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Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations

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ABSTRACT

The widespread technology use among current college and university students has made higher educational institutions worldwide acknowledge the need of incorporating it in teaching and learning for explicit reasons. But does access and usage of technology enhance academic performance and foster student engagement in reality? Researches in the last over two decades have conjectured both the positive and negative outcomes of the students' continuous interface with technology. Student engagement and self-directed learning (SDL) are the two other themes that have independently attracted considerable interest of researchers, ascribable to the explicit and implicit assertions that both are related to the academic success. Additionally, the relationship of technology use with these two academic behaviors have also been investigated although not very extensively. The current study aimed to inspect a path model with technology use, student engagement, self-directed learning and academic performance among undergraduate students. 761 students responded to an online survey comprising three scales: Media and Technology Usage and Attitude Scale (MTUAS), Self-Rating Scale of Self-Directed Learning (SRSSDL), and student version of Utrecht's Work Engagement Scale (UWES-S). The results showed that use of technology has a direct positive relationship with students' engagement and self-directed learning, however, no significant direct effect was found between technology use and academic performance. The findings point towards the complex interchange of relationships of the students' technology use with student engagement, self-directed learning and academic performance. The implications and future research directions are discussed.

1. Introduction

The present day college and university students comprise of a generation who are brought up in a digitally rich environment and engrossed in a world permeated with various types of Information and Communication Technologies (ICTs). However, the actual usage of these technologies for the academic purposes, by this technologically-revolutionized era-generation variously termed as "Millennials" or Gen Y (Howe & Strauss, 1991), "the net generation" (N-Gen; Tapscott, 1998), "digital learners" (Brown, 2000), digital natives (Prensky, 2001), "learners of the digital era" (Rapetti & Cantoni, 2010) etc., are continually debated. Does the persistent absorption and engagement with technology facilitate or hamper their learning experiences and academic performance? Given the fact that technology affordances are in concurrence with learning environments, i.e., from retrieving and sharing information to instant access and interaction with faculty and peers, it seems plausible that students may be using various technologies to facilitate and augment their learning experiences and effectively meeting academic challenges. However, the opinions vary: on the one end of the spectrum are those holding the belief that digital technology does augment and actually have already 'transformed' the teaching and learning in higher education (e.g., Beetham & Sharpe, 2013); on the other end are those who perceive these technologies as 'disruptive', and thereby a challenge for the universities to cope with, as Losh (2014) observes, "Not all modes of digital engagement are suited to education". Nonetheless, it is apparent that the ubiquitous and ever evolving digital technology has infiltrated in the ecosystem of the higher education, and explicably got the attention of researchers' focusing on numerous

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related issues, particularly the effectiveness and efficacy of technology vis-à-vis learning and teaching processes and outcomes.

The effect of technology with regard to students' academic achievement is persistently marked in growing literature of the last over two decades, albeit demonstrating inconsistent results ranging from both positive and negative to zero effects and relationships. We are presenting a selective literature representing the varied results. Supporting the positive outcomes, Fonseca, Martí, Redondo, Navarro, and Sánchez (2014) indicated that through the use of technology, students were able to achieve a greater level of direct engagement with the proposed content, which in turn improved overall achievement. They indicated that technology was highly correlated with student motivation, and also found a significant correlation between technology use and academic achievement. In another study Cheng, Lin, and She (2015) found that the students' long term knowledge retention in a technology enhanced classroom (*Virtual Age*) subsequently influenced learning outcomes; and students who use technology outperform in engagement and achievement (e.g., Fonseca et al. 2014; Gulek & Demirtas, 2005). Using a longitudinal design, Gulek and Demirtas (2005) provided substantial evidence that using technology enhances student learning and educational outcomes. The findings of the study revealed that compared to non-technology users, students using technology showed significantly higher achievement (overall GPA) and had high scores on criterion referenced standardized tests.

Similarly, Trimmel and Bachmann (2004) found that students who used technology in classrooms reported higher participation rates, more interest in learning, and a greater motivation to perform well as compared to the students who did not use technology. Drain, Grier, and Sun (2012) concluded from the results of their study on high school students that "intelligent use" of electronic devices improves academic performance measured via GPA & standardized test scores; results specifically showed that students who reported spending more time using their electronic devices for academic purposes did better in school than those who claimed they used their devices for other purposes.

In a review of earlier studies of computer and internet use/gaming and its effects on cognitive skills besides some other factors like social skills, relationships, sense of reality and violent behavior among children and adolescents, Subrahmanyam, Greenfield, Kraut, and Gross (2001) found the evidence of some immediate cognitive skills improvement like spatial, iconic, and attentional skills among users of some computer games. However, the researchers recommended more empirical evidence to validate the assumption that long term computer and Internet use (both game and nongame) can lead to long term improvements in cognitive skills and thereby on academic achievement. In another study, Hu and Kuh (2001) used data from 71 four-year colleges and universities in the United States (N = 18,344) and found that using Internet for course material had positive effects on the students' intellectual development and career preparation, as well as personal development. Similarly, in a study conducted on university students of Pakistan, Suhail and Bargees (2006) found positive effects of Internet use in terms of improved grades and reading, writing and information-processing skills among three quarters of the participants.

Conversely, a number of studies have reported either negative relationship or no significant relationship between technology use and academic performance. Fuchs and Wössmann (2004) surveyed students in 31 countries using a very thorough, detailed survey in order to eliminate other probable causes of the downward inclination of academic performance, stated in their results that the "sheer ubiquity of information technology is getting in the way of learning" (as cited in Ferguson, 2005). Findings from a recent study by Sana, Weston, and Cepeda (2013) suggest that technology use in classrooms has a negative effect on achievement, as measured by performance on a comprehension test. The studies examining the relationship of specific types of technology usage with students' academic performance have also demonstrated mixed results. For example, Jacobsen and Forste (2011) found a negative correlation between calling, texting, and GPA among university students in the United States. Instant messaging (IM) which today's college students prefer to use over email (Carnevale, 2006; Horrigan & Rainie, 2005; Junco, 2005) has been studied in relation to academic performance, and results indicate the detrimental effect of IM on school work (Junco & Cotten, 2011); and level of IM use related to academic impairment (Huang & Leung, 2009). Similarly, Lepp, Barkley, and Karpinski (2014, 2015) found that cell phone use/texting was negatively related to GPA and positively related to anxiety. Previously, Fox, Rosen, and Crawford (2009) have also reported that the time spent on instant messaging during classroom time is negatively correlated with the GPA. Along the similar lines, a number of studies have identified the negative relationship between the frequency of cell phone use and academic performance (e.g., Harman & Sato, 2011) academic difficulty (Hong, Chiu, & Hong, 2012) "intensive" cell phone use and school failure (Sanchez-Martinez & Otero, 2009). Some earlier studies have also reported the negative effect of the internet usage and college students' academic progress e.g., Malaney (2004–2005) indicated that some students reported that their grades had suffered in consequence of spending too much time on internet. Corroborating these findings, Kubey, Lavin, and Barrows (2001) and Kuh and Hu (2001) found that heavily indulging in online recreation is closely linked to impaired academic performance.

However, Pasek, More, and Hargittai (2009) didn't report any negative relationship between Facebook use and grades, whereas in the same year Karpinski and Duberstein (2009) had reported a negative correlation between grades and Facebook usage, though the sampling strategy and analytical design of the study was reportedly limited (Pasek et al. 2009). Hunley et al. (2005) found no significant correlation between computer use and grade point average among adolescents. Furthermore, students' grade point averages (GPA) were not found to be closely correlated with specific activities, such as searching for information, E-mailing, and playing games (link).

Given the fact that current college and university students comprise of a generation of Millennials and even Post-Millennials whose constant interface, competence and confidence with the digital technologies have supposedly led them to develop different learning styles and behavioral characteristics and probably an inherent technological capability of multitasking termed 'parallel processing functions' by Prensky (2003), although the proposition is challenged by some critics, and secondly, owing to the affordances these technologies provide, it is intuitively assumed that the usage of these technologies should be influencing their academic performance and outcomes. However, as is evident through the literature the results are confounding and inconsistent. A number of arguments ranging from the contextual and affective to cognitive factors, are presented to elucidate the incongruity of results e.g., some researchers have argued that it is not the quantity of time that students spend online which affects the outcomes rather what they actually do online does matter more vis-à-vis the outcomes (Chen & Tzeng, 2010) and the use of such technologies by students does not necessarily entail that they use them for their academic activities (Bennett, Maton, & Kervin, 2008; Romero, Guitert, Bullen, & Morgan, 2011). Along similar lines, Paretta and Cattelano (2013) stated that in-depth observations of students' technology-based practices suggest them to be sometimes of little academic relevance. Observing 730 individual behaviors of students in the

library, the result indicated that though 60% of overall behavior was study related; however, 73% of those working on a computer were significantly more likely to be engaging in a non-study behavior like checking e-mails, visiting Facebook, or other Web sites, etc. In addition, Hong, Hwang, Liu, Ho, & Chen (2014) suggested that 'cognitive failure' may also reflect a decrease in the efficiency of perceptual levels of Internet learning. A detailed review of the studies related to explanations of outcomes is beyond the scope of this research paper, hence summing up with Danah Boyd's (2014) title of the analysis of young people's uses of digital technology in general, 'It's Complicated', seems quite apposite!

Notwithstanding the diverse research results, it is evident that there is considerable and continued interest in exploring the usage of technology and its outcomes and influences on the academic performance of the college and university students. Most of the research studies have focused on the relationship either between a specific or a couple of technology types and the academic performance, though a few studies have also examined the variety of types of technology. As a matter of fact, today's youth is utilizing and engrossed in a variety of technology concurrently, an amenity enabled through the modern technology and made accessible anytime anywhere e.g., the mobile phones. Hence, the present study is an attempt towards further explication of the relationships between the usage of the varied types of technology and the academic performance among the four year undergraduate students. Considering the literature outcomes, it is postulated that technology use and academic performance are related. However, in assessing this relationship more comprehensively, a path analysis model will be used.

In addition, for further exposition of the effects of technology use on students' academic behavior, two other significant and related variables i.e., student engagement and self-directed learning (SDL) will also be examined in the present study.

1.1. Technology, student engagement and self-directed learning: a significant triad?

Student engagement, a broad term that covers physical, academic, and emotional responses, has been the focus of attention of researchers for the last few decades. Student engagement characterizes both the time and energy students dedicate in communications with others through academically purposeful activities (Kuh, 2001). While much has been written on engagement in the classroom and on engagement with technology tools, not much research has been done on the intersection of the two. Research suggests the depth of engagement correlates to the depth of learning, however, an important question is, does technology use contribute to student engagement? There is some research evidence that using technology/social media as an educational tool can lead to increased student engagement (Annetta, Minogue, Holmes, & Cheng, 2009; Chen, Lambert, & Guidry, 2010; Junco, 2012a; Junco, Helbergert, & Loken, 2011; Patera, Draper, & Naef, 2008).

Since technology provides a compelling source of interactive tools for academic purposes ranging from taking notes, participation in discussion forums, access to supplementary resources, software and applications and facilitate student-student and student-faculty interactions, it may foster engagement and self-directed learning (Fried, 2008; Hyden, 2005; Juniu, 2006; Rust, O'Donovan, & Price, 2005; Weaver & Nilson, 2005; White & Robertson, 2014; Williams, Karousou, & Mackness, 2011). Students who use information technology for academic purposes are reported to more likely contribute and participate in active, academic collaboration with other students (Nelson Laird & Kuh, 2005). Promoting a deeper connection between the students, educators, and course content, such partnership specifies that as engagement with technology increases, engagement with academics also increases (Mehdinezhad, 2011). Through the boundless prospects of collaboration, the technology provides, students are enabled to participate in a community of learners resulting in increased accomplishment of learning outcomes, like critical thinking and individual student development, as they become more engaged with the course content (Carini, Kuh, & Klein, 2006; Kuh, 1993, 2009; Kuh, Cruce, Shoup, Kinsie, & Gonyea, 2008; Pike, Kuh, & McCormick, 2011). However, Gosper, Malfory, McKenzie, and Rankine (2011) examined students' engagement with technologies and explored students' preferred technologies that support learning, and results indicated that with an exception to social networking, students preferred to use several Web 2.0 tools (emails, learning management systems, YouTube, podcasts) to support their learning at university.

Embedded in the dominion of adult education (Knowles, 1975; Tough, 1971), the concept of Self-Directed Learning (SDL) has been recognized and researched for decades; however, digital revolution has brought it to the forefront and its context has changed with the presence of technology in current learning avenues. Self-directed learning and self-regulated learning are often used interchangeably, however, existing educational theories attempt to bring in conceptual clarity of the two concepts, e.g., Jossberger, Brand-Gruwel, Boshuizen, & Wiel (2010) suggest that the skills of the two concepts ascribe to different levels: the construct of self-directed learning to be situated at the macro level, while self-regulated learning is identified to be at the micro-level. Some theorists have distinguished the two concepts as covert and overt regulatory schemes e.g., Pilling-Cormick & Garrison (2007) view self-directing learning capabilities as the overt management of the external learning environment and self-regulating learning capabilities (SRLC) as the covert management of the internal learning environment (cognitive and affective), analogous to Pintrich's (2004) concept of SRLC, an intra-individual system.

Notwithstanding the differences and similarities in the two concepts, the interesting and novel communication networks and virtual learning communities accessible through the information and digital technologies have expanded the meaning of lifelong learning (Kim, 2010; Thorpe, 2005) to which both the self-directed learning and self-regulated learning are considered to be the vital tools.

SDL is promoted as one of the critical skills for 21st Century students and the development of SDL skills are much emphasized e.g., Glenn (2000) as cited by Barnes, Marateo, & Ferris (2007) stated, "Net Geners need self-directed learning opportunities, interactive environments, multiple forms of feedback, and assignment choices that use different resources to create personally meaningful learning experiences". It is argued that technology-rich learning environment can provide students with great opportunities and abilities to be self-directed in their learning as it warrants the students to be not only knowledgeable about the pertinent resource selection, but also the management and appropriate usage of the information (Fahnoe & Mishra, 2013). The self-directed aspects of learning (the choice of what, when, and how long to study) which social media and other technologies provide have significant repercussions in the effectiveness of the user's learning efforts (Tullis & Benjamin, 2011). It has been suggested that self-directed learning could provide a more direct route into understanding the actual dynamics of and relationships between learning and technologies (Candy, 2004). Despite a significant level of agreement about the influence current technology affordances could have on SDL, as is evident from the review of literature, not much empirical evidence is available regarding the impact of technology use on self-directed learning. The present study aims to address the gap by

examining the impact of a variety of technologies on self-directed learning (SDL), in addition to the students' academic performance and student engagement. Using a path model to test the interrelationships, the study would add an innovative dimension to the existing body of literature.

Based on the findings of previous research representing both positive and negative correlations of technology with the academic performance, and the correlations of technology use with student engagement (e.g., Fonseca et al., 2014; Junco, 2012a), SDL (e.g., Fahnoe & Mishra, 2013) and academic performance (e.g., Hunley et al., 2005), it was hypothesized that: (a) use of various types of technologies will be correlated with the students' academic performance (GPA), and (b) there will be a positive correlation between: (i) the technology use and Self-Directed Learning (SDL), and (ii) technology use and student engagement. Further, as indicated by the review of studies on student engagement, self-directed learning and academic performance (Carini et al., 2006; Kuh, 1993, 2009; Kuh et al., 2008; Nelson Laird & Kuh, 2005; Pike et al., 2011), paths connecting student engagement and SDL, as well as SDL and academic performance were also added to the hypothesized model. The final path model of the study is presented in Fig. 1 (Fig. 1 here).

2. Methodology

2.1. Participants

The sample comprised a total of 761 female undergraduates enrolled in a private university in Saudi Arabia (M = 20.79 yrs, SD = 1.97). Of those reporting their year in college, freshmen (n = 228) comprised 30%, sophomores (n = 238) 31%, juniors (n = 164) 22%, and seniors (n = 131) 17%. Participants were moderately using media and technology (M = 5.72, SD = 1.58), but 28% (n = 216) of them reported that they did not have a Facebook account. All participants indicated that they use technology daily, with smartphone (M = 7.25, SD = 2.09) being the most used technology and Email being the most popular medium (M = 6.79, SD = 2.31). The sample was quite similar to the recent smartphone demographics provided by the Neilson Company ("Smartphones Dominate the Saudi Market", 2014).

2.1.1. Measures

2.1.1.1. Media and technology usage and attitudes scale. A relatively new scale, the media and technology usage scale (MTUAS; Rosen, Whaling, Carrier, Cheever, & Rokkum, 2013) includes a total of 60 items comprising 15 subscales namely; Smartphone Usage (9 items), General Social Media Usage (9 items), Internet Searching (4 items), E Mailing (4 items), Media Sharing (4 items), Text Messaging (3 items), Video Gaming (3 items), Online Friendships (2 items), Facebook Friendships (2 items), Phone Calling (2 items), TV Viewing (2 items), Positive Attitudes Toward Technology (6 items), Anxiety About Being Without Technology or Dependence on Technology (3 items), Negative Attitudes Toward Technology (3 items) and Preference for Task Switching (4 items). Only Media and Technology Scale assessing frequency of media and technology usage were used for the purpose of this research. Forty items (1–40) are scored on a 10 point frequency scale ranging from 1 (never) to 10 (all the time). Item #41 – #44 constituting social media sites usage subscale are scored on a multiple choice format with scores ranging from 1 (0) to 9 (751 or more). To reduce response time and length, the Attitudes scale of MTUAS with a total of 16 items (4 subscales) was not used in the present study. Reliability and validity evidence of the MTUAS indicate that the subscales can be used together or separately as they are internally reliable and externally valid (Rosen et al., 2013). Consequently, MTUAS can be used with all subscales or selected ones as needed. The reliability of MTUAS in our dataset was α = 0.94 with subscale values ranging between 0.62 and 0.94.

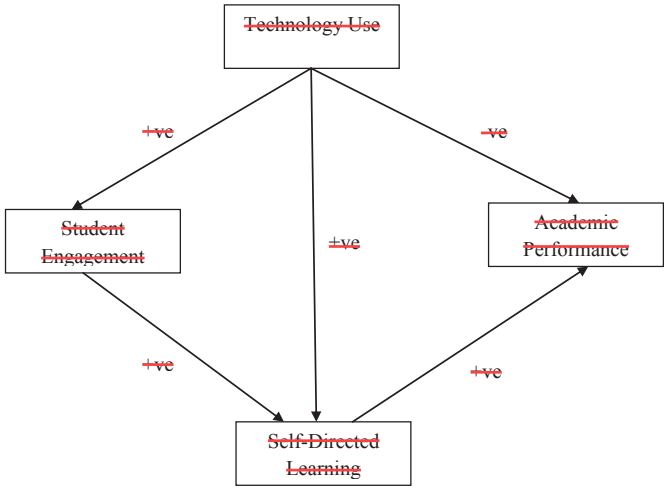

Fig. 1. Research model for predicting the interrelations.

2.1.1.2. Self rating scale of self directed learning. To measure self-directed learning with a self reporting scale, we used a 60 item scale; self rating scale of self directed learning (SRSSDL) developed by Williamson (2007). The scale examines learners on 5 broad ranges or domains of self direction namely; Awareness (factors that facilitate learning), Learning Strategies (strategies a self directed learner should adopt), Learning Activities (activities that learners should engage in), Evaluation (attributes that help learners in monitoring learning activities) and Interpersonal Skills (interpersonal skills of learners that assist in learning). Each domain of the SRSSDL consists of 12 statements that identify learners' levels of self directedness in learning in higher education. The responses on each item are rated on a 5 point Likert scale with values ranging from 1 (never) to 5 (always). The overall reliability of SRSSDL was α = 0.97.

2.1.1.3. Utrecht's work engagement scale. Engagement was assessed with a shortened student version of Utrecht's work engagement scale (UWES-S; Schaufeli, Bakker, & Salanova, 2006) comprising 9 items that assess Vigor, Absorption and Dedication. All UWES-S items are scored on a 7 point frequency rating scale ranging from 0 (never) to 6 (always). The UWES-S has correlated as expected with measures of academic performance, (e.g., GPA) and behavior (e.g., burnout). Validations of the UWES support the use and reliability of one factor model instead of three dimensional model (See Shaufeli & Bakker, 2004). The reliability of the UWES in the dataset was α = 0.91.

2.1.2. Procedure

The participants were provided with informed consent prior to participating in the study and were sent a cover letter through the university's internal email system along with a link to Google forms and were requested to voluntarily respond to the questionnaire comprising three instruments; MTUAS, SRSSDL and UWES-S. The academic performance was measured through self-repoted Grade Point Average (GPA). All participants were ensured of the confidentiality and anonymity and were informed that the gathered responses will be exclusively used for research purposes.

2.1.3. Data analysis

During the first phase of data analysis, scores on all variables were computed in accordance with respective author's criteria. All data were analyzed via Statistical Package for the Social Sciences version 23 (SPSS v.23.0).

Descriptive statistics were conducted to illustrate the demographic characteristics of the sample as well as their use of technology. Correlations were computed to evaluate the relationship between technology use, self directed learning and engagement. Intercorrelations among the four variables were examined in order to safeguard the validity of regression analysis, in case of multicollinearity, i.e., highly correlated variables. The results from the correlation analysis are presented in Table 1.

To answer the research questions, a path analyses was conducted to test the model involving technology use, student engagement, self directed learning and academic performance. The model comprised of one exogenous (technology use) and three endogenous (student engagement, self directed learning and academic performance) variables. According to Ho (2006), path analysis allows a researcher to combine causal theory and multiple regression in order to assess the direct and indirect effects between variables of interest. To estimate the direction and magnitude of the paths in the model presented in Fig. 1, we used the maximum likelihood method. Additionally, linear regression was also performed to identify the best predictors (technology variables) of student engagement, self directed learning and achievement.

3. Results

3.1. Preliminary analysis

Correlational analysis were used to examine the relationships between students' technology use, self direction, and engagement scores. Results indicated that technology use was positively correlated with self direction, $r(759) = 0.46$, $p < 0.01$ and engagement, $r(759) = 0.31$, $p < 0.01$. There was a moderate correlation between self direction and engagement, $r(759) = 0.55$, $p < 0.01$. Further, self direction was also positively correlated with achievement, $r(668) = 0.12$, $p < 0.01$. No significant correlations were found between other variables. The results from the correlation analyses along with means and standard deviations of the four research variables are presented in Table 1 (Table 1 here).

3.2. Path analysis

Results of the path analysis indicated a satisfactory fit of the model to the data. The chi-square value was nonsignificant, χ^2 (df = 1, N = 761) = 0.14, $p = 0.71$. As can be seen from Fig 2, our hypotheses were supported as follows: Technology use has a direct effect on student engagement ($\beta = 0.31$, $p < 0.01$) and self directed learning ($\beta = 0.32$, $p < 0.01$). Further, technology has a negative effect on academic performance ($\beta = -0.08$, $p = 0.06$) but a positive indirect effect through self directed learning (path = 0.32×0.15). There was also a positive direct effect of engagement on self direction ($\beta = 0.45$, $p < 0.01$). In summary, the results of the path analysis provided strong support for the proposed theoretical model presented in Fig. 1.

Table 1
Correlations among research variables.

	1	2	3	4	M	SD
1. Technology use	–	0.31**	0.46**	−0.01	5.72	1.58
2. Student engagement		–	0.55**	0.07	3.09	1.16
3. Self-directed learning			–	0.12**	216.78	37.03
4. Academic performance				–	3.13	3.06

** $p < 0.01$.

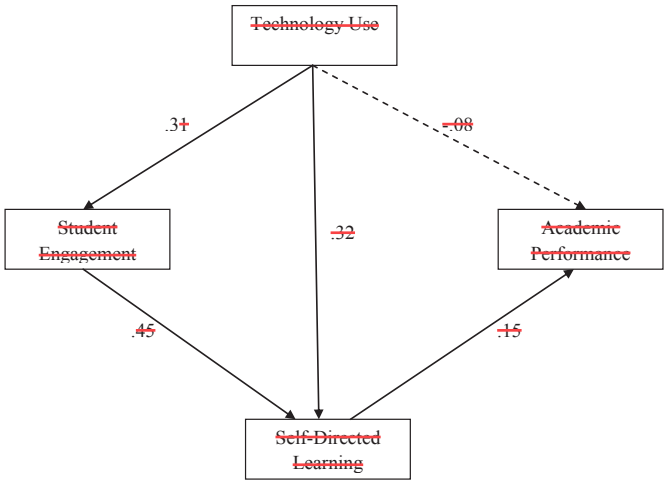

Fig. 2. Standardized regression coefficients for the path model.

3.3. Technology as predictor of student engagement, self direction and academic performance

Three separate multiple regression were performed to predict student engagement, self direction and academic performance from 11 media and technology variables (MTUAS); Smartphone Usage, General Social Media Usage, Internet Searching, E-Mailing, Media Sharing, Text Messaging, Video Gaming, Online Friendships, Facebook Friendships, Phone Calling and TV Viewing. Technology use significantly predicted engagement (F (11, 533) = 7.56, $p < 0.001$, $R^2 = 0.14$, Adjusted $R^2 = 0.12$), self-directed learning (F (11, 533) = 13.72, $p < 0.001$, $R^2 = 0.22$, Adjusted $R^2 = 0.21$) and academic performance (F (11, 464) = 3.63, $p < 0.001$, $R^2 = 0.08$, Adjusted $R^2 = 0.06$). The summary of regression analysis is presented in Table 2 (Table 2 here).

Based on the summary of regression analysis, Table 3 lists the positive and negative predictors of student engagement, self direction and performance (Table 3 here).

4. Discussion

The present study examined the relationship between the technology usage and student engagement, self-directed learning (SDL) and academic achievement among undergraduate university students. Findings of the path analysis demonstrated that technology use predicts self-directed learning ($\beta = 0.32$, $p < 0.01$) and student engagement ($\beta = 0.31$, $p < 0.01$), but has a negligible overall relationship with academic performance ($\beta = -0.08$, $p = 0.06$). However, a perusal of the sub-sets of technology use exhibit that whereas media sharing, social media use, and Facebook friends were positive predictors, phone calling and watching TV were negative predictors of academic performance. Interestingly, the use of social media emerged as a positive predictor of all the variables, i.e., student engagement ($\beta = 0.14$, $p < 0.01$), self-directed learning ($\beta = 0.08$, $p < 0.01$) and academic performance ($\beta = 0.14$, $p < 0.01$).

These findings are in line with the studies demonstrating the positive relationship of technology use with student engagement (Annetta et al., 2009; Chen et al., 2010; Clements, 2015; Esteves, 2012; Gibbs & Poskitt, 2010; Golubski, 2012; Heiberger and Harper, 2008; Junco et al., 2011; Junco, 2012a; Nelson Laird & Kuh, 2005; Patera et al., 2008; Sheard, Carbone, & Hurst, 2010).

Table 2
Linear model predictors and 95% confidence intervals of student engagement, self-directed learning and achievement.

	Engagement				Self-directed learning				Academic performance			
Technology use	*b*	SE B	*β*	*95% CI for B*	*b*	SE B	*β*	*95% CI for B*	*b*	SE B	*β*	*95% CI for B*
constant	1.95	0.23	–	[1.50, 2.40]	158.89	6.48	–	[146.17, 171.62]	−0.05	0.02	–	[−0.10, 0.00]
Email	0.10	0.03	0.19**	[0.04, 0.15]	2.80	0.81	0.18**	[1.21, 4.38]	0.00	0.00	0.07	[−0.00, 0.01]
Text messaging	−0.03	0.03	−0.06	[−0.09, 0.03]	0.03	0.90	0.00	[−1.73, 1.79]	0.00	0.00	0.01	[−0.01, 0.01]
Phone calling	0.04	0.02	0.09	[−0.01, 0.09]	0.52	0.68	0.04	[−0.82, 1.86]	−0.01	0.00	−0.19**	[−0.01, −0.00]
Smartphone	−0.02	0.04	−0.03	[−0.09, 0.05]	2.38	1.05	0.14**	[0.31, 4.45]	0.00	0.00	0.01	[−0.01, 0.01]
Watching TV	0.03	0.02	0.07	[−0.01, 0.08]	0.42	0.65	0.03	[−0.86, 1.70]	−0.01	0.00	−0.14**	[−0.01, −0.00]
Media sharing	0.03	0.03	0.06	[−0.03, 0.08]	0.18	0.80	0.01	[−1.38, 1.75]	0.01	0.00	0.10	[−0.00, 0.01]
Internet usage	0.07	0.03	0.14**	[0.01, 0.12]	2.03	0.77	0.14**	[0.52, 3.54]	−0.00	0.00	−0.02	[−0.01, 0.01]
Video games	−0.06	0.02	−0.13**	[−0.11, −0.02]	0.28	0.63	0.02	[−0.96, 1.52]	−0.00	0.00	−0.02	[−0.01, 0.00]
Social media use	0.07	0.02	0.14**	[0.02, 0.11]	1.21	0.62	0.08**	[−0.01, 2.43]	0.01	0.00	0.14**	[0.00, 0.01]
Facebook friends	−0.04	0.03	−0.05	[−0.10, 0.02]	−0.30	0.88	−0.01	[−2.03, 1.43]	0.01	0.00	0.11**	[0.00, 0.02]
Online friends	−0.01	0.05	−0.01	[−0.10, 0.09]	−0.94	1.38	−0.03	[−3.64, 1.76]	0.00	0.01	0.01	[−0.01, 0.01]

**$p < 0.01$.

Table 3
List of positive and negative predictors of engagement, self-directed learning and achievement (highest standardized β are reported in parentheses).

Engagement	Self-directed learning	Achievement
Positive		
Email (0.19)	Email (0.18)	Social media use (0.14)
Internet use (0.14)	Smartphone usage (0.14)	Facebook Friends (0.11)
Social media use (0.14)	Internet use (0.14)	
	Social media use (0.08)	
Negative		
Video Games (−0.13)	–	Phone calling (−0.19)
		Watching TV (−0.14)

As for the relationship between technology use and academic performance, the findings reveal a bi-directional trend; overall technology use has negative but insignificant relationship with the academic performance, however, significant positive correlations emerged between some of the specific types of technology for instance social media use. The pattern of findings are partially in line with the results of some studies demonstrating a positive relationship between the usage of diverse kinds of technology and academic performance, e.g., (Bawaneh, 2011; Eyyam & Yaratan, 2014; Jackson, Eye, Witt, Zhao, & Fitzgerald, 2011). However, our findings of positive relationship between social media use and academic performance are in contradiction to some studies where inverse relationships between the social networking sites (SNS) use and academic performance have been reported (e.g., Rosen et al., 2013; Stollak, Vandenberg, Burklund, & Weiss, 2011). Facebook users have lower GPAs (Karpinski, Kirschner, Ozer, Mellott, & Ochwo, 2013; Kirschner & Karpinski, 2010) and spend fewer hours per week studying than non-users (Junco, 2012a, 2012b; Kirschner & Karpinski, 2010). In an earlier study Kubey et al. (2001) revealed that heavy internet use for leisure was highly correlated with decreased academic performance. Interestingly, better academic grades and higher learning satisfaction have been reported among light internet users than among heavy users (Chen & Peng, 2008).

The results indicating towards the negative but insignificant relationship between overall technology use and academic performance are supported by the findings of Junco and Cotten (2012); Lepp et al. (2014); Wentworth and Middleton (2014) as well as Jacobsen and Forste's (2011) study whose results based on robust regression indicate a negative relationship between the use of various types of electronic media and first-semester grades. There could be two possible explanations of these outcomes: 1) students though engaged with varied kinds of technology may not necessarily be using technological skills for academic purpose as some researches have pointed out that although the Digital Natives are adept and highly fluent with the practical skills of game playing, social networking, texting, and surfing information on the web, it could not be a reliable indicator that they are making best use of these skills for their academic purposes at all (Gurung & Rutledge, 2014; Rowlands et al., 2008; Selwyn, 2009), and 2) the high frequency usage and multitasking may be leading to distractions and shortage of time for academic tasks respectively. Lepp et al. (2014), also found a negative correlation between technology use and GPA/achievement, and suggested that students who are high frequency technology users spend less time in pursuit of academic tasks such as attending classes, completing assignments and studying. It seems plausible that an interplay of several factors and mechanisms ranging from cognitive and contextual to social and ecological, underlie these relationships, and hence it is imperative to test various models of technology use and its effects and outcomes, cross sectionally as well as cross culturally.

An interesting finding from the path model point toward the indirect effect of technology use on academic performance through self-directed learning (path = 0.32 × 0.15), as also proposed by Candy (2004). Moreover, self-directed learning (SDL), often interchangeably used for self-regulated learning, though the two concepts are operationally different (see e.g., Saks & Leijen, 2014), was found to be significantly positively related with both technology use and engagement. The findings are congruent with a host of studies showing a positive relationship between self-directed learning & achievement in numerous undergraduate and graduate contexts both online and classroom environments (Chou & Chen, 2008; Gabrielle, Guglielmino, & Guglielmino, 2006; etc.).

Our model affirms the previously mentioned assumptions that even though the 'technology native' students are self-motivated, engaged, proficient with and skillfully navigate through the modern technologies, it is essential that carefully designed pedagogy is promoted to not only increase student engagement, but the self-direction as well, which leads to increased academic performance (Hyland & Kranzow, 2011), and faculty/educators should consider the ways of integrating technologies that promote learning and critical thinking (Facione & Facione, 2007; Prensky, 2003), as the method of utilization and context of utilizing the technology tools is more important than the mere presence of tools (Unwin, 2007). McGrath, Crowley, Toomey, Murphy, & Dunne (2015) have suggested that in the absence of faculty supervision, self-directed learners 'may be compounding errors/uncertainties while practicing skills unsupervised'.

From the patterns of the findings it could be deduced that if empirically tested models of technology use are effectively channeled in the academic environments and incorporated in

pedagogical strategies, it may not only enhance academic performance, student engagement and self-directed learning, but may also alleviate the negative outcomes, as researches have indicated that 'technology integrations are fairly influential on increasing student engagement' (Hancock & Betts, 2002; Mama & Hennessy, 2010; McGrath, 1998) and that ineffective technology integrations not only not contribute to student engagement, but could lead to negative effects (Cole, 2009). Wang's (2009) premise that technology when integrated into the learning process benefits students in two ways: from being receivers of knowledge to the active and engaged learners compelling them to become more responsible for their own education, supports the assumption, too.

4.1. Limitations and future directions

While the findings have added an insightful perspective to the complex interrelationships between the constructs of student engagement, self-directed learning, academic performance and technology usage, and indicate towards multiple avenues for follow up research, nevertheless, there are certain limitations. First of all, the criterion of academic performance is measured solely as reflected by self-repoted GPA. Though this trend is widespread in such studies, it doesn't reflect the academic achievement and/or total learning. Future studies may add various other assessments of learning in addition to GPA. Second, the role of faculty and organizational dimensions are crucial to student engagement and learning, as Silén and Uhlin (2008) observed, "the students need challenges, support, and feedback in their struggle to become self-directed learners and thus require ongoing attention from faculty". Future research incorporating the faculty role and organizational dimensions vis-à-vis the incorporation of technology in pedagogy would definitely yield additional insights and richer understanding of the model.

It would also be interesting to look further into the models including specific technologies with student engagement, self-directed learning/self-regulated learning and academic achievement. The nature of the study is correlational and hence demonstrates the relationships only; to examine the causality, experimental designs, particularly pre- and post-experimental design should be considered. Besides, the sample of the study comprised of only female undergraduates from a single educational institution and cultural milieu; studying samples from various cultural settings, educational institutions, including both male and female students are recommended. Lastly, the inherent limitations of self-reports apply to this study as well; future studies may consider using multimethod approach to overcome the shortcomings related to self-reports. In additional, mixed methodology would also render better and richer understanding of the nuances of the interrelationships.

5. Conclusion

For any higher educational institution worldwide, a crucial issue is, does technology improve student learning (Loveless, 1998) and student engagement, and how best to inculcate the self-directed learning skills a.k.a the life long learning skills among students. Using a path model, the present multivariable study provides a unique contribution to the existing literature by exploring the interelationship among a set of critical constructs of academic behaviors central to today's educational settings: technology use, student engagement and self-directed learning and academic performance. The results are discussed in the light of assumptions grounded in the existing literature and it is recommended that new models should be tested empirically to explore the trajectories (paths) of technology use to better comprehend how it can be used as an effective pedagogical and educational tool to enhance academic achievement in conjunction with the elevation of student engagement and promotion of self-directed learning among todays' technology driven generation of students.

Author note

The study concept was developed by Rashid and Asghar. Data collection, data analysis, and data interpretation were performed by Asghar in consultation with Rashid. Both Rashid and Asghar did the review of literature and drafted the manuscript. Rashid wrote the final abstract, introduction/review of literature, discussion and conclusion, as well as limitations and future directions, and commented on the manuscript at all stages. Rashid also provided critical revisions and finalized the paper. Both authors approved the final version of the manuscript for submission.

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