**Abstract**

Digital technology is now an integral part of our lives. The digital age is characterized by changes that require readjustment in many areas of the education system. Technology can serve and support the teaching, learning, and assessment process. One way of teaching that incorporates technology is the ‘flipped classroom’ approach - a type of hybrid teaching that includes both face-to-face and distance learning (Horn & Staker, 2011). In this approach, distance learning is delivered through recorded videos, and face-to-face learning takes place in small groups (Bishop & Verleger, 2013). Online assessment tasks can support the flipped classroom approach, assisting both teacher and learner in various ways. These include stipulated time limits (Noguera et al., 2019; Henderson, 2016), unlimited locations and resources, providing the learner with immediate feedback (Whitelock, 2006), greater convenience for teachers when it comes to circulating exercises for exams, and more. Although many studies have been conducted in the respective fields of the flipped classroom and online assessments, there are very few studies looking into a combination of the two aspects (teaching and assessment together), or investigating online assessments as a tool to accompany and support learning in the flipped classroom. One of the few studies that has focused on this combination is that of Henderson (2016).

A chemistry-based approach is when the application of chemistry and its connection to real-world situations are at the center of chemistry teaching. In this approach, chemical concepts are taught on a ‘need-to-know’ basis, where students learn concepts in order to understand real-world phenomena. The research literature shows that there are many advantages in using a context-based learning approach for the sciences. For example, it contributes to students’ “level of interest and enjoyment” (Avargil et al., 2012), enhances student understanding of the curriculum (Wannagatesiri et al., 2017), and raises student awareness of the relevance of educational content to real life and the real world (Bennett & Lubben, 2003; Parchmann et al., 2006; Stolk et al., 2016; Wannagatesiri et al., 2017; King & Henderson, 2018). It is important to note that this approach is currently being applied and researched within higher education and in upper secondary schools, but less so in middle schools: “Many studies have been conducted around context-based teaching in science for high school students and above, but very little has been done in context-based learning in science for middle school students” ( King & Henderson, 2018).

**Purpose of the study and its questions**

The purpose of this study is to implement and investigate an innovative chemistry teaching process, incorporating flipped classroom methodologies and online assessment into context-based learning in chemistry, from the perspective of middle school students. In addition, the study examines and characterizes generic activities carried out by learners on their own initiative, as well as their academic achievements. These goals are achieved by: (a) examining learners’ attitudes toward, and perceptions of, context-based learning in the flipped classroom approach to chemistry, using a structured, open-ended questionnaire; (b) examining learners’ awareness of context-based learning, through an examination of generic activities (initiated by the students themselves) that assist technology and chemistry-related learning, while attempting to characterize them using a travelling journal; and, (c) examining learners’ general performance and achievement in online assessment tasks, by analyzing the correlation between their achievement in online tasks used as a tool for assessment, and their achievement in a conventional written test.

**Research questions**

1. What are students’ attitudes toward context-based learning in a hybrid chemistry environment? And, how do they perceive it?

2. Are students carrying out generic activities (on their own initiative) that are both assisted by technology and chemistry-related (except for the dedicated activities set by the subject teacher)? And if so, how can these activities be characterized?

3. Is there a correlation between students’ achievement in online assessment tasks and their achievement in conventional written tests?

**Study variables**

1. Learners’ attitudes towards context-based learning - This includes learners’ attitudes, as expressed in written feedback in the structured, open-ended questionnaire.

2. Context-based activity type - Two types of context-based activities (mentioned in the student logs) were examined: dedicated activity and generic activity. Generic activity is further characterized as: learner activity, content activity, and content-learner activity.

3. Student performance – Scores were collected via two assessment tools: online tasks and conventional written tests. For each student, an average score for four online assessment tasks completed across the study unit was calculated, and a conventional written test score was obtained at the end of the study unit.

**Methodology**

The study population included one class of 32 seventh grade students in a private middle school in the Arab sector. The class is comprised of 17 boys and 15 girls. The study combines quantitative and qualitative methodologies and several research tools were used, including:

1. A structured open-ended questionnaire, which the students were asked to submit, containing feedback on their attitudes toward, and perceptions of, context-based chemistry learning in the flipped classroom approach.

2. A travelling journal, in which students documented their activities. The journal was intended to be used to record (using either a computer or mobile phone) any activity students carried out, which was related to the topic of chemistry. For every such activity, students were asked to report the time, place, and content, as well as the activity’s relationship to real life or the real world, from their own perspective.

3. Assessment tasks (online and written). The study analyzed the students’ grades and average scores in four online assessment tasks, performed throughout the study unit. In addition, a conventional written test was carried out at the end of the study unit. The students’ scores in the online assessment tasks were compared with their scores in the traditional test.

Both qualitative and quantitative methodologies were incorporated into the analysis of the activities, attitudes, opinions and perceptions of the learners. The analysis of generic activities in the present study is based on a “model for characterizing mobile activities in context”, developed by Ezra (2017), which has been adapted to the present study. The settings (after adaptation) for the present study are, as follows:

• Content - The activity content is related to a real-life or real-world context, but the learner did not follow the ‘non–noticing case’ link: Four such activities were found, out of a total of 22 generic activities.

• Learner - The activity content is not related to a real-life or real-world context, but the learner did follow the ‘self-relation case’ link. One such activity was found, out of a total of 22 generic activities.

• Content-Learner - The activity content is related to a real-life or real-world context, and the learner followed the link. There were 17 such activities, out of a total of 22 generic activities.

It should be noted that Ezra makes has two separate definitions of ‘real-life’ and ‘real-world’, and the categories listed above would relate only to his definition of real-world. However, no distinction between real-life and real-world has been made for the present study, so the above categories relate to both the real world *and* real life, in this context. The Ezra model has therefore been partially implemented into, but not fully adapted to, the current study. It should be noted that the Ezra model was developed for “contextual learning”, but it was also found to be appropriate for context-based learning in an online environment.

**The main research findings**

Students’ perceptions and attitudes toward context-based learning in a hybrid environment in chemistry (Question 1) - students' attitudes and perceptions were analyzed for the three components of the flipped class method: (1) context-based learning in a hybrid environment in chemistry; (2) video learning; and, (3) online assessment tasks.

Learner attitudes and learner perceptions of the three components of teaching were characterized using the students’ comments. The resulting positions were grouped into primary and secondary categories (hereafter referred to as, ‘categories’ and ‘sub-categories’), after coding the attitudes and perceptions and finding a common denominator between them:

A. Cognitive: understanding; performance and achievement; concentration and memory

B. Emotional: mental calmness; pleasure and interest; comfort

C. Awareness of relevance: ability of learners to provide real-life and real-world examples, and content related to the topic being studied

D. Flexibility: time limit (When? How much?); location restriction (Where?); accessibility of available resources (books, notebooks, the internet, etc.)

E. Responsibility: the learner is developing responsibility for his or her own learning process

F. Affinity with technology: the learner's affinity with, and preference for, learning technologically

Generic, technology-aided chemistry activities (Question 2) - the findings of the study showed that a total of 106 dedicated study activities were carried out in the study unit, compared with 22 generic activities. A z test was performed, to distinguish the proportion of mobile phone use for dedicated activities (36 out of 105), versus mobile phone use for generic activities (16 out of 22). The test results showed a statistically significant difference \*\* Z-Score = -3.3341, P-Value <0.01 between the two types of use (mobile phone versus computer), which indicates more widespread mobile phone use for generic activities, compared with more widespread use of computers for specific activities. As mentioned earlier, the analysis and characterization of generic activities relied on a “model for characterizing mobile activities in context”, developed by Ezra (2017), adapted to the present study. The definitions after adaptation to the present study.

Regarding the third research question, which deals with students’ achievement in the online assessment tasks and the conventional written test, it was found that students’ achievement in the online assessment tasks (or, E-Tasks) ranged from 0-98, with a mean of 73.9 and standard deviation of 23.1. Students’ achievement in the conventional written test ranged from 10-95, with an average of 73.9 and a standard deviation of 18.4. A strong positive correlation was found between student achievement in the online assessment tasks (mean 73.9, SS 23.1) and their achievement in the conventional written test (mean 73.9, SS 18.4) {r = 0.630, p <0.01}.

In conclusion, the findings of the study indicated positive learner attitudes toward context-based learning in a hybrid chemistry environment. Students preferred to use a computer for dedicated activities, and a mobile phone for generic activities. At the end of the study unit, students also demonstrated high awareness of the relevance of real-life and real-world phenomena to the study content and material. Student achievements in the online assessment tasks matched their achievements in the conventional written test.

**Discussion, main conclusions and new research directions**

The findings of the present study indicated positive learner attitudes toward incorporating technology into the learning process. References made by students to an “affinity for technology”, and the “flexibility” that technology allows, such as access to available resources and sources of information, and the ability to search for information during a lesson, mirror the findings published in a previous study, by Manny Ican, Berger Tikochinsky, and Bashan (2015), as part of the Smart School project. Furthermore, students expressed positive attitudes toward distance learning via videos within the flipped classroom approach.

These findings encourage us, researchers and teachers alike, not to worry about incorporating technology into the teaching process for younger children. Learners themselves have found that incorporating technology into their learning allows them to innovate, take personal responsibility for his or her learning process (Sletten, 2017), and be flexible in terms of both the time and location at/in which they learn (Burgman & Sams, 2012; Herreid & Schiller, 2013; Henderson, 2016). Unlike most studies, which have been conducted in higher education or upper secondary schools, the current study applies to middle school and therefore relatively young students, in order to investigate students’ attitudes toward distance learning via videos in the flipped classroom.

The most positive learner attitudes related to the online assessment tasks, and learners explained their attitudes toward such tasks by praising: the flexibility in terms of performance (when to do the task, and how much time they are allowed to spend on the task) (Henderson, 2016; Noguera et al., 2019), the resources available (books, notebooks, the internet), and the high levels of concentration, relaxation, and stress-free mental health and comfort afforded them (Noguera et al., 2019), which make online assessment tasks easier than a standard test, allowing them to ultimately score higher in all their assessments. Previous research has also indicated that learners have positive attitudes toward online assessments, although for other reasons, such as the benefit of instant feedback on automated e-assessment online assessment tasks (Di Battisa et al., 2004; Whitelock, 2006; Bahar & Asil, 2018). Again, most studies in the research literature investigate the attitudes of students in upper secondary schools or higher education institutions, but the current study examines the attitudes of younger, middle school students. Contrary to the findings of the current study, as described here, the findings of other studies (Patronis et al., 2019) indicate that students actually have a preference for written (or, “pen and paper”) exams.

Findings from analysis of the structured open-ended questionnaire indicate the positive attitude of learners toward context-based learning in a hybrid chemistry setting. It was evident that this approach received strong testimony from learners who received content which was largely clear and appreciated in their own estimation, and from their own perspective - similar to previous studies indicating learners’ positive attitudes to understanding scientific content within a context-based learning approach (Bennett et al., 2007; Wannagatesiri et al., 2017). Learners also gained a high level of pleasure from, and interest in, this approach (King, 2012; Avargil, Herscovitz, & Dori, 2012; Wannagatesiri et al., 2017). In addition, research findings show that context-based learning in chemistry does help learners see the relevance between the curriculum and phenomena that students encounter in real life and the real world. These findings are similar to previous findings in the research literature (Bennett & Lubben, 2003; Parchmann et al., 2006; Stolk et al., 2016; Wannagatesiri et al., 2017; King & Henderson, 2018). Unlike most studies, carried out in higher education or in upper secondary schools, the current study applies to junior high and younger students, because very little research has yet been carried out around contextual learning in science for middle school students (King & Henderson, 2018); nonetheless, the current study provides similar findings to previous studies.

The findings of the study show a significant difference between the types of devices students used to perform generic and dedicated activities. These findings invite new research directions, such as: how do young students perceive objects in terms of digital self-ability, and how can digital self-ability be increased? And, how do students perceive an electronic device in terms of its possible uses?

Learners’ achievement in the online assignments provided was found to be (strongly) correlated to their achievement in the conventional written test. This suggests that online assessment tasks are useful in assessing learners’ performance, and perhaps even acting as test preparation for them, although this argument needs further testing and may serve as a guide for further research. At the same time, it is recommended that the validity and reliability of online assessments is investigated, and that their suitability for different populations and ages is also assessed.

A strong correlation between the degree of student involvement (how often they do online exercises and participate in online experiences) and their achievement in the final test was found in the research literature (Henderson, 2016); students who did not submit online assessment tasks failed the final test, whereas students who persisted in the online assessment tasks increased both their self-assessment scores and online assessment scores, as well as obtaining high scores in the final (written) test. Another study, by Soffer and Cohen (2019) examined student engagement characteristics around online courses, and their impact on academic achievement, while trying to distinguish between those who complete online courses and those who do not. Course topics and ongoing assignments predicted completion of the course, while (in addition to these variables) course materials and reading forums also predicted success in the final exam. These testimonies support the theory that the degree of a learner’s involvement in, and use of, online assignments contributes to their eventual success and achievement. Monitoring learner activity on a website accompanied by a profession, can serve as a topic for further research, forecasting and predictions of dropout or success.

**Research contributions**

The research described here may add to the existing body of knowledge about learners’ attitudes toward the opposite classroom approach, as well as to online assessments. Studies indicate that questions remain about how students experience diverse forms of online assessment (Stodberg, 2012). The study may contribute to reducing the existing gap pointed out by researchers, Bahar and Asil (2018), who noted that, despite a wealth of research on attitudes toward computer-based teaching, attitudes toward online assessments require some focus due to the lack of research carried out in the field, as yet. Furthermore, research may help develop content and learning units that will serve teachers. In a study by Stolk and his partners (2016), researchers noted that the successful implementation of a pedagogical approach reliant on context-based learning requires professional development for teachers. Although many studies have been conducted in the field of reverse class, and others in the field of online assessments, there have to date been very few studies dealing with a field that combines these two aspects, investigating online assessments as a tool to support learning in the opposite class approach. One of the few studies to focus on this combination so far is Henderson (2016). Many studies have been conducted around context-based learning in science for high school students and above, but very few studies have been conducted about context-based learning in science for middle school students (King & Henderson, 2018). The research described here may narrow the current gap in research literature on science-based learning for middle school students.

This study also sheds light on a topic which was neither defined by the study itself nor given as an answer to a specific research question; this is the emotional aspect to this type of learning, reported on by students. Students reported high levels of relaxation, peace of mind and comfort when conducting online assessments, and high levels of stress and anxiety around traditional written tests, which are limited in time, location, and available resources and tools. These findings contradict the findings of Patronis et al. (2019), which indicate students’ preference for “pen and paper” in exams. These statements on the part of learners reveal the extended value of online assessments, as well as inviting new research directions.