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The impact of paper-based, computer-based and mobile-based self- assessment on students' science motivation and achievement

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ABSTRACT

The present study focuses on the implementation of a self - assessment procedure in a Physics class, extended during a seven weeks period in a European secondary level school. The researchers used three modes of assessment based on paper and pencil, computer-web and mobile devices respectively. The aim of the study is to investigate the effect of each mode of assessment on students' motivation and achievement. Analysis of pre- and post-motivation tests revealed a more positive motivational orientation of students towards computers and mobile devices as assessment delivery mediums. Also, student evaluation implemented after the phase of the experimental procedure showed a significant increase in learning achievement for low-achieving students who participated in the mobile-based and computer-based assessment. The positive effects of computers and mobile devices on students' learning motivation suggest that they can be used as a promising alternative to paper and pencil assessment procedures.

Keywords

Mobile learning, self- assessment, mobile-based assessment, computer-based assessment, motivation, STEM

1. Introduction

Science, Technology, Engineering, and Math (STEM) education is gaining more and more importance lately due to the growing demand in Science and Technology jobs from one site and the decline in student interest to follow STEM careers from the other (DPE, 2013; U.S. Department of Education, 2013). Different pedagogical approaches along with appropriate educational technologies need to be employed in order to enhance students' motivation towards STEM disciplines (OECD, 2008, Kearney, 2010). Assessment is one fundamental issue in every educational ecosystem. Different assessment delivery media (paper and pencil, computers or mobile devices) lead to different assessment modes: Paper-Based Assessment (PBA), Computer-Based Assessment (CBA) or Mobile devices-Based Assessment (MBA) respectively. One way to enhance students' learning motivation can be accomplished through appropriate assessment practices and conditions (Stefanou & Parkes, 2003). According to Wenemark et al. (2011) testing mode has an impact on test-taking motivation and hence testing performance.

The present study investigates the impact of different assessment media (paper-based, computer-based and mobile-based) on students' motivation and achievement towards learning high-school Physics. Since Physics is in the heart of STEM, investigating the impact of different assessment modes onto learning motivation and performance may lead to further enhancement of student motivation, engagement and achievement. The study starts with a brief theoretical background about learning motivation and self-assessment. Then, it proceeds with the experimental method (participants, instruments, procedure). Results section follows along with discussion and conclusions as well as limitations and future research.

2. Theoretical Background

Motivation is "the process whereby goal-directed activity is instigated and sustained" (Pintrich & Schunk, 2002, p. 5). Motivation to learn is "a student tendency to find academic activities meaningful and worthwhile and to try to derive the academic benefits from them" pp. 205-206 (Brophy, 1988) and it is a critical factor affecting learning (Lim, 2004). Many theories provide frameworks to study learning motivation. The current research uses the work of Glynn and Koballa (2006) as the theoretical framework to study the construct of Science learning motivation. The exploratory factor analysis by Glynn et al. (2009) provided insight into how students conceptualized their motivation to learn science. According to this framework, the current study considers the following subcomponents of Science learning motivation: intrinsic motivation, extrinsic motivation, self-efficacy, self-determination, personal relevance and anxiety. Intrinsic motivation refers to doing something because it is interesting and enjoyable while extrinsic motivation refers to doing something because of external rewards (Deci & Ryan, 1985). Self efficacy refers to students' belief that they can achieve well in science (Lawson, Banks, & Logvin, 2007). Self-determination refers to the control students believe they have over their learning of science (Black &

Deci, 2000). All the above motivational components influence self-regulatory learning (Glynn & Koballa, 2006). In order to provide the appropriate learning conditions for self-regulatory learning we implemented a series of self-assessment tasks. During the process of self-assessment, students have the ability to monitor and evaluate the quality of their own learning. Research shows that self-assessment improves student motivation, engagement and learning (McMillan, & Hearn, 2008).

Self-assessment can be delivered through paper-and-pencil, computers-web or internet-connected mobile devices. Despite the ongoing shift from traditional paper-and-pencil towards computer-based assessments (Scherer & Siddiq, 2015), the impact of computers and mobile devices vs. paper-and-pencil delivery modes on students' performance and motivation has not been fully explored yet. Comparisons of test scores across different assessment types produced contradicting results (Nikou and Economides, 2013). In some studies students scored higher on computer versus paper administration (Clariana & Wallace, 2002; Wallace & Clariana, 2005), while in others no difference in test scores were found (Jeong, 2012; Chua & Don, 2013).

There is an interesting line of research that focus on investigating different delivery mediums with respect to students' attitudes (Macario, 2009; Macedo-Rouet et al., 2009; OECD, 2010; Deutsch et al., 2012; Sun, 2014; Hwang & Chang, 2011; Chen, 2010; Huff, 2015), motivation (Chua & Don, 2013; Chua, 2012; Timmers et al., 2013; Shih et al., 2011; Romero, Ventura, & de Bra, 2009) and learning achievement as well (Chen & Chung, 2008; Cakir & Simsek, 2010; de-Marcos et al., 2010; Looi et al., 2011; Song, 2014; Looi, Sun & Xie, 2015). Most studies show mixed results. However, there are a considerable number of studies providing evidence that technology mediated delivery modes have a positive impact on attitudes and performance. Table 1 presents an overview of the results. There are studies revealing the positive impact that computer-based assessments have on student motivation and learning (Chua, 2012; Wilson, Boyd, Chen, & Jamal, 2011). Also, other studies show that mobile-based assessments can promote learner's motivation both inside the classroom boundaries e.g. classroom response systems (Sutherlin, Sutherlin, & Akpanudo, 2013) as well as in ubiquitous learning scenarios outside the classroom (Shih, Chu, Hwang, & Kinshuk, 2011; Chu, Hwang, Tsai, & Tseng, 2010). Usually, studies focusing on the impact of technology mediated assessment on learning motivation and performance deploy a single learning or assessment strategy. To our knowledge, no studies exist that comparatively investigate the effect that paper-and- pencil-, computer- or mobile-based self-assessments have on the motivational orientation and learning achievement of high-school students towards learning science. In the context of STEM secondary education, the current study adds to the existing literature by comparatively and simultaneously investigating both motivational factors and performance issues in respect to all three self-assessment delivery modes (paper-, computer- and mobile-based).

Table 1.
Impact of paper-, computer- and mobile-based delivery on students' attitudes, motivation and performance

Study		Results
Computer-based assessments		
Chua and Don (2013)	-	computer-based testing increased participants' intrinsic motivation, self-efficacy and anxiety
Timmers et al. (2013)	-	positive effects of invested effort and self-efficacy on achievement in computer-based assessments
Deutsch et al. (2012)	-	a web-based mock examination changes attitudes in favor of computer-based assessment
Chua (2012)	-	CBT develops stronger self-efficacy, intrinsic and social testing motivation
Cakir and Simsek (2010)	-	no significant difference exists between students who studied in a computer-based environment and a paper-based environment
OECD (2010)	-	students enjoyed computer-based tests more than the paper-and-pencil tests
Macedo-Rouet et al. (2009)	-	students preferred paper-based delivery mode for learning and assessment
Macario (2009)	-	most student participants prefer computer-based assessments over paper-and-pencil based ones
Mobile-based assessments		
Looi, Sun and Xie (2015)	-	the experience of the mobilized science curriculum improves students' test results, engagement and self-reflection
Sun (2014)	-	mobilized science curriculum increases students' motivation for answering questions and improves student learning in terms of test achievement
Song (2014)	-	the use of mobile devices (compared to the paper-based material) leads to better students' understanding of the subject matter with positive attitudes toward seamless science inquiry
Looi et al. (2011)	-	a mobilized science curriculum (compared to a traditional program) increases student engagement and performance
Hwang and Chang (2011)	-	a formative assessment mobile–based approach promotes students' learning interest and attitude and also improves learning achievement
de Marcos et al. (2010)	-	m-learning auto assessment improves student achievement
Romero, Ventura and de Bra (2009)	-	students were highly motivated and enjoyed using mobile application for testing while no significant differences in the results obtained
Chen & Chung (2008)	-	personalized mobile-based English vocabulary learning promotes learning performances and interests of learners

3. Methodology

3.1 Participants

The participants were 66 students from a European upper high school. The sample consisted of 34 males (51%) and 32 females (49%). The average age of students was 16.2 (SD = 0.99). They were all enrolled in a Physics course (part of their official curriculum) having the same educational background. All students had the same exposure to information technologies. Based on a self-reported questionnaire about computer efficacy as well as mobile-devices efficacy they were asked to fill in (Kenny et al., 2012), they had the same average level of computer and mobile devices skills. Students were randomly assigned into three groups: 23 students (35% of the participants) to the paper and pencil group (PBA), 21 students (32% of the participants) to the computer group (CBA) and 22 students (33% of the participants) to the mobile-devices group (MBA). PBA group used paper and pencil, CBA group used computers and MBA group used mobile devices in order to answer a series of fourteen (14) self-assessment tasks delivered to them during a period of seven weeks (2 tasks per week).

3.2 Instruments

The assessment tasks were quizzes designed by the classroom teacher and they were drawn from the field of Electromagnetism (electrical fields, electric potential, magnetic fields, electromagnetic induction and Laplace force). Each quiz consisted of 10 multiple choices, true-false or fill-in-the blank questions capturing conceptual knowledge. The quiz questions were the same over the PBA, CBA and MBA while the interface kept as similar as possible among the three media of delivery. Fig. 1 shows a sample question in CBA and Fig. 2 shows the same question in MBA.

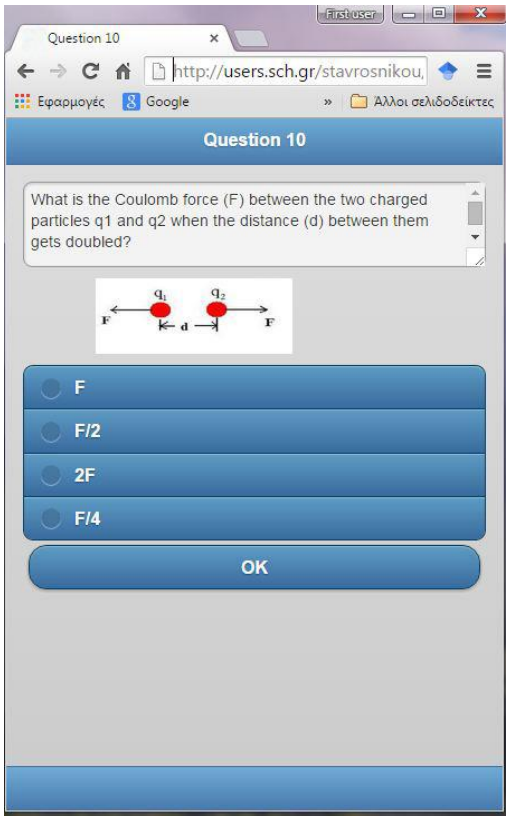

Figure 1. Sample question in CBA

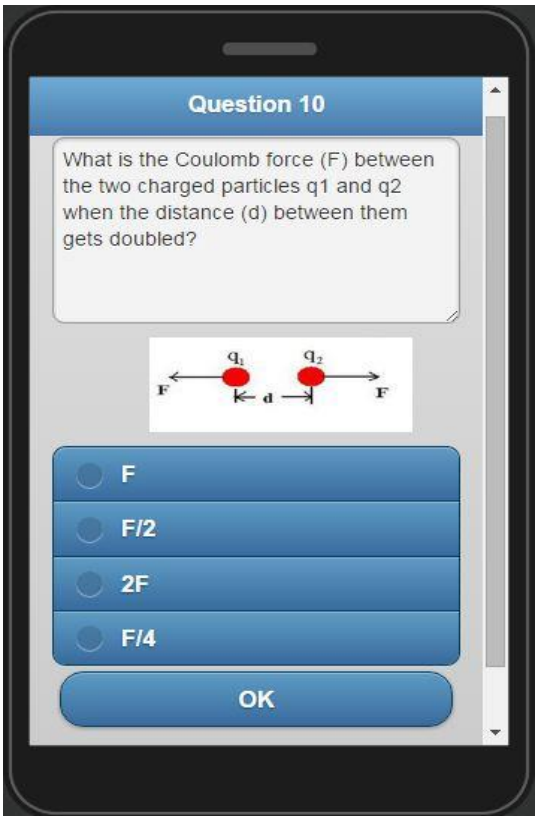

Figure 2. Sample question in MBA

Each question was followed by a simple form of feedback indicating correct/incorrect along with a short informative message stressing the appropriate study material for review when appropriate. Students were asked to answer the quizzes after school hours, during their personal study time. While in CBA and MBA feedback was given online, in PBA a separate instruction sheet with the answers was given for student assistance. Their ultimate goal was to support students to self-monitor their progress and keep them engaged.

The questionnaire used to evaluate student motivation is the Science Motivation Questionnaire (SMQ). It is a 30-item questionnaire developed by Glynn and Koballa (2006) and it is used to assess six components of students' motivation to learn science in college or high school. The six components are intrinsic, extrinsic, personal relevance, self-determination, self-efficacy, and anxiety. The questionnaire has been extended to a discipline-specific version, the Physics Motivation Questionnaire (PMQ).

The questionnaire proved to be reliable and valid with high internal consistency (Glynn, Taasoobshirazi, & Brickman, 2009; Bryan, 2009). Appendix A. shows the motivational scales of the adapted version of PMQ (with permission from its authors) that measure motivation towards the three assessment modes. The motivation scales ranged from 1 (Strongly disagree) to 5-points Likert type scale (Strongly agree).

3.3 *Research Design*

The experimental procedure follows a quasi-experimental pre-post test research design as depicted in Figure 3.

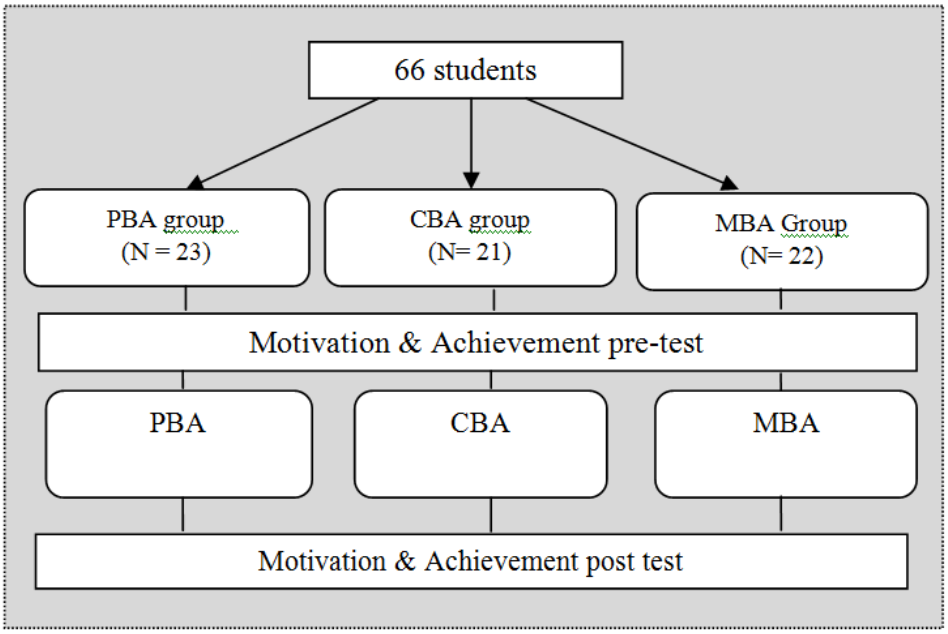

Figure 3. Research design

The three groups were equivalent in terms of prior ability and motivation. 20 multiple-choice questions from the fields of Electricity and Magnetism used to evaluate student ability in Physics before the implementation of the seven week self-assessment procedure. One-way analysis of variance, reveals that no significant difference on Physics achievement among the three groups exist [$F(2,63) = 0.365$, $p = 0.696$] at this initial stage. Also, one-way analysis of variance, reveals that there was no significant difference on motivation among the three assessment modes, [$F(2,63) = 0.220$, $p = 0.803$]. The internal consistency (Cronbach's alpha) for all motivational subscales for both pre-test and post-test conditions were all satisfactory (> 0.7) as Table 2 shows. These values indicate an acceptable level of reliability and validity.

Table 2.
Reliability (Cronbach's alpha) for pre-test and post-test subscales

	pre-test motivation	post-test motivation
Intrinsic	0.89	0.90
Extrinsic	0.71	0.72
Personal Relevance	0.77	0.79
Self-determination	0.81	0.83
Self-efficacy	0.85	0.79
Anxiety	0.88	0.89
Overall Motivation	0.77	0.79

After the seven week self-assessment procedure, students answered the same Physics Motivation Questionnaire (as a post-test). Also their knowledge gain in the field of Electromagnetism was assessed through a 20 multiple-choice questions from Electricity and Magnetism domain.

4. Data Analysis and Results

Table 3 shows the paired samples t-tests comparing the means for the grades and motivation along with its subscales between the pre-test and the post-test condition for mobile-based assessment (MBA), Table 4 for computer-based (CBA) and Table 5 for paper-based (PBA). The values of Cohen's d effect size were calculated based on the mean and standard deviation scores. Cohen defined effect sizes as small when $d \leq 0.49$, medium when $0.50 \leq d \leq 0.79$ and large when $d \geq 0.80$ (Cohen, 1988).

4.1 The impact of assessment delivery medium on learning achievement

Results show that there was an overall increase in learning achievement (grades) for all testing modes. For the MBA group there was a significant difference between the post-test and pre-test grades [$t(21) = 5.38$, $p = .00$; $d = 0.35$]. Also there was a significant difference [$t(20) = 4.81$, $p = .00$; $d = 0.19$] between post-test and pre-test grades for the CBA group. Post-test grades for MBA and CBA are significantly higher than the pre-test grades accordingly. For the PBA group there were no significant differences between pre- and post-test grades.

4.2 The impact of assessment delivery medium on motivation

Results show that there was an overall increase in student motivation for all testing modes. For the MBA group significant differences between the motivation means (pre-test and post-test values) were found for overall motivation [$t(21) = 8.12$, $p = .00$; $d = 0.22$], intrinsic motivation [$t(21) = 6.71$, $p = .00$; $d = 0.40$], extrinsic motivation [$t(21) = 4.21$, $p = .00$; $d = 0.24$], and self-efficacy [$t(21) = 14.82$, $p = .00$; $d = 0.12$]. Also significant differences were found for the CBA group and specifically for the overall motivation [$t(20) = 3.81$, $p = .00$; $d = 0.13$], intrinsic motivation [$t(20) = 6.32$, $p = .00$; $d = 0.36$], extrinsic motivation [$t(20) = 4.29$, $p = .00$; $d = 0.26$] and self-efficacy [$t(20) = 5.92$, $p = .00$; $d = 0.24$]. There were no significant differences between pre- and post-test motivation values for the PBA group.

Table 3.
Paired samples test on grades and motivation for mobile-based assessment

	pre-test Mean (SD)	post-test Mean (SD)	Mean Difference	T test t value (df=21)	Effect size (Cohen's d)
Grade	14.41 (3.48)	15.54 (2.97)	1.14	5.38 **	0.35
Overall Motivation	95.27 (22.33)	100.21 (21.46)	4.72	8.12 **	0.22
Intrinsic	14.54 (3.39)	15.90 (3.57)	1.36	6.71 **	0.40
Extrinsic	16.59 (3.89)	17.59 (4.29)	0.99	4.21 **	0.24
Personal Relevance	15.59 (3.57)	15.77 (3.58)	0.18	0.85	0.05
Self-determination	18.45 (4.48)	18.63 (4.24)	0.19	1.29	0.04
Self-efficacy	16.59 (3.89)	18.18 (3.59)	1.59	14.82 **	0.44
Anxiety	13.59 (3.23)	13.95 (2.90)	0.36	1.63	0.12

* p < .05, **p < .01

Table 4.
Paired samples test on grades and motivation for computer-based assessment

Dimension	pre-test Mean (SD)	post-test Mean (SD)	Mean Difference	T test t value (df=20)	Effect size (Cohen's d)
Grade	13.52 (3.40)	14.14 (3.13)	0.62	4.81 **	0.19
Overall Motivation	96.85 (22.66)	99.76 (21.41)	2.90	3.81 **	0.13
Intrinsic	15.71 (3.56)	17.05 (3.80)	1.30	6.32 **	0.36
Extrinsic	16.62 (3.93)	17.66 (4.21)	1.05	4.29 **	0.26
Personal Relevance	15.71 (3.56)	15.57 (3.28)	- 0.14	- 0.77	-0.04
Self-determination	18.57 (4.23)	18.76 (4.01)	0.19	1.23	0.03
Self-efficacy	15.71 (3.93)	16.61 (3.37)	0.90	5.92 **	0.24
Anxiety	14.71 (3.38)	15.04 (3.05)	0.33	1.43	0.11

* p < .05 , **p < .01

Table 5.
Paired samples test on grades and motivation for paper-based assessment

Dimension	pre-test Mean (SD)	post-test Mean (SD)	Mean Difference	T test t value (df=22)	Effect size (Cohen's d)
Grade	13.86 (3.40)	14.21 (3.44)	0.34	1.40	0.10
Motivation	93.52 (20.27)	94.17 (20.78)	0.65	1.76	0.03
Intrinsic	14.39 (3.21)	14.69 (3.35)	0.30	1.57	0.09
Extrinsic	16.21 (3.57)	16.17 (3.83)	-0.04	-0.19	-0.01
Personal Relevance	15.21 (3.28)	15.13 (3.47)	-0.08	-0.40	-0.02
Self-determination	18.13 (3.86)	18.04 (3.94)	-0.09	-0.42	-0.02
Self-efficacy	16.21 (3.57)	16.39 (3.65)	0.17	0.99	0.86
Anxiety	13.39 (2.85)	13.47 (3.18)	0.09	0.42	0.02

* p < .05, **p < .01

4.3 Performance and Motivation for low, medium and high achievers

Also results indicate that the assessment delivery mode has a differentiated impact on performance and motivation depending on the student achievement level. Table 6 shows performance and motivation levels for MBA, CBA and PBA for low, medium and high achievers. For low-achieving students participating in MBA there was a significant difference between post- and pre-test grades [$t(6) = 6.30$, $p = .00$; $d = 1.47$] and motivation values [$t(6) = 13.48$, $p = .00$; $d = 1.07$]. Also for medium-achieving students participating in MBA there was a significant difference between post- and

pre-test grades [t(7) = 3.42, p = .00; d = 0.53] and motivation values [t(7) = 3.72, p = .00; d = 0.57]. Low-achieving students participating in CBA also have a significant difference in grades [t(7) = 9.00, p = .00; d = 0.64] and motivation [t(7) = 7.52, p = .00; d = 0.46]. Also a significant difference was found in motivation of CBA high-achievers [t(4) = 4.47, p = .00; d = 0.27]. No significant differences in grades and motivation were found for the rest of student subgroups.

4.4 Performance, Motivation and Gender

One-way analysis of variance, revealed that there was no significant difference on motivation between male and female students, [F(1,64) = 1.83, p = 0.180] before the tests. Also, there was no significant difference on motivation levels between male and female students after the tests, [F(1,64) = 1.89, p = 0.169] indicating that the testing modes did not affect differently performance and motivation of male and female students.

Table 6.
Performance and motivation for low, medium and high achievers

	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Difference	T test t value	Effect size (Cohen's d)
		Mobile-based testing			
Low-achievers				(df=6)	
Grade	10.43 (1.40)	12.57 (1.51)	2.27	6.30 *	1.47
Motivation	71.71 (9.07)	78.75 (0.14)	7.04	13.48 **	1.07
Medium-achievers				(df=7)	
Grade	14.37 (1.06)	15.00 (1.31)	0.63	3.42 *	0.53
Motivation	100.50 (5.26)	103.50 (5.15)	3.00	3.72 *	0.57
High-Achievers				(df=6)	
Grade	18.43 (1.07)	19.00 (1.27)	0.57	1.50	0.23
Motivation	112.86 (8.89)	117.36 (8.05)	4.50	2.04	0.21
		Computer-based testing			
Low-achievers				(df=7)	
Grade	10.00 (1.85)	11.12 (1.64)	1.12	9.00 **	0.64
Motivation	73.60 (8.94)	77.50 (8.07)	3.87	7.52 *	0.46
Medium-achievers				(df=7)	
Grade	14.33 (1.06)	14.50 (1.19)	0.17	1.00	0.11
Motivation	102.00 (9.50)	104.87 (9.14)	2.87	0.20	0.02
High-Achievers				(df=4)	
Grade	17.8 (0.84)	18.40 (0.89)	6.00	2.45	0.14
Motivation	125.2 (7.60)	127.20 (6.90)	2.00	4.47 *	0.27
		Paper-based testing			
Low-achievers				(df=8)	
Grade	9.57 (1.30)	09.43 (1.51)	0.14	2.00	0.04
Motivation	77.58 (8.80)	77.71 (0.14)	0.13	7.57	0.12
Medium-achievers				(df=7)	
Grade	14.35 (1.12)	14.44 (1.31)	0.09	0.07	0.16
Motivation	99.90 (4.56)	101.50 (5.15)	3.00	1.90	0.06
High-Achievers				(df=5)	
Grade	18.14 (1.07)	18.43 (1.27)	0.29	2.50	0.04
Motivation	114.43 (9.79)	115.86 (8.05)	1.43	4.04	0.02

* p < .05, **p < .01

5. Discussion and Conclusions

This study aims to contribute to the related literature by comparatively examine the impact of paper-, computer- and mobile-assisted self-assessment on student motivation towards learning Physics. Previous research shows that appropriate use of digital technologies can have significant positive effects on students' attitudes and achievement (Serradell-López et al., 2010). The current study provides evidence that the delivery mode of self-assessment (through paper and pencil, computer or mobile device) has an impact on students' motivation and learning achievement.

Analysis of the results indicate that when mobile devices or computers are used for delivering self-assessments to high school students, their overall motivation towards learning science (including intrinsic motivation, extrinsic motivation and self-efficacy) increases. Higher learning motivation levels are also accompanied by higher learning performance as well, confirming previous research findings that motivation is the most important driving force to explain online students' achievement. (Castillo-Merino & Serradell-López, 2014).

Students' engagement in the assessment procedure using computers or mobile devices (instead of the traditional paper-and-pencil assessments) encourages their motivational beliefs. Study participants, especially low achievers, self-reported an increased interest (intrinsic and extrinsic motivation) and self-efficacy. High school students enjoy participating in self-assessments using computers or mobile-devices (intrinsic motivation) and also feel rewarded (extrinsic motivation). Previous research investigated the factors that impact the behavioral intention to use computer-based assessment from the perspective of the Technology Acceptance Model (Terzis & Economides, 2011). Furthermore, motivational enablers have been introduced in the above model to study the acceptance of mobile-based assessment as well. Intrinsic motivation has been found to have a sound impact on behavioral intention to use mobile-based assessment (Nikou & Economides, 2014).

Beyond intrinsic motivation (the inherent enjoyment and interest of the task itself) and extrinsic motivation (the motivation to engage in an activity because it is rewarding itself and also may be perceived as being personally important), students also feel confident about using computers or mobile devices to answer the questions. Students' perceived ability to succeed in the assessments refers to as self-efficacy. Engagement with technology can empower students' self-efficacy in general and in relation to STEM education (Shank & Cotten, 2014). Previous studies have shown that students' perceptions of their own ability and efficiency to use digital technologies positively influence not only their motivation but also their achievement as well (Castillo-Merino & Serradell-López, 2014).

Students' beliefs that computer- and mobile- based assessments are interesting tasks, along with their self-efficacy beliefs that they themselves are able to perform well on these tasks, are closely related with better learning engagement and achievement. Computers and especially mobile devices are appealing tools for teenagers and seem to increase their science learning motivation when they are used in self-assessment and

learning. Increased motivation leads to increased achievement as well. The findings of the study also suggest that the positive impact on science learning motivation and achievement is greater for the medium and low achieving students. Low achieving students are usually the unmotivated students. This study provides evidence that the use of computers and mobile devices in self assessment procedures positively affects more the low-achieving students by significantly increasing their motivation and performance. Furthermore, it is not surprising that the motivational advantage is greater for the mobile devices (Ciampa, 2014; Sun, 2014).

Low motivation is a problem usually relevant to low-stakes testing scenarios and may raise important issues regarding test validity or accountability measures (Finn, 2015). However, assessment, when appropriately delivered, may enhance motivation (Black & Wiliam, 1998; Wise, 2014). Also, it has been shown that online self-assessment improves final exam pass rates (Ćukušić, Garača, & Jadrić, 2014). The current study provides evidence that appropriate use of different assessment delivery media (e.g. computers, mobile devices) has the potential to enhance student learning motivation and hopefully achievement. Furthermore, the findings of this study provide an important implication that educators and educational policy makers, in the context of their general effort to diminish the problem of poor motivation towards science learning, should consider alternatives (i.e. computer- or mobile-based assessments) to paper-based assessments.

However, the positive impact that computers and especially mobile devices have on students' motivation level needs further investigation. Future research with larger samples, a longer duration, different age groups or cultural backgrounds and different educational subjects will further investigate the impact of computer-based and mobile-based self-assessment on student learning motivation and achievement.

Concluding, a better understanding of the impact of the assessment delivery mode on student science learning motivation and achievement will contribute to improved design of educational scenarios and policies with ultimately better educational outcomes.

Appendix A.

The Science Motivation Questionnaire © 2006 Shawn M. Glynn & Thomas R. Koballa, Jr., modified for Physics (replacing the word "Science" with the word "Physics") and adapted with permission of its authors.

Intrinsic motivation– the inherent satisfaction from taking a Physics test.

– I enjoy answering the Physics test (1).

– Answering the Physics test is more important to me than the grade I receive (16).

– I find answering the Physics test is interesting (22).

– I like the Physics test because it is challenging (27).

– Answering the Physics test gives me a sense of accomplishment (30).

Extrinsic – External factors contributing to learning Physics i.e. grade, rewards.

– I like to do better than the other students on the Physics test (3).

– Earning a good Physics grade by answering the test is important to me (7).

– I want to perform better in the Physics test because I need recognition from my classmates (10).

– I think about how the Physics test can help me get a good grade (15).

– I think about how my Physics mark can help my future career (17).

Personal relevance – Motivation based on the relevance the Physics test has with the students' own personality and goals.

– The Physics test I answer relates to my personal goals (2).

– I think about how the Physics test will be helpful to me (11).

– I think about how I will use the Physics test to me achieve my goal (19).

– I like answering the Physics test because it is relevant to my personality (23).

– The Physics test I answer has practical learning value for me (25).

Self-determination – student's belief that he/she is in control of learning Physics.

– Answering the Physics test is not difficult (5).

– I put enough effort into answering the Physics test (8).

– I use strategies that ensure I answer the Physics test well (9).

– I can learn better from taking the Physics test (20).

– The Physics test is what I have expected (26)

Self-efficacy – student's belief that he/she can do well in Physics.

– I expect to do as well as or better than other students in any Physics test (12).

– I am confident I can answer most of the questions in the Physics test (21).

– I believe I have master the knowledge and skills in the Physics test (24).

– I am confident I did well in the Physics test (28).

– I believe I can earn a good grade in the Physics test (29).

Anxiety – Students' tension and nervousness against the testing procedure.

– I am nervous about how I will do on the Physics test (4).

– I become anxious when it is time to take a Physics test (6).

– I worry about failing the Physics test (13).

– I am concerned that the other students are better in the Physics test (14).

– I hate taking the Physics test (18)

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