arabic language has a different phonology, grammar and writing system from English. For the first time we realized how much the expression and assessment of scientific knowledge depended on language literacy (Shea, Shanahan, Gomez-Zwiep, & Straits, 2012; Bradley & Bradley, 2004).

Students at our current university in the UAE are primarily local with a minority of students from other Arabic countries. The university has two campuses. The primary language of instruction is English and faculty members are drawn from over fifty different nationalities. In the Science section of the University College (this college is responsible for core curriculum courses) faculty in Abu Dhabi alone are from six different nationalities. This places students in the position of international students as described by Arkoudis (2006) and cited by Jewels and Albon (2012), though they are studying at a Federal Institution. Teaching English Language Learners (ELLs) is always challenging and this is also true for Western English-speaking faculty teaching in non-English speaking environments (Jewels & Albon, 2012). The situation becomes increasingly complicated when faculty are required to teach science to a majority of non-science majors. There is the added dimension of stimulating interest, increasing student engagement and encouraging students towards intrinsic motivation.

The major objectives of core-curriculum science courses are to encourage critical thinking, develop cognitive maturity and increase student awareness of global scientific issues, especially those related to the environment. Having previously been advanced level (A' Level) examiners, in a system similar to that of the British, we thought using conventional assessments and known teaching strategies such as anthropomorphism, story-telling and problem papers, would stimulate and encourage critical thinking among students. It soon became apparent this was not the case. The results of my first quiz, which I thought was quite simple, were disastrous. Students failed to pick up nuances of the language, cues in the questions and were totally thrown by stimuli. They therefore had no access to context clues geared to thought stimulation and information retrieval. Assessment results and general observations revealed low comprehension, lack of retention and transferability, rote learning, fatigue and frustration and reduced critical thinking. These observations became our inspiration to find pedagogical strategies to increase student comprehension and performance, while increasing student self-efficacy and critical thinking. We began to ask ourselves questions such as:

1. How are the different epistemic conventions of disciplines creating complications for our ELLs? Is this the reason for the observed lack of transferability of knowledge and skills taught in other courses?
2. How do differences in cultural values and expressions between students and instructors impact student comprehension?
3. In what ways do the situatedness of language and meanings impact student learning? For example students regularly used the phrase “too much” to mean “a lot”.
4. What are the factors responsible for rote learning and ritual reproduction of material noticed in exams? Are these the result of prior educational experiences, lack of comprehension due to deficiencies in language competence or a combination of both?
5. To what extent do our current methods of assessment test literacy rather than critical thinking and knowledge comprehension?

6. What teaching and learning strategies best communicate and assess scientific knowledge in UAE classrooms?

In an effort to answer questions 4, 5 and 6, and minimize the effects of some of the factors outlined above we tried various pedagogical strategies, some of which have their roots in language teaching. The strategies outlined in this report were specifically tried based on the physical, social and cultural environment, the course objectives and English language competence of our students. With each semester, as we learned more about local culture and teaching Arabic ELLs, we acknowledged and accommodated the exigencies of teaching science in this environment.

METHODOLOGY

The study employed an action research methodology. Action research deals primarily with the understanding of practice, the improvement of the context of the practice and an improvement of the practice itself (Carr & Kemmis, 2004). The study took place over five semesters (32 classes of more than 800 male and female students) and involved two professors observing, trying methods, reflecting and sharing on their classroom practices; teaching science to non-science majors in an Arabic English language learning environment. The process was cyclical and involved the following steps:

1. Identification of the issues
2. Designing strategies as a plan of action
3. Gathering data through teacher observations, solicited and unsolicited feedback from students
4. Organizing the data by seeking patterns
5. Analyzing the data
6. Reflecting, sharing and discussing the results with each other
7. Drawing conclusions
8. Implementing feedback into designing new strategies

FINDINGS and DISCUSSION

The results and discussion are centred around each of five teaching strategies reported. The strategies include: student-generated concept sketches, mind mapping, group work, traditional literacy techniques and gamification and online student response systems. Each strategy is explained using definitions and examples of student work, where applicable. Comments are made on the usefulness of each technique to our classes, teaching core-curriculum science.

Each of the strategies used were grounded in a learning theory. Both sketches and mind maps are useful for main idea selection, organisation of material and meaning making. These characteristics help students with scaffolding, as new knowledge is anchored to prior knowledge. This has its roots in cognitive constructivist theories as purported by psychologists such as Piaget, Bruner (1960, as cited in Palinscar, 2005) and Ausubel, Novak & Hanesian (1978, as cited in Ausubel,1980). These theories emphasize the construction of knowledge through organization and social interaction, all of which are facilitated by these two methods. We were able to adapt our teaching, as we had readily available external representations of the cognitive models of students. This helped us in turn to influence the mental schema of students through corrective actions.

Group work, gamification and student response systems helped students to improve their existing mental schema through social constructivist opportunities. These techniques facilitate active and social avenues for learning, as students have more interactions with their peers. According to Woo and Reeves (2007), peer interactions promote conversation, discussion and negotiation of meaning. These activities augment the learning outcomes of our course, focussed on ELLs learning science.

The literacy strategies discussed in the paper are sentence frames, word lists, code-switching and modelling of activities. Some may argue that these techniques do not encourage deep learning. However, we believe these methods, mainly founded on behaviourism have their place inside our unique classrooms. There have been arguments to support the use of modelling, demonstration and reinforcement of activities close to the target response, in teaching factual content (Palinscar, 2007). We have found these methods very useful in teaching content matter to students who do not have the language abilities to communicate in writing what they are thinking, and who get lost in advance organisers meant to illuminate concepts.

Student-Generated Concept Sketches

A student-generated concept sketch is an annotated drawing that illustrates the basic concept being taught (Johnson & Reynolds, 2005). One of the first things noticed in our classrooms is that many students, especially females are comfortable and well able to express themselves through drawing/sketching. According to students the social and religious culture does not promote public displays of creative expression such as dancing and singing, so especially females, express themselves through art. We made use of this aspect of the culture by asking students to provide annotated representational drawings after interacting with prompting materials on content such as global warming, photochemical smog and ozone layer depletion. Figure 1 provides an example of a student-generated concept sketch.

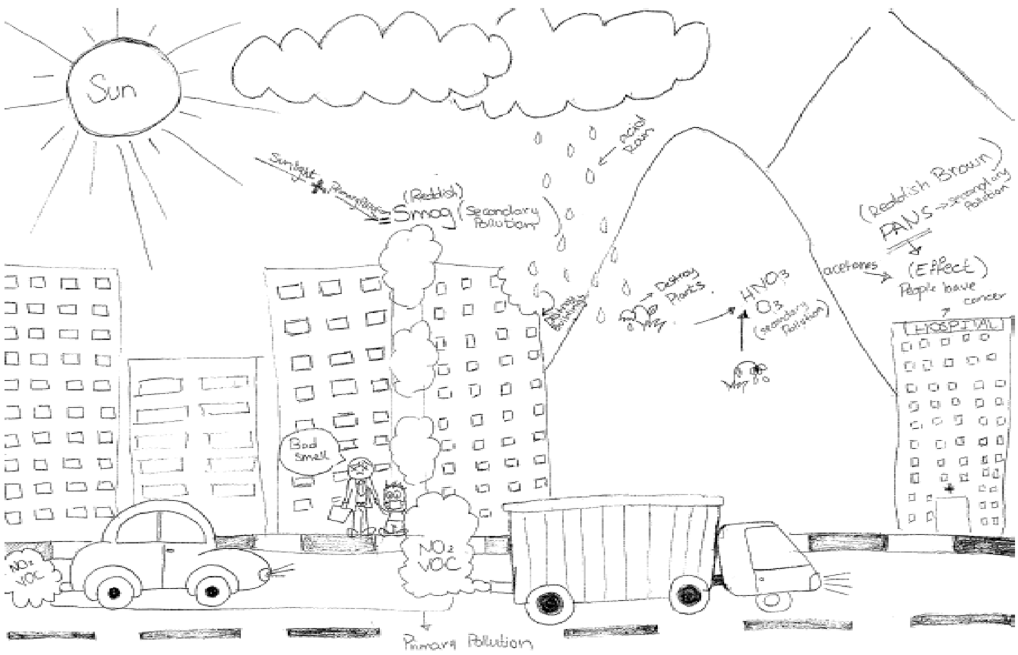

Figure 1: *Student Sketch on Photochemical Smog*

From the sketches it became immediately obvious the conceptions/misconceptions students had. For example, it was clear whether students could differentiate between the behaviour of tropospheric and stratospheric ozone, and carbon dioxide and chlorofluorocarbons as pollutants with different environmental effects. We were then able to correct misconceptions by giving students immediate oral or written feedback on their sketches. This made for excellent formative assessment and was easy for both students and instructors. In a study looking at feedback from Middle Eastern students studying in English, Jewels and Albon (2012) reported that students saw instructor feedback as essential to their achievement.

Students were also allowed to use sketches to represent their answers in summative assessments. Students expressed happiness that their answers were not lost in translation. According to Jewels and Albon, it is easy for faculty who teach ELLs to forget that they do not teach English they teach in English and so they frequently misinterpret students inability to express themselves in the language (linguistic intelligence) as students' misunderstanding of content (logical/mathematical intelligence) (Jewels & Albon, 2012; Prophet & Badede, 2009). These professors penalize students heavily for incorrect language use. Students who have been on the receiving end of this kind of misdirected grading tend to focus on expression rather than deep erudition, and frequently resort to plagiarism and rote learning to raise their scores. Although no rigorous scientific study was done on the effectiveness of the concept sketching technique in our classrooms the following benefits were noted:

- Increased contact between students and instructors
- Easy identification of student misconceptions
- Increased student engagement through active participation
- Increased student confidence in seizing opportunities to express their opinions
- Increased student self-efficacy towards previously difficult concepts
- Development of reciprocity and cooperation among students
- Prompt and painless feedback provided by instructors
- Extensive language use is not required, which frees the working memory of students for increased critical thinking
- Increased organization of knowledge by students

According to Chickering & Gamson (1987) and Kerns et al. (2005) the benefits listed above exemplify good teaching. Limitations of the method included not all students liking to draw and some science topics not readily lending themselves to representational sketches.

Mind Maps

Mind maps are visual tools used to organize information. Usually there is a single concept, around which ideas, images and words are added. Major ideas are directly connected to the central concept and supporting ideas branch out from major ideas. The major benefits of mind maps include the ease with which they are drawn, the freedom of creative expression (students may add colours and graphics as desired) and the ability to document associations between concepts (Davies, 2010; Eppler, 2006).

We thought mind maps would be particularly useful in our classes because of the artistic and creative abilities of our students and the limited language use required. Mind maps help to scaffold difficult academic vocabulary (Bradley & Bradley, 2004) and force students to organize information by making associations between concepts, which results in increased student engagement. ELLs regularly tune out in class unless something grabs their attention. The diversity among faculty means students are exposed to a multiplicity of English Language accents within a day. This is very difficult especially when we consider that even native English speakers have a hard time understanding each others' accents. Using mind maps during lessons helps to retain student focus. Mind maps help communicate ideas and relationships without the need to process too much semantic information. This is especially useful to ELLs, as it reduces the cognitive load of the learner. Figure 2 provides an example of a student-generated mind map illustrating air pollution effects.

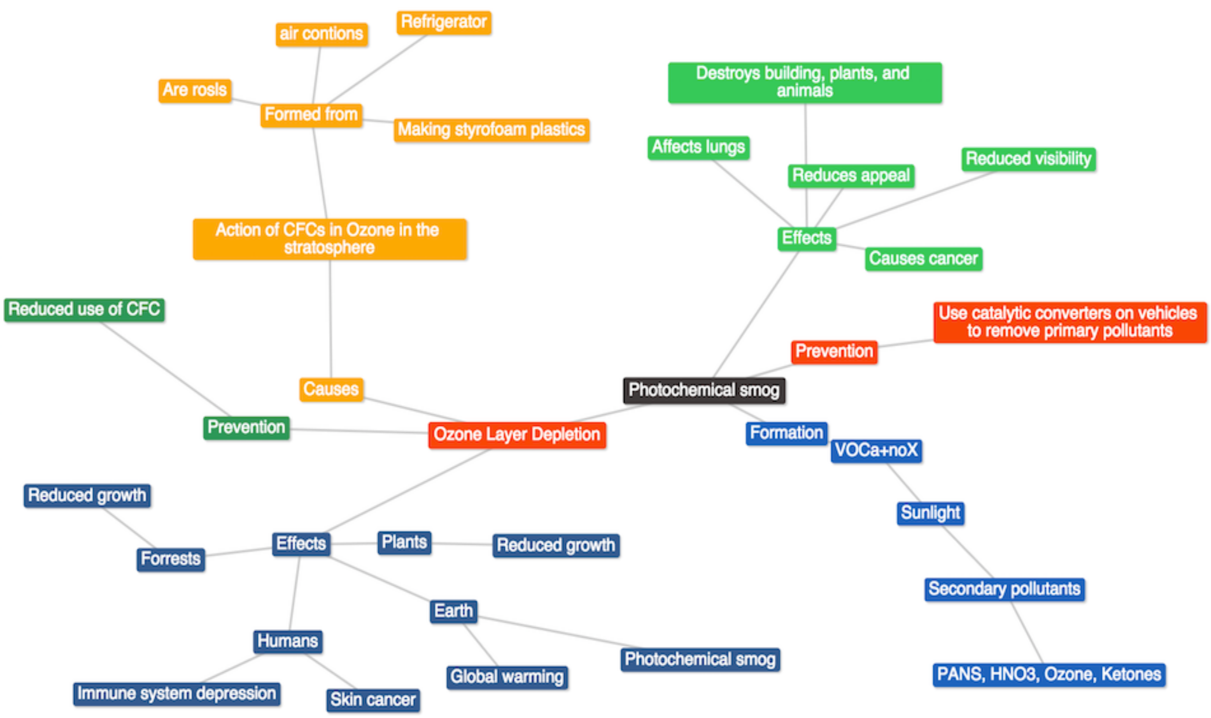

Figure 2: *Student mind map showing Ozone Layer Depletion and Photochemical Smog*

Teaching, revising and encouraging students to take notes using mind maps have been very useful in teaching the science modules. There are several lessons within each unit. Teaching using a mind map to recap past lessons and introduce new ones enables students to see each lesson in perspective with the rest of the unit. Student-generated mind maps also help students to associate concepts within a lesson. The authors found mind maps especially useful where concepts were not easily represented using annotated sketches. It was also useful to add variety to the class as different topics were introduced. The main benefits to using mind maps in our classes were:

- Easy creation - using online tools, apps or pencil and paper
- Students gained practice in the organization of information
- Student misconceptions were easily identified
- Mind maps were generated by students using smartphones, tablets and laptops
- Students practiced writing key words and phrases
- Extensive language use was not required for expression but there was an avenue for scaffolding technical vocabulary
- The visual nature and flexibility in individual creative expression appealed to students

Group work

Group work was another technique we found extremely beneficial in the Middle East. According to Jewels and Albon (2012) there may be a need for specific pedagogies for Arab cultures. This idea is not farfetched as due to differences in social and physical environments specific strengths and weaknesses are highlighted among different ethnic groups. Increasingly educators are realizing that a "one size fits all" pedagogical approach is inadequate to fulfil the demands of diversity within the modern classroom. A number of social, cultural and environmental reasons precipitated our push to incorporate a collaborative approach in our classroom practices. These include:

- Student distraction - Some students who are distracted in the large lecture setting but became much more focused in small groups. Class sizes are relatively small (30±5), yet they are still too large for us to interact with each student on an individual basis, during a teaching session. It was therefore decided to work with groups of 2-4 students and this made things very manageable.
- Range of student abilities - Students are on a range of abilities, some with disabilities as well, group work gave them a chance to engage with material and get specialized attention.
- Complimentary student abilities - Students could be grouped to compliment each other's abilities or grouped according to abilities that would facilitate academic development.
- Lack of student engagement - The element of competition among groups, even without external incentives, increased student engagement.
- Practical applications of theory - Group work facilitated practical applications of theoretical information given in the lecture.
- Culture – The Middle Eastern culture encourages teamwork and the group consensus or needs are favoured over individual success.
- Arabs have familial and social responsibilities, which are obligatory. Students are therefore not always able to find time outside of class to do homework. Group work in class took care of work that in other contexts would be done as homework.

Topping (2005) believes it was from such community collaborations as observed among Arabs that peer assisted learning (PAL) had its origins. The benefits of PAL, such as reciprocity among students, improved study habits, persistence on task and increased exam performance, have been extensively documented. Lee (2010) explained that in a peer assisted environment, where students are well motivated, the positive effect on their study achievements is clearly seen. A peer assisted learning environment results in improvements in both student performance and retention in a particular course (Tien, Roth, & Kammeier, 2002). We found similar results from our group work activities and there was an obvious increase in student science self-efficacy.

Working in small groups helped to create a relaxing environment for our students. It has been found that appropriately planned peer assisted learning activities, creates an informal learning environment where potentially intimidating factors are eliminated, such as very structured lessons from "fearsome" instructors (Huijser, Kimmins, & Evans, 2008). We believe that creating a comfortable, "safe" environment is paramount to learning, taking into consideration the stark differences in cultures and languages that exist between faculty and students. Research has shown that humans are emotional learners and deep erudition is accomplished when we are relaxed in a non-threatening learning environment. This is keenly emphasized in this environment as students regularly comment on the "kindness" of the instructor in student evaluations. This value is well appreciated by female pupils who withdraw when feeling threatened.

Sharif (2012) stated in his findings, that at the tertiary level ELL students benefitted most from working with peers. The students found such environments more comfortable and hence were able to practice using and understanding the foreign language, which better enabled them to understand subject content. Again, our findings concurred; we found that students, who may have been timid to ask for clarification in halting English, had no reservations with each other. They therefore got the opportunity to practice the English language, in a less intimidating, and what they may see, as a less embarrassing, setting. The planned group assignments further helped with students' understanding when those who understood a concept explained the material in the mother tongue to the one(s) that may have found it challenging.

Additional documented benefits from a peer assisted learning environment, which were also observed from our interventions, were increase levels of time allotted to specific task and practice (Jewels & Albon, 2012), coupled with a greater sense of accountability by the students involved (Topping, 2009). We have noticed increased student engagement, participation and understanding, increased self-confidence and more sustained student performance. Another noted benefit stemming from the group work in class is the formation and cementing of friendships outside of class, which has reduced the friction of group homework activities, especially those geared towards summative assessment. Student feedback has been positive and quite a few students have expressed their pleasant surprise that science classes are interesting and engaging.

Group work as a pedagogical strategy works especially well among male Emiratis. It is an aspect of the Middle Eastern culture that one does not refuse to assist another who has asked your help. Setting group work using worksheets has resulted in huge success in classes as students work to help each other in real camaraderie.

Literacy strategies

Teaching at a university where the language of instruction is English and the native tongue of students is Arabic brings home forcefully the need for instructional strategies in science and language to complement each other. As faculty in the General Studies section of the university we encounter students at the beginning of their university careers. Matriculation for entry requires a minimum International English Language Testing System (IELTS) score of 5.0. This means students are still developing their English language competence, which makes every teacher a language teacher. As science teachers in previously English speaking environments we did not realize the close overlap between the two disciplines. As McCullagh and Jarman (2009) state, it is a challenge to shift one's science pedagogical culture from viewing language as a marginal activity to one that places it at the core. However, as we quickly found out this was one of the great demands of our job. A thorough search of the literature showed that the majority of the work done in combining science and literacy is done at the primary and secondary levels. Yet, with many Gulf Cooperation Council (GCC) and other non-native English speaking countries opting to educate students in English at the tertiary level this is an issue of increasing importance (Ministry of Higher Education and Scientific Research, 2014; Prophet & Badede, 2009).

A comparison of Science with reading and writing skills shows a startling overlap (Sessoms, 2012). Many of the skills developed in literacy are also used in science. Facilitating language literacy competencies in the science classroom therefore results in huge benefits for the learner. Table 1 illustrates a comparison between science, reading and writing skills (Sessoms, 2012).

Table 1. *Comparison of science skills with reading and writing skills*

Science Skills	Reading Skills	Writing Skills
Observing	Note details	Descriptions and observations
Hypotheses	Predicting	
Inferences	Inferring	Problems and solutions
Comparing and contrasting, noting similarities and differences	Comparing and contrasting	Comparing and contrasting
Communicating	Communicating	Descriptions
Classifying	Sequencing	Organizing main ideas
Collecting and organizing data	Summarizing	Summaries
Interpretation of data and graphs	Recognizing main ideas	Analysis, persuade and convince
Linking cause and effect (independent and dependent variables)	Recognizing cause and effect	Cause and Effect
Drawing conclusions	Drawing conclusions	Summaries

The science skills in the table are all developed in the core curriculum science courses we teach. Recognizing this we began to seek language teaching pedagogies that could be applied to our classes. Borrowing from literacy, we have gained positive results using the following strategies inside the classroom.

<u>Sentence Frames</u>

Students sometimes find it difficult to find words to express ideas or show the relationship between ideas. The latter was one challenge faced by students when writing scientific hypotheses. The definition for a hypothesis is a testable statement. Challenges faced by students included knowing the difference between a question, an idea and a testable statement.

Sentence frames involve students filling in gaps in a pre-prepared sentence frame to produce a structure they find difficult to formulate on their own (Carr, Sexton, & Laguno, 2007). Signal words are used to cue students on how to frame their statement and clue in the instructor to what the student wishes to say. The "**IF** (independent variable), **THEN** (dependent variable)" format was used to help students to relate their independent and dependent variables in a hypothesis. For example, **<u>IF</u>** the temperature increases **<u>THEN</u>** the solubility of sugar in water increases. This strategy was particularly successful when students were taught how to identify the cause and effect, independent and dependent variables, and later use the If/then format to complete hypotheses.

Completing sentence frames gives students the chance to participate without the added pressure of thinking how to formulate a hypothesis or conjecture correctly as a statement. The task then becomes one of completion rather than generation, which is more attainable. This method has been very successful in science classes with less task-mature ELLs. Students show greater self-confidence in writing hypotheses.

<u>Word Lists</u>

A list of key terms is sometimes provided for students to aid with definitions at the beginning of teaching a concept. The definitions are explained and sometimes linked with kinesthetic actions to facilitate recall. For example the words *convergent*, *divergent* and *transform* are defined while moving the hands together, apart and moving past each other to reinforce understanding while teaching about the movement of tectonic plates. Repetition of the words and their definitions throughout the course also helped to buttress meanings. Root words and prefixes are used to illuminate meanings and form scaffolds for student memory. An example includes the prefix bio – *meaning life* and shows *a connection between life and living things*. This prefix turns up frequently in the environmental science course in words such as: **bio**me, **bio**diversity, **bio**tic, **bio**sphere, and **bio**mass. Relating each of these words with life and living things helps to form a latch for remembering the definitions. This is very necessary for ELLs, especially those with a mother tongue such as Arabic, which not only has different sounds, grammar and writing system, but has few connections to English to provide clues.

Code-Switching

While teaching specific concepts the authors tried to use some words from Arabic to facilitate understanding. When trying to explain the different levels of an independent variable, for example, the word *Kemmiya* (English spelling) was used to emphasize the importance of quantity/amount as the independent variable is changed. Other words used during instruction included: *Icktashif* – discovery and *Adilla* – evidence. Although there seems to be conflicting ideas on the use of code-switching in classes we have found this to be a powerful way of communicating some concepts. As mentioned previously code-switching was also allowed during group activity and seemed to enhance rather than detract from the lesson.

Modelling of activities

Receiving instructions in a foreign language can be daunting for language learners (Prophet & Badede, 2009). Sometimes students do not complete an assignment because they simply do not understand the instructions. Sometimes it is a matter of the language being difficult and sometimes the instructions are too long and complicated and increase learners' fatigue. Recognizing this, we tried to increase students' science self-efficacy by modelling activities. The results were particularly dramatic in an individual project where students had to complete a report on an experiment they had carried out based on a research question they conceived. The report had detailed requirements of research questions, conjecture, hypothesis, possible outcomes, data collection, representation and analysis and conclusions. Students were required to use APA format throughout the report.

The activity was modelled and students were taken through a mock report presentation. Though the reports covered a wide range of topics, using this model as a template, students felt empowered and many were able to write excellent reports on other topics, by following the outlined steps. Modelling of assignments makes instruction explicit and reduces learner anxiety. There were fewer incidences of students omitting whole sections of an assessment either by accident, lack of understanding or language deficiencies.

Gamification and the use of online student response systems.

Karl Kapp, in his book *The Gamification of Learning and Instruction: Game-based methods and strategies for training and education*, defines gamification as "…using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning and solve problems" (Kapp, 2012).

The easy access and availability of mobile devices and Wi-Fi in the classroom and the expertise in electronic devices displayed among students makes gamification a good choice for Emirati pupils. All students have access to at least one mobile device at all times. In fact, one challenge faced by instructors is to have students use these devices only for educational purposes in class. The use of online student response systems such as Socrative and Kahoot! has been very successful in increasing student engagement and subsequent performance on summative assessments.

Socrative is an online student response system that allows instructors to monitor student progress through use of real time questioning, with instant result aggregation and visualization (Berte & West, 2014). Teachers can gauge the whole class' current level of understanding and provide instant feedback through this platform. Socrative comes with apps for both teachers and students and these may be stored across a variety of mobile devices for easy access. Each teacher is assigned a unique virtual classroom number. Teachers deploy their stored quizzes and students are allowed to enter the classroom and take the test as long as they have access to the number. Each quiz has a unique socrative number that can be shared among socrative teachers. The main features of Socrative used inside our classrooms include:

- Deployment of stored quizzes. During revison classes students are able to take socrative quizzes and get instant feedback. As teachers we are able to monitor student preparation. One feature we have found very useful is the ability to leave the "classroom" open so students gain access at all hours outside of class.
- Space Race. Socrative also has a gaming feature called the *space race*. This feature allows students, or groups of students to race against each other as they take the quiz. Each group is assigned a colour and students are able to monitor their progress relative to other groups based on the movement of the corresponding coloured rockets, if the teacher displays her screen on the board. Groups advance based on the number of correct answers to the quiz. This feature has resulted in increased student engagement during revision.

Kahoot! is a classroom response system which creates an engaging learning space, through game-based digital pedagogy (GetKahoot.com, 2014). It is similar to Socrative as it can be used across all mobile devises and allows teachers to store quizzes. It has additional gaming mechanics such as music, points and timer, but is more limited than Socrative in the length and variety of question types. Kahoot! is great during revision as it has the ability to peak student engagement and the whole class participates. It pulls out even the most introverted students as it increases the competitive edge. Both male and female Emirati students are highly competitive and are experts at video games. Kahoot! usually has students calling for more revision.

CONCLUSION

Research has documented reduced critical thinking, concept development and academic achievement in science among second language learners (Cassels & Johnstone, 1984; Johnstone & Selepeng, 2001; Prophet & Badede, 2009). According to Johnstone and Selepeng (2001), a reduction on average of 25% of the working space available for critical thinking has been observed among language learners. Many countries, including those in the Middle East, continue to offer content instruction in a foreign language, English. The issues are complex, as currently English is the primary language of trade and countries aim to prepare their graduates to be competitive in the marketplace. Despite the obstacles to learning content as ELLs, we have found that using a combination of the pedagogic strategies outlined, dramatic improvements in students' engagement occur. Having the students participate in these mostly active learning activities seemed extremely beneficial in improving their discussions, negotiation of meaning and ultimate motivation in wanting to study science. These benefits relating to group work have been well documented (Sharif 2012, Topping, 2009). Generally, these collaborative and cooperative activities were effective for supporting a range of desirable learning outcomes. These effects include improved academic achievement and other attitudinal outcomes such as enhanced interpersonal skills (Prince, 2004). Drawings and mind maps have also proven to be successful in main idea selection, organization and relating ideas (Davies, 2011, Johnson & Reynolds, 2005, Leopold & Leutner, 2012). Increases in student grades over previous semesters, which did not employ these strategies, were observed. We have also noted increased satisfaction among students, characterised by a decrease in the number of student letters at the end of the semester asking for work for extra credit. Increased positive comments and increasing student evaluation scores have also encouraged us. Students have expressed a liking for the course instructional methods and have articulated their desire to see more of this type of pedagogy in their other courses. Akin to this, other colleagues have consulted with us on the methods of our interventions, as mutual students have requested these in their classes.

We will therefore continue to incorporate these and other active learning strategies into our teaching. We do not see this project as complete, but on going, as we assimilate more of the culture, nature and environment of our students. Having observed the efficacy of these teaching methods we plan to do extensive qualitative and quantitative studies on individual strategies to establish their usefulness to other science instructors at the college level. These results will also inform the choice of reference materials and assessment of student performance used in our courses.

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