The Impact of Using SMS as Learning Support Tool on Students' Learning

Al-Mothana M. Gasaymeh[1] & Osamah M. Aldalalah[2]

[1] Curriculum & Instruction Department, Al-Hussein Bin Talal University, Ma'an, Jordan

[2] Instructional Technology Department, Jadara University, Irbid, Jordan

Correspondence: Al-Mothana M. Gasaymeh, Curriculum & Instruction Department, Al-Hussein Bin Talal University, Ma'an, Jordan. Tel: 962-772-155-238. E-mail: gasaymeh@gmail.com

Abstract

This study aimed to investigate the impact of using Short Message Service (SMS) as learning support tool on students' learning in an introductory programming course. In addition, the study examined students' perceptions of the advantages and disadvantages of the use of SMS as a learning support tool in their class. The participants in this study were 52 students who were enrolled in two sections introductory programming course. For the purpose of the study, nonrandomized control group, pretest–posttest and qualitative interview designs were used. The control group consisted from 23 students, while the experimental one consisted from 29 students. A total number of 36 SMS messages were sent to each student, in the SMS group, over a period of 12 weeks. The messages contained different types of information, i.e. short review of programming concepts, hints to solve assignments, and triggering questions.

At the end of the experiment, semi-structured interviews were conducted with ten students from the SMS group. The analysis of the collected data showed that the use of SMS as learning support tool contributed significantly in improving students' learning. All the interviewed students believed that the use of SMS technology as learning support tool has more advantages than disadvantages. Based on the findings, this study provided some recommendations regarding the implementation of the SMS in the Jordanian higher education settings.

Keywords: SMS, students' learning, SMS-based instructional design, SMS as learning support tool, mobile learning

1. Introduction

In the last decade, mobile phones technologies have become very popular tools for the great majority of the Jordanian citizens. According to the Telecommunications Regulatory Commission (TRC), the mobile penetration rate in Jordan reached 123 percent by the end of the first quarter of 2012, higher than the internet penetration rate of 53 percent (TRC, 2012). The penetration rate refers to the active subscriptions within a specific population. One of the popular services of mobile phones technologies among Jordanian adults is the Short Message Service (SMS). SMS is a system that enables mobile phone users to exchange text messages. In Jordan, SMS has been used for advertising (Zabadi, Shur, & Elsayed, 2011), banking services (Khrawish, & Al-Sa'di, 2011), and governmental services (Jordanian e-Government, 2012). Furthermore, the use of SMS is popular among young Jordanians for chatting, participating in TV shows, and for sending greetings (Ibrahine, 2008; Mansur, 2010).

The worldwide popularity of SMS has motivated some educators to explore the use of SMS in educational settings: SMS technology, for example, has already been used to communicate administrative information for students (Naismith, 2007), to send small bites of educational contents to students (Lu, 2008; Zhang, Song, & Burston, 2011), to create and enhance in-class discussion (Markett, Sanchez, Weber, & Tangney, 2006; Goh & Hooper, 2007), to send persuasive and motivational quotes to students (Goh, Seet, & Chen, 2012), and to send quizzes to students (Shahreza, 2006).

However, educational and administrative applications of SMS in Jordanian higher education are very limited. The researchers examined the provided electronic administrative and educational services of all of the Jordanian public universities and they found lacking of SMS services. Furthermore, there are quite limited research studies

that investigate the applications of SMS and their advantages and disadvantages in the Jordanian higher education (Al.Qomoul, 2011).

As a communication tool, SMS has been perceived as an everywhere, immediate, convenient, unobtrusive, and cheap mode of communication (Leung, 2007; Rau, Gao, & Wu, 2008). However, SMS has some limitations as communication tool. SMS has limited number of characters that can be sent via one message (160 characters in Latin alphabets and 70 characters in non-Latin alphabets) and it cannot be used to send pictures and visual stimulation (Leung, 2007; Bieswanger, 2007).

As learning support tool, SMS can be used to send information related to an educational content for students. Mellow, (2005) highlighted three modes in which SMS can be used to send educational content. The *push* mode, that involves the instructor sending educational SMS to the students. Second, the *pull* mode, in which students order specific educational SMS through pre-specified electronic or paper list of content. Finally, the *interactive* mode, in which the educational questions are pushed by the instructors or pulled by the students, then answers and feedbacks would be exchanged between the students and the instructor.

The popularity of SMS among young Jordanian people, the lack of empirical research studies the investigate the SMS applications in Jordanian higher education, and the different reported applications and advantages of SMS technology in education, have triggered the need to investigate the integration of SMS technology in the Jordanian higher education field.

The purpose of this study is twofold: first, the study aimed to investigate the impact of using SMS as learning support tool on students learning in an introductory programming course; second, the study examined students' perceptions of the advantages and disadvantages of the use of to the use of SMS as a learning support tool in their introductory programming course.

2. Literature Review and Theoretical Framework

2.1 SMS Applications in Higher Education

"The most ubiquitous and stable mobile technologies namely Short Message Service (SMS) texting (Traxler, 2005) on cellular phones has great potential in education" (So, 2009, p. 114). A great part of the research studies, that investigated the applications of SMS technology for educational purposes, were limited to the language learning, where several research studies has recognized the potential of SMS technology to increase students language learning, i.e., English words and idioms (Kennedy & Levy, 2008; Cavus, & Ibrahim, 2009; Basoglu, & Akdemir, 2010; Zhang et al., 2011; Hayati, Jalilifar, & Mashhadi, 2013). The applications of SMS technology for educational purposes were investigated in various ways in different contexts. For example, educational SMS was used to support traditional face-to-face learning. Example of such use was reported in Cavus, and Ibrahim' (2009) study, where the researchers conducted an experimental study (*n=45*) that aimed to examine the possibility of using SMS to support first-year university students learning new English words in traditional English language class. The researcher followed one-group, pretest–posttest design. The researcher sent 48 short mobile messages through the push mode over 9 days. The findings revealed that the SMS was effective in teaching the students new English words.

Another application of educational SMS involve relaying on such tool as the main delivery method of educational content. For example, Hayati, Jalilifar, and Mashhadi, (2013) conducted a comparative study (*n=45*) that aimed to examine English as a Foreign Language (EFL) students' learning of English idioms through educational SMS in comparison with in-class contextualized learning and paper-based self-study approach. The researcher followed nonrandomized two control groups, pretest–posttest design. The students in the SMS-based group received 80 English idioms and their definitions through SMS technology, where each student in the group received four short mobile messages a day for 20 days. The findings showed that educational SMS enhanced students' gaining of English idioms more than in-class contextualized learning and paper-based self-study approach.

The potential of educational SMS to enhance students learning can be attributed to interrelated technological and pedagogical reasons. Educational SMS allow students to learn on their own pace, away from the traditional classroom (Cavus & Ibrahim, 2009), where students can learn anytime and anywhere (Basoglu, & Akdemir, 2010). "The benefits of being able to learn on the move at any place underpin an approach toward a flexible as well as personalized learning environment" (Hayati, et al., 2013, p. 76). Students tend to perceive the received SMS "simultaneously as personalized and as something shared with fellow students" (Harley, Winn, Pemberton, & Wilcox, 2007; p. 237). The convenience offered through receiving small size of educational content on easy to access and easy to use mobile phone, rather than using paper-based educational materials distributed in

classrooms have also contributed in enhancing students' learning (Zhang et al., 2011; Hayati, et al., 2013). "Learning in smaller chunks has support from learning psychology and short-term memory literature" (Bruck, Motiwalla & Forster, 2012, p.530). Furthermore, using SMS to send small bites of educational contents would allow students to invest their spare time in learning (Junfeng, 2010).

However, despite the findings of research studies that empirically showed that educational SMS would enhance students' learning, some researchers found that depending solely on the SMS technology to deliver educational content would only be effective for short term learning but not for long term one (Lu, 2008; Zhang et al., 2011)

Mixed results were found regarding students' reaction to the implementation of SMS to send information related to educational content. In one side students perceived SMS as effective, beneficial, motivating, flexible, convenient, stimulating, enjoyable, and entertaining teaching method (Kennedy & Levy, 2008; Cavus, & Ibrahim, 2009; Basoglu, & Akdemir, 2010; Zhang et al., 2011; Hayati et al., 2013). Students reported that SMS allows them to "take advantage of fragmented time" (Zhang et al., 2011; p.208), and make them feel that learning task is easier through breaking it down into small bites (Zhang et al., 2011). Students felt that using SMS as learning support tool improved their engagements in the course and helped them to "form the habit of self-regulated learning" (Zhang et al., 2011; p.208), where SMS "keeps people on task" (Kennedy & Levy, 2008, p. 323).

On the other sides, students reported some drawbacks and negative issues related to the use of SMS to send educational content. Some of the drawbacks were related to the limited capacity of the mobile phones in term of small screen size and keyboard (Hayati et al., 2013) and limited storage capacity (Zhang et al., 2011). Similar findings were reported in Stockwell's (2008) study ($n=75$) that aimed to investigated learners' awareness for and practice patterns of mobile learning. In Stockwell's (2008) study the researcher designed internet-based vocabulary learning system. There were two versions of the system, mobile and personal computer versions. The findings showed that that the majority of learners did not tend to use the mobile phone for language learning. The main barriers of intending to use mobile phone were "cost of internet access, the small screen size, the nature of the keypad, computers were sufficient, and the nature of the study environment" (Stockwell, 2008; p. 260).

Students also reported some negative issues related to the SMS technology i.e., the limited characters in a single SMS massage (Zhang et al., 2011) and the lack of pictures and visual stimulation (Cavus, & Ibrahim, 2009; Hayati et al., 2013). In addition, students have encountered some difficulties retrieving old educational messages on their phones (Zhang et al., 2011; Hayati et al., 2013). Some students reported that "messaging could be a source of annoyance and distraction" (Zhang et al., 2011, p. 210).

To date, a few research studies have focused on the applications of SMS in computer programming learning. One of these studies was conducted by Kert, (2011), the study aimed to investigate the effect of using educational SMS to support programming education. The researcher followed pretest–posttest control group design in which 40 students were divided in two equal groups, the experimental group and the control group. The students in both groups were registered students at programming language course in a Turkish university. Beside the receiving instruction in traditional classroom, the students in the experimental group received 27 mobile messages, which contain educational content, over seven weeks. The messages were sent in different time within the weekdays. The analysis of the two test scores show that there were significant differences between the pretest and posttest scores in favor of the posttest in the two groups. Furthermore, there were significant differences between the posttest scores for the experimental groups for the favor of the experimental group. The results of this study support the findings the of the research studies (Cavus, & Ibrahim, 2009; Basoglu, & Akdemir, 2010; Zhang et al., 2011; Hayati et al., 2013) that investigated the effectiveness of educational SMS in language learning.

Reviewing the literature showed scarcity of research studies that investigated the integration of SMS in the Jordanian higher education. The existing studies that examined the use of SMS to support learning were limited in term of number of participants, period of SMS implementation, and the learning subjects, i.e., language learning. In the discussed research studies, the purpose of the SMS experiments were limited to help students' retentions, where the designs of SMS experiments were supported from the principles of behaviorism learning theory. However, SMS can be integrated to help students' learning from the perspectives of other learning theories.

2.2 Theoretical Positions Underlying the Use of SMS in Educational Process

The ability of SMS to facilitate learning can be argued from any of the three major learning paradigms, namely behaviorism, cognitivism and constructivism.

Based on behaviorist learning paradigm, learning is occurred when an appropriate response is associated with a specific stimulus, where such association can be strengthened through positive reinforcement and practice (Ertmer & Newby, 1993). In this context, SMS can be used to send small information with its explanation or question along with its answer for learners. From this perspective, educational SMS can serve as stimulus-response tool as well as reinforcement for what students have learned in the class.

From the perspective of cognitive learning theory, learning has been viewed "as involving the acquisition or reorganization of the cognitive structures through which humans process and store information". (Good & Brophy, 1990; p. 187). The cognitive learning theory stresses the role of the mental operations and the memory processes in learning (Lave, 1993), where learning can be facilitated through repetition as well as hierarchical and meaningful information (Mergel, 1998). Through the lenses of the cognitive learning theory, educational SMS can be used to move students' short term memory to long term memory through the repetition of some of the key points that have been reviewed the traditional classroom. In addition, educational SMS can support students' understandings though connecting prior learning with new educational content.

Finally, constructivist scholars believe that "individual's knowledge is a function of one's prior experiences, mental structures, and beliefs that are used to interpret objects and events" (Steinmetiz & Nahrstedt, 2004, p.178). Therefore, learning should be active, constructive, intentional, authentic, and cooperative (Jonassen, Peck, & Wilson, 1999). In the context of constructivism learning environment, educational SMS can be used to stimulate learners to get involved in the learning process to facilitate more learner-centered environment outside the traditional classroom. Furthermore, educational SMS can be sent to students to motivate them to work in groups leading to collaborative learning. In his model for designing constructivist learning environments, Jonassen (1999) highlighted the need for instructional supports for students, in form of modeling, coaching, and scaffolding. Educational SMS can play integral role in providing such support while the students are away from the classroom.

3. Purpose of the Study

The purpose of this study is twofold: first, the study aimed to investigate the impact of using SMS as learning support tool on students learning in an introductory programming course; second, the study examined students' perceptions of the advantages and disadvantages of the use of to the use of SMS as a learning support tool in their introductory programming course. For the purpose of the study, two groups of students were formed, control and experimental groups. The students in the control group did not receive SMS support in the introductory programming course, while the students in the experimental group received SMS to support their learning in the course.

The study had two central research questions, which are:

1. What is the impact of using SMS as learning support tool on students' learning in an introductory programming course?

- Is there significant difference between the introductory programming students' pretest scores and posttest scores in the experimental group?

- Is there significant difference between the introductory programming students' posttest scores in the control and experimental groups?

2. What are the experimental group students' perceptions of the advantages and disadvantages of the use of SMS as a learning support tool in their introductory programming course?

4. Research Methods

Two different designs were used to achieve the twofold purpose of the study. In order to examine the impact of using SMS as learning support tool on students' learning in an introductory programming course, nonrandomized control group, pretest–posttest design was used. The same test was administrated twice to all subjects, before and after the SMS experiment, i.e., using of SMS as learning support for the students in the experimental group. The selected level of significance (alpha) was at 0.05 levels. The experiment lasted for twelve weeks, where each student in the experimental group received a total of 36 messages within these weeks.

In order to explore students' perceptions of the advantages and disadvantages of the use of SMS as learning support tool, ten students (5 female and 5 male students) were randomly selected for interviewing purposes. Semi-structured interviews were conducted with the participants.

4.1 Participants

The participants were group of students who were enrolled in an introductory programming class during fall 2012. The class presents introduction to programming concepts using Visual Basic 6 and its applications in education. The class offered by the department of curriculum and instruction, at college of education in a Jordanian university. The class was required for all the students in the college of education, where the students registered in the class in their third of fourth year of their undergraduate program. The age range of the participants was between 21 and 24 years old. All the students were new to programming. The language of instruction in the class was English.

The class offered in two sections in different days and time, but in the same computer lab. The class meets twice a week for three hours. The first researcher was the instructor of the two section of the class. The number of the students in the first section was 23 (8 male and 15 female students); while in the second section there were 31(18 female and 13 male students). A total number of 52 students, all the students in the first section and 29 students from the second section, approved to participate in the study. The researcher followed quasi experimental research where the first whole section (n=23) was randomly assigned to the control group, while the second whole section (n=29) was assigned to the experimental group. All the students, in the two groups, completed the study without dropping out.

4.2 Instruments

There were two instruments used in the current study, the pre-/posttests and the interview questions. Posttest was the same test as the pretest. The two instruments were developed by the researchers. The test was developed to measure students' knowledge and understanding of some main concepts related to visual basic 6. In the previous semester, a pilot study was carried out to establish reliability of the test, the Cronbach reliability coefficient for the test was found to be 0.7. The test consisted from 20 items in form of paper-based "drill- and- practice" questions.

The interview questions were constructed to investigate participants' perceptions of the advantages and disadvantages of the use of SMS as learning support tool in their class. The interview questions were reviewed by two colleagues in order to examine the validity of them; the reviewers provided some minor changes to interview questions. The interview questions were adjusted based on reviewers' comments. Each interviewed student answered five open-ended questions (Appendix A).

4.3 Procedure

After acquiring students' consents to participate in the study, the phone numbers of the students in the experimental group were collected at the beginning of the semester. Before starting the use of SMS as learning support tool with the experimental group students, a pretest was administrated in the second week of the semester for all the students in the control and experimental groups. At the beginning of the third week, SMS was implemented to support students' learning in the experimental group. Since it was the first time for the students to use SMS in the educational settings, the push mode was selected to keep the SMS integration as simple as possible. A total of 36 messages were sent to each student in the experimental group over 12 weeks. The researchers sent 3 messages a week in three different days. The educational content of the sent messages were developed and sequenced based on the analysis of the educational content of introductory programming course. Based on the reviewed learning theories, three types of educational contents were sent using SMS. Messages contained review of the main programming concepts that had been discussed in the class, messages contained hints to help students solving their assignments and projects, and messages contained triggering questions that would be discussed and solved in the next class meetings. The language of the sent messages was English. Table 1 shows example of these messages.

Table 1. Examples of the SMS that had been sent to support students' learning

Type of the messages	Examples
Review of programming concepts	To develop VB6 applications, there are three main steps: 1. Draw the user interface, 2. Assign properties to controls, 3. Attach code to controls.
	To set properties at run time in vb6, the code format is: ObjectName.Property = NewValue

Hints to solve assignments	For the dice assignment, to generate random number (n) between 1 to 6, the zero should be eliminated from the numbers. Therefore, use the following code: n = Int (1 + Rnd * 6).
	For the letters assignment, to ensure that the user would not leave the textbox empty, use the following code: if txtletter.text= "" then MsgBox ("Please, enter an answer")
Triggering questions	Now we know how to execute operation by clicking on a command, but how can you repeat certain operations at regular time intervals in VB6?
	Now we know how to draw graphics using controls, but how can you draw graphics using codes in VB6?

All the messages were sent in the weekdays that the students have no class meetings in order to help them keeping up with course. The messages were sent between 4 pm and 7 pm, in order to ensure that the students would not be in other classes at the time of receiving the messages. After the end of the experiment, a posttest was administrated in the fifteenth week of the semester for all the students in the control and experimental groups. After the administrating the posttest, ten students, from the SMS group, were randomly selected for interviewing purposes. Semi-structured group interviews were conducted with each one of them. The second researcher conducted the interviews. Each interview lasted from 20 to 30 minutes.

4.4 Data Analysis

Quantitative and qualitative data analysis techniques were used to analyze students' responses. In order to answer the first research question, two types of t-tests were used. The t-test for dependent samples was used to examine the difference between the pretest and posttest results of the students in the control and experimental groups. In order to test the initial equivalence among groups, the t-test for independent samples was used to examine the difference between the mean of the pretest results of the students in the control and experimental groups. In order to determine the effects of the SMS experiment i.e. using of SMS as learning support for the students in the experimental group, the t-test for independent samples was used to examine the difference between the mean of the posttest results of the students in the control and experimental group. In addition, analysis of covariance (ANCOVA) was employed to determine whether the means of posttest scores would be significantly different between the two groups when controlling for pretest as a covariate.

In order to answer the second research questions, participants' responses to the interview questions were organized, coded, interpreted, and represented.

5. Results

5.1 The Impact of Using SMS as Learning Support Tool

In order to answer the first part of the of the first research question, t-test for dependent samples was performed. Table 2 shows that, for the participants in the control group, the mean of the pretest scores (M = 15.21, SD = 6.12) was significantly different than the mean of the posttest scores (M = 69.34, SD = 13.50), t (22) = -27.35, p = .00. In addition, for the experimental group, the mean of the pretest scores (M = 15.69, SD = 6.23) for the participants was significantly different than the mean of the posttest scores (M = 77.93, SD = 9.86), t (28) = -46.91, p = .00.

Table 2. T-Test for dependent samples for the pretest and posttest of the control and experimental groups

		Mean	N	Std. Deviation	t	df	Sig. 2-tailed
Control Group	Pretest	15.21	23	6.12	-27.35	22	.00
	Posttest	69.34	23	13.51			
Experimental Group	Pretest	15.69	29	6.23	-46.91	28	.00
	Posttest	77.93	29	9.86			

In order to answer the second part of the of the first research question, t-test for independent samples was performed. Table 3 shows that the mean of the pretest scores for the participants in the control group (M = 15.21, SD = 6.11) was not significantly different than the mean of the posttest scores for the participants in the experimental group (M = 15.68, SD = 6.22), t (50) = -.274 p = .78. But the mean of the posttest scores for the participants in the control group (M = 69.34, SD = 13.50) was significantly different than the mean of the posttest scores for the participants in the experimental group (M = 77.93, SD = 9.86), t (50) = -2.64, p = .011. The mean of the posttest scores for the participants in the experimental group was higher than the control group.

Table 3. T-Test for independent samples for the pretest and posttest of the control and experimental groups

		Mean	N	Std. Deviation	t	df	Sig. 2-tailed
Control Group	Pretest	15.21	23	6.11	-.274	50	.785
Experimental Group	Pretest	15.68	29	6.22			
Control Group	Posttest	69.34	23	13.50	-2.64	50	.011
Experimental Group	Posttest	77.93	29	9.86			

Furthermore, Pearson correlation coefficient between the pretest and posttest of the control and experimental groups was computed. The results showed that that pretest and posttest of the control and experimental groups were positively correlated, Pearson's r (52) = .7, p < .05.

Therefore, ANCOVA was conducted to show whether the means of posttest scores would still be significantly different between the two groups when controlling for pretest as a covariate. Table 4 shows the results of the Analysis of ANCOVA. The independent variable was the teaching method (the control group or experimental group). The dependent variable was the students' posttest scores and the covariate was the students' score on the pretest. The results indicate that after controlling for pretest scores, the differences in posttest scores are statistically significantly different between the two groups, F(1,49)=12.55, p < .05.

Table 4. Analysis of covariance for the posttest of the control and experimental groups

Source	SS	df	Mean Square	F	Sig.
Pretest	3592.71	1	3592.71	55.91	.000
Method	806.53	1	806.53	12.55	.001
Error	3148.36	49	64.25		
Total	293475.00	52			

5.2 Students' Perceptions of the Advantages and Disadvantages of the Use Of SMS

5.2.1 Advantages of the Use of SMS

Overall, the interviewed students showed positive perceptions regarding the use of the SMS as a learning support tool in their education. Several advantages of the use of SMS as a learning support tool were reported. Some of

these advantages were technology related. Most participants reported that they are familiar with the use of the SMS technology, where they considered it cheap and easy to use technology.

Ahmad stated that *"I am used to communicate with my relatives and friends by SMS all the time. My phone plan allows me to send 500 messages for free each month and I usually use all of these messages. Vise verse, I receive several messages a day".* In addition, Muna stated that*" I love to send and receive SMS because it is fast and easy to use".*

Some participants pointed to the convenience of using SMS as an electronic communication mode, where they appreciated the capabilities of SMS technology in terms of being quiet, immediate, anytime, and anywhere mode of communication.

Sana stated that "*among the different technological communication methods, I prefer to use SMS because I can send and receive messages anywhere and anytime using my cell phone"* Furthermore, Ayman stated that "*SMS allow me to communicate with others when I cannot use voice call such as in official meetings or family gathering".*

As a learning support tool, the interviewed students valued the use of SMS to support their leaning. The majority of the students pointed that sending educational contents using SMS had facilitated their learning and helped them in the retention process of the key concepts of the subject of the class. Ahmad noted that *"educational SMS made learn about the important information that I need to focus on".* Moreover, Mohammad pointed that "*receiving educational content, using SMS made me remember these content better because I learn about these content more than once, in the classroom and by SMS, where whenever I have free time I open my messages inbox to re-read the educational SMS".* While, Sawsn stated that *"it is really easier to remember educational content when it is in form of smaller units received overtime not at once".*

Most of participants believed that receiving educational SMS has improved their understanding of the educational materials. Fares stated that *"the educational hints that I received helped me in getting my assignment done, I remember once that I was working on an assignment and I received a hint through SMS that really helped me getting through that homework".* In addition, Jamel noted that *"the educational hints helped me keep thinking about the assignments".*

The students believed that the use of SMS helped them in indirect way to in their class. Some of the students believed that SMS ring acted as a stimulus for them to study on the subject of the class. Jana stated that "wh*enever I hear the ring of SMS I remember that I need to open my computer to study or to work on an assignment related to visual basic 6".* While others noted that the use of SMS made them rely more on it to communicate with other students in matters related to the class, where that improve their learning. Fares stated that *"I have never used SMS to communicate with peers, but in this class, receiving educational SMS from instructor has motivate me to get other students' phone number and to exchanges messages related to the subject of the class".* Some students pointed to the role of the questions, that had be sent to them using SMS, in keeping them connected to the class. Fadia stated that *"sometime when I cannot answer a question sent by the SMS, I make sure to attend the next class to know the answer".*

5.2.2 Disadvantages of the Use of SMS

All the interviewed students believed that the use of SMS technology as learning support tool has more advantages than disadvantages. However, some of the reported disadvantages were related to the technology itself. A few students mentioned the limited capacity of the SMS in term of the limited number of characters that can be sent in one SMS message. In addition, couple of students complained about the lack of formatting options in the SMS. Jana stated that *"with SMS you can only send or receive plain text without being able to modify the text such as changing the size, color, or type of the text".*

As a learning support tool, some participants criticized the use of SMS in one way direction (instructor to students). Jamel explained *"it was a good idea to use SMS to send educational information for students, but I think a better idea is to use SMS as a two-way channel of communication between instructor and students to exchange different type of information such as educational and administrative information".* In addition, Sawsn stated that *"using SMS in two-way communication will be very helpful for me, where I can have immediate help when I face difficulties related to the subject of the class".*

6. Discussion

6.1 The Impact of Using SMS as Learning Support Tool

The analysis of the students' scores in the pretest and posttest revealed that students' learning had significantly improved in the two sections of the programming class i.e. the one with the use of SMS as learning support tool and the one without the use of the SMS. However, the finding of the study indicated that teaching through traditional face-to-face instruction with the use of SMS as learning support tool was more effective to improve students' learning than relying on only in-class instruction in the programming course. The findings of this study supported the findings of the literature that discussed the potential of SMS to support students learning, e.g. the Cavus, and Ibrahim's, (2009) study in which the SMS was used to support traditional face-to-face learning for English words, Kert's (2011), study in which SMS was used to support traditional face-to-face learning for programming education, and Hayati, Jalilifar, and Mashhadi's, (2013) study in which the SMS was used to send English idioms to English as a Foreign Language (EFL) students. However, the findings of the current study showed that effectiveness of SMS to be used to send different educational contents, e.g., hints to solve assignments and triggering questions, rather that only plain piece of educational content.

Based on the different types of the received SMS, this result can be justified through the lenses of different learning theories. From the behavioural and cognitive perspectives, sending SMS the consisted of small piece of information i.e. review of programming concepts, that had been discussed in the class, provided the students with multiple opportunities for repetition without information overload, consequently better retention and learning was achieved. From the cognitive and constructivist perspectives, the triggering questions helped the students to connect their prior knowledge to new topic. While the educational hints provided students with off-class instructor support to help them understanding and solving assignments and projects.

6.2 Students' Perceptions of the Advantages and Disadvantages of the Use of SMS

Students' perceptions of the implemented learning technology have direct effect on the successful integration of the technology (Cope & Ward, 2002). The analysis of the students' responses to the interview questions showed that students perceived the use of SMS technology as learning support tool to have more advantages than disadvantages. The reported advantages can be categorized in two groups, technology –related and education-related advantages. The findings indicated that the students perceived SMS as being familiar, easy to use, immediate, convenient, ubiquitous, and quiet communication technology. As leaning support tool, the students perceived SMS as an effective tool in their learning in direct and indirect ways. The direct advantages include helping them focusing on and remembering key points in the class, and supporting them in understanding and completing their assignments and projects. While the indirect advantages include motivating the students to review the class materials and to solve assignments, encouraging students to use SMS to communicate with other students in relation to class subject, and motivating students attend the class. The presented findings regarding the students' positive perceptions of the use of SMS as learning support tool were similar to the findings reported in literature e.g. Kennedy & Levy, (2008), Zhang et al., (2011), and Hayati et al., (2013) studies that investigated students' perceptions of the use of SMS in language learning.

Students' positive perceptions of the use of SMS in their education were helpful in understanding the positive impact of the use of SMS on students learning. Besides helping students focusing on, remembering, and understanding programming concepts, the use of SMS was effective in motivating students to learn in term of reviewing class materials, solving assignments, and attending class. Research studies have shown a significant association between students' learning and their motivation to learn (Wentzel, & Wigfield, 1998; Linnenbrink & Pintrich, 2002). In addition, the use o SMS as learning support tool have encouraged collaboration among students, where students started to rely more on SMS to exchange information related to the subject of the class. From the perspective of constructivism, students' cooperation is an essential for their learning (Jonassen, et al., 1999).

The number of the reported disadvantages of the use of SMS as learning support tool was limited. The reported technology related disadvantages were the limited number of characters that can be sent in one messages, and the lack format options for the text in the mobile messages. Similar findings were reported in Zhang et al., (2011), where students complained about character limit in SMS. However, in contrast with the results of other studies, e.g., Stockwell, (2008); Zhang et al., (2011); and Hayati et al., (2013), students did not complained about the difficulties in retrieving old messages and the limited capacity of the phone in term of small screen size and keypad. That can be attributed to the advanced models of mobile phone they own e.g., smart phones and PDAs.

On the educational use of SMS, the findings indicated the some participants believed that the main disadvantages of the SMS experiment were related to the limited use of the SMS. Some students believed the use of SMS

would be more advantageous if it was used to send administrative information along with the educational ones. Furthermore, some students complained about the SMS being used one way communication rather than two ways. Such reported disadvantages give indication about the students' interest of extending the use of SMS to provide more learning and administrative support.

7. Conclusion

From this research study, it can be concluded that the use of SMS as learning support tool is an effective tool to support students' programming learning in multiple ways. SMS can improve students' focus on and retention of the main concepts of programming language. It can help students to understand and solve programming assignments and projects. Furthermore, the use of SMS in the learning process has the potential to act as motivational tool for the students to learn. The findings showed that SMS had stimulated the students to review class materials, to solve assignments, to cooperate with each other, and to attend class. Overall, the students' perceptions of the SMS as communication tool and as learning support tool were positive.

Similar to the findings that showed the effectiveness of SMS in language learning, SMS also can be an effective learning support tool in programming education. The findings of this study were similar to the findings of several research studies (Kennedy & Levy, 2008; Cavus, & Ibrahim, 2009; Basoglu, & Akdemir, 2010; Zhang, et al., 2011; Hayati, et al., 2013) that showed the potential of SMS to facilitate learning from the behaviorism perspective i.e. support retention. In addition, the results of this study showed the potential of SMS to support students' learning from the perspectives of cognitivism and constructivism learning theories.

In the light of the current findings, developing countries, e.g. Jordan should take advantages from the potential of mobile phones technologies for educational and administrative applications. Mobile phone services are already available and mobile phones are very popular among students who have limited access to internet and computers. In opposite to computer and internet technologies, mobile phone technologies do not require large investments in technological infrastructures and resources. However, more research studies are needed to investigate the various applications of SMS e.g., the use of SMS as motivational tool, two-way interaction tool, and administrative tool. In addition, further research studies need to investigate the potentials of other mobile phone services e.g., podcast, Multimedia Messaging Service (MMS) and mobile videos for educational purposes.

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Appendix

Appendix A: Open-Ended Survey Questions

1.   What do you think about the use of SMS as educational tool?

2.   What are the advantages of SMS as an educational tool?

3.   What are the disadvantages of SMS as an educational tool?

4.   In which ways the use of SMS as an educational too affect your education?

5.   What are your suggestions to improve the use of SMS as an educational tool?