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An applied model of learner engagement and strategies for increasing learner engagement in the modern educational environment

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ABSTRACT

Mobile technology's ubiquity has caused a shift in how students learn and how pedagogy can take place. Educators have the potential to engage students more fully in the modern educational environment, by making learning content and interactions accessible via mobile devices, both within and outside of the classroom. There is a need to leverage the learning science literature on learner engagement to identify the most effective means of utilizing mobile and online technology to engage learners. Utilizing foundational engagement theory, this paper presents an Applied Model of Learner Engagement, including the individual, task and environmental factors that influence how likely a student is to become engaged in learning content. Based on this model, we present instructional interventions that educational practitioners can utilize to more effectively engage learners, as well as best practice guidance for achieving this, with mobile and online learning technology, in the modern educational environment.

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Introduction

Educators have long grappled with capturing and maintaining learner attention (Howard, 2015). However, twenty-first century educators must overcome a somewhat new and pervasive competitor for student attention: mobile devices. Mobile devices are used for a range of everyday tasks and have become embedded into society to the degree that individuals often have difficulty disconnecting from them (Ling, 2012). In a learning environment, mobile devices can therefore become a distraction, as educators compete to gain learner attention over this constant temptation to connect to content and individuals outside of the learning context. As such, educators are often hesitant to use mobile technology in the classroom. There is evidence that mobile devices can be detrimental in the classroom (Amry, 2014). However, evidence has also supported the use of mobile devices in learning environments to enhance learning (Scornavacca, Huff, & Marshall, 2009).

Mobile technology's ubiquity has caused a shift in how students learn and how pedagogy can take place. For example, students find textbooks expensive and unnecessary, instead relying on their mobile phones to find the answers immediately online (Tessier, 2014). Furthermore, some students forego note taking due to the perpetual availability of online learning materials accessible via their mobile devices (Stacy & Cain, 2015). This strong connection to the mobile device creates a unique window into the attention of the learner. Educators have the potential to engage students more fully by making learning content and interactions accessible via these beloved devices. Educators may have greater success in the current educational environment if they utilize mobile devices

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both within and outside of the classroom (McHaney, 2011). For example, educators can reach out to students via mobile devices prior to learning opportunities to prime the students, during learning opportunities to more heavily involve the students, and after learning opportunities to reinforce target knowledge and skills. In fact, some educators have adapted by making content available online using mobile learning, blended courses (a hybrid of online and in-person learning), and fully online courses, and there is evidence to show mobile devices can improve knowledge acquisition (Sheng, Nah, & Siau, 2005).

However, there is a need to leverage the foundational learning science literature on learner engagement to identify the most effective means of utilizing mobile and online technology to engage learners. By grounding mobile device-based teaching methods in learning science, we can provide instructors guidance for how they can utilize this technology to optimize learning. Toward this, we present an Applied Model of Learner Engagement that is grounded in theory and constrained by feasibility of implementation in the modern educational environment. Based on this model, we also present interventions that educational practitioners can utilize in hand with mobile technology to more effectively engage learners.

Method

We utilized both a top-down and bottom-up approach to develop the Applied Model of Learner Engagement. From a top-down perspective, we reviewed a range of theoretical models of engagement in the literature. Those models most influential include (a) Sinatra et al.'s continuum of engagement measurement, (b) Skinner, Furrer, Marchand, and Kindermann's (2008) model of engagement and dissatisfaction in the classroom, (c) Appleton, Christenson, Kim, and Reschly's (2006) conceptualization of cognitive and psychological engagement, (d) Cleary and Zimmerman's (2012) model of self-regulation, and (e) Landhäußer and Keller's (2012) model of the flow experience. From a bottom-up perspective, we identified influencing factors and outcomes/indicators of engagement from the literature using the primary keywords of learner engagement, flow, involvement, and motivation, combined using "and" logic with each of the secondary keywords of training, individual differences, task factors, environmental factors, and measures. These keywords were searched in the following databases: Google Scholar, Florida Institute of Technology library databases and holdings, ProQuest, PsycBooKS, Science Direct, Emerald Insight, Wiley Online Library, Taylor Francis Online, and Research Gate. Additionally, findings were acquired through reference sections of relevant articles and a "cited by" list search.

Approximately 150 abstracts were reviewed for relevancy, 59 of the publications were selected for full review, resulting in 54 publications that were reviewed in detail and from which information related to engagement, influencing factors and outcomes were extracted. From this literature review, 22 influencing factors were initially identified. Of these factors, 13 influencing factors that were relevant to the modern educational environment were included in the model based on empirical/theoretical support by at least three supporting references. These 13 factors are divided into three groups, with six factors related to the individual learner, five factors related to the learning task, and two factors related to the learning environment.

This literature review was then extended to identify instructional interventions that can target influencing factors and increase learner engagement, during and between learning opportunities. For the purposes of this effort, we define an intervention as an instructional tool or method that facilitates the presentation of relevant information to be learned, creates opportunities for learners to practice skills, and/or provides feedback to learners during and after activities (Salas & Cannon-Bowers, 2001). We initially identified 14 instructional interventions, of which 10 were included based on empirical/theoretical support by at least two references and feasibility of implementation in the modern educational environment. Finally, we developed best practice guidance for implementation of these interventions in the modern education environment, with mobile technology in particular.

Learner engagement theory

Engagement can be defined as a person's active involvement in an activity, wherein learner motivation represents the driving force behind learner activities (Appleton et al., 2006). Sinatra, Heddy, and Lombardi's (2015) continuum of engagement measurement posits that engagement can be examined from different levels of granularity involved in the learning process. The first and most prominent is micro-level engagement, defined by Sinatra et al. (2015) as an individual's engagement in a moment, task, or learning activity. Micro-level engagement takes place in a class, a scenario, or a lesson with a time course on the order of minutes to hours. The second level of engagement, macro-level engagement, represents engagement across time (days and weeks) and contexts (class, home, group work) such as interactions/activities related to the learning task that take place before and after a learning event (e.g. online, review of learning content to be covered, post-learning self-assessment).

We propose here that an even greater level of granularity is available by integrating Csikszentmihalyi's (1997) concept of flow, which represents the highest degree of micro-level engagement. Flow is experienced when interaction with the learning task results in the learner being in "a state of effortless attention, arising through an interaction between positive affect and high attention" (De Manzano, Theorell, Harmat, & Ullén, 2010, p. 301). Flow often results in an individual becoming completely absorbed in a task and losing track of time, has a time course of seconds to minutes, and has been found to lead to improved task performance and learning outcomes (Engeser, 2012). The state of flow is optimized under three key conditions: clear task goals are provided to the individual, immediate feedback is given on performance progress, and an individual's present skill level is matched to the challenge being faced (Engeser & Rheinberg, 2008).

An applied model of learner engagement

These three levels of engagement form the basis of the Applied Model of Learner Engagement, which proposes interactions between the levels, with flow having the potential to lead to prolonged micro-level engagement and vice versa, and micro-level engagement having the potential to lead to macro-level engagement and vice versa. The model, illustrated in Figure 1, presents factors that most prominently influence the likelihood of a learner becoming engaged, including factors related to the individual learner, the learning task and the learning environment. The model does not include all factors with the potential to influence engagement, but those with the most supporting evidence within the literature reviewed. The factors included provide practitioners opportunities to intervene and increase learner engagement. The model also presents engagement outcomes, or measurable

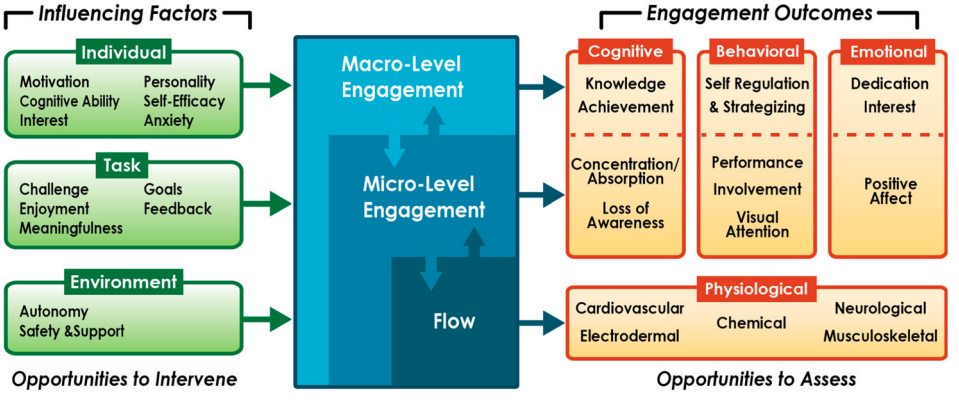

Figure 1. Applied model of learner engagement.

indicators of learner engagement that provide practitioners opportunities to assess engagement levels and adapt learning content accordingly.

The goal of the model, in its current state, is to provide a theory-based, yet practical tool that practitioners can utilize to inform instructional design. Future work on this model will include empirical studies that will allow us to statistically model the relationships between the components, and ensure it is theoretically and empirically valid. The focus of this paper is on the influencing factors and how instructional interventions can be leveraged to improve learner engagement via these factors. The influencing factors are presented in Table 1 and discussed further in the following sections.

Individual factors

Our model includes six individual factors that influence an individual's propensity to become engaged in a learning task.

Motivation

The first individual factor, motivation, refers to the desire to be actively involved in learning and is derived from one's own beliefs, goals, values, or from external rewards (Cook & Artino, 2016; Fives & Manning, 2005). One type of motivation is learning goal orientation, wherein individuals are motivated by a desire for mastery of a material (Dweck, 1986), as opposed to a desire to perform well. Learning oriented individuals are often intrinsically motivated, seek challenges, and experience enjoyment and flow in tasks where the demand level fits their skill level (Baumann, 2012; Engeser & Rheinberg, 2008; Landhäußer & Keller, 2012; Noe, Tews, & McConnell, 2010). On the contrary, individuals who are performance oriented, often have a fear of failure, are extrinsically motivated, experience less flow (Engeser & Rheinberg, 2008), and tend to avoid demands that threaten their competence (Gully & Chen, 2010).

Cognitive ability

A second individual factor, cognitive ability, is a multidimensional construct involving an individual's capacity to learn, problem solve, think abstractly, and comprehend ideas (Choi & Hannafin, 1995). Individuals with high cognitive ability, or perceptions of high cognitive ability, are more likely to

Table 1. Factors influencing learner engagement.

Factors	Supporting references
Individual factors	
Motivation	Cook and Artino (2016); Baumann (2012); Landhäußer and Keller (2012); Gully and Chen (2010); Noe et al. (2010); Engeser and Rheinberg (2008); Fives and Manning (2005); Dweck (1986)
Cognitive ability	Gully and Chen (2010); Fredricks et al. (2004); Choi and Hannafin (1995); Dweck (1986)
Interest	Durik and Harackiewicz (2007); Hidi and Renninger (2006); Fives and Manning (2005); Renninger (1992); Hidi and Baird (1988)
Personality	Ullén et al. (2012); Gully and Chen (2010); Noe et al. (2010)
Self-efficacy	Miele and Scholer (2017); Engeser (2012); Landhäußer and Keller (2012); Gully and Chen (2010); Skinner et al. (2008); May et al. (2004); Kahn (1990)
Anxiety	Gully and Chen (2010); Noe et al. (2010); Skinner et al. (2008)
Task factors	
Challenge	Miele and Scholer (2017); Cook and Artino (2016); Engeser and Rheinberg (2008); May et al. (2004); Nakamura and Csikszentmihalyi (2002); Csikszentmihalyi (1997); Kahn (1990); Dweck (1986)
Enjoyment	Sinatra et al. (2015); Landhäußer and Keller (2012); Ullén et al. (2012)
Meaningfulness	Hidi and Renninger (2006); May et al. (2004); Kahn (1990)
Goals and Feedback	Wollenschläger et al. (2016); Cleary and Zimmerman (2012); Landhäußer and Keller (2012); Noe et al. (2010)
Environmental factors	
Autonomy	Hidi and Renninger (2006); Rotgans and Schmidt (2011); Fredricks et al. (2004); Deci et al. (1991)
Psychological Support and safety	Skinner et al. (2008); Alonso-Tapia and Pardo (2006); Appleton et al. (2006); May et al. (2004); Kahn (1990); Kanfer and Ackerman (1989)

experience cognitive engagement, and in turn, higher achievement and performance (Fredricks, Blumenfeld, & Paris, 2004; Gully & Chen, 2010). Perception of one's ability or intelligence influences motivational engagement: those who believe their ability is low, or that intelligence is fixed, aim only to succeed; however, those who believe their ability is high, or that intelligence is malleable, aim to seek challenge, and are thus more likely to become engaged (Dweck, 1986).

Interest

A third individual factor, interest, is the desire to re-engage with an activity due to meaningfulness, features, positive feelings, and past knowledge (Hidi & Renninger, 2006). Interest can be situational, (i.e. produced by environmental stimuli; Hidi & Baird, 1988), or individual (i.e. a sustainable interest depending on the individual's predisposition; Renninger, 1992). Situational interest can be triggered by environmental features such as intensive graphics (Hidi & Renninger, 2006) and can lead to improved engagement for those with low individual interest in the learning material (Durik & Harackiewicz, 2007). Situational interest can be transformed into individual interest by increasing value (e.g. highlighting how the learning material applies to the learner's personal goals), resulting in improved effort, motivation and engagement in a learning activity (Durik & Harackiewicz, 2007; Fives & Manning, 2005; Hidi & Renninger, 2006).

Personality

A fourth individual factor that influences learner engagement is personality. Personality traits such as openness and emotional stability have been linked to motivational processes and engagement in learning (Gully & Chen, 2010). Neuroticism, a high reactivity to negative stimuli and a proneness to negative affect has been associated with attentional lapses, and preventing learner engagement and flow (Ullén et al., 2012). High conscientiousness has been shown to lead to higher self-efficacy and motivation, as these individuals are commonly goal oriented, find meaningfulness in work, and are likely to experience flow (Gully & Chen, 2010; Noe et al., 2010; Ullén et al., 2012).

Self-efficacy

A fifth individual factor, self-efficacy, refers to the belief that one can achieve what one sets out to do (Gully & Chen, 2010). Individuals who are high in self-efficacy are better able to adjust their goals to their skill-set (Engeser, 2012) and are more likely to become engaged (Kahn, 1990). If self-efficacy is low, individuals will have lower feelings of safety, motivation, or availability to engage in the task (Kahn, 1990; May, Gilson, & Harter, 2004; Miele & Scholer, 2017). Further, low self-efficacy can cause individuals to experience anxiety and to disengage (Keller & Landhäußer, 2012; Skinner et al., 2008).

Anxiety

The sixth, and last individual factor to influence engagement is anxiety. Anxiety, is a heightened level of stress which can reduce the motivation of the individual, and increase belief of task irrelevancy leading to a decrease in flow (Noe et al., 2010; Skinner et al., 2008). Challenge levels incongruent with skill can cause individuals to feel threatened and experience anxiety (Gully & Chen, 2010). Lower self-efficacy due to anxiety can lead to disengagement (Noe et al., 2010; Skinner et al., 2008).

Task factors

Our model includes five factors related to the learning task that influence how likely a learner is to become engaged.

Challenge

The first task factor is level of challenge. Challenge is experienced when a learner's physical or mental effort and ability are tested by a task (Cook & Artino, 2016). When skills exceed challenge, individuals

feel relaxed or bored, while challenges exceeding skill level can lead to anxiety (Nakamura & Csikszentmihalyi, 2002). Optimizing the presence, level, and appropriateness of a challenge can lead to intrinsic motivation, flow and micro-engagement (Csikszentmihalyi, 1997; Kahn, 1990; May et al., 2004; Nakamura & Csikszentmihalyi, 2002). To maximize learning effectiveness, training should minimize the challenge-skill gap (i.e. match challenge levels to current skill set) and ensure that challenge levels grow with individual progress (Dweck, 1986; Miele & Scholer, 2017; Nakamura & Csikszentmihalyi, 2002). Challenge, however, does interact with characteristics of the individual. Individuals who are motivated by hope in success experience flow when there is a match between challenge and skill, in constrast, individuals motivated by fear of failure are much less likely to experience flow in these situation (Engeser & Rheinberg, 2008).

Enjoyment

The second task factor, enjoyment, refers to the positive affect experienced before, during, or after a task and influences how much individuals want to participate in the task (Sinatra et al., 2015). Enjoyment in a task can create intrinsic value for a task, with high enjoyment being both an indicator and a by-product of flow (Landhäußer & Keller, 2012). How enjoyable a student finds a task can predict the intensity at which students choose to engage (Sinatra et al., 2015). Furthermore, enjoyment in a learning task can lead to macro-level engagement as the individual is more likely to come back to, and engage in, the learning content on their own time (Ullén et al., 2012).

Meaningfulness

The third task factor, meaningfulness, also referred to as value, represents an individual's sense of receiving a return on investments from task performance in a currency of physical, cognitive, or emotional energy (Kahn, 1990). Meaningfulness has a significant positive effect on engagement (May et al., 2004), and a potential to maintain learner interest and macro-engagement in a learning activity (Hidi & Renninger, 2006). In contrast, when a performer feels that a task is meaningless, apathy and disengagement can result (May et al., 2004). Meaningfulness can be experienced as a result of a learner feeling challenged, experiencing variety, utilizing creativity, and receiving incentives (Kahn, 1990).

Goals and feedback

The fourth and fifth task factors to influence learner engagement are goals and feedback. During learning, students analyze and monitor their goals, capabilities, and value to engage in a task; and then reflect on the outcomes or feedback and adjust (Cleary & Zimmerman, 2012). Goal clarity is important as it provides the learner with a sharper understanding of what needs to be accomplished, how to accomplish the task, and leads to higher engagement (Keller & Landhäußer, 2012). Feedback is information related to an individual's performance or execution, which directs them to the desired learning outcome (Wollenschläger, Hattie, Machts, Möller, & Harms, 2016), allowing them to appropriately regulate their performance. When the task presents clear goals and the learner is able to receive feedback on how they are performing with respect to these goals, engagement can be positively influenced (Noe et al., 2010).

Environmental factors

Our model includes two environmental factors that influence how likely a learner is to become engaged in a learning task.

Autonomy

The first environmental factor is autonomy, or the ability of the individual to control the task (e.g. a choice between topics or the time when the task will be completed; Hidi & Renninger, 2006). Allowing an individual to make choices when completing tasks induces self-determination, encourages

participation, and encourages cognitive engagement (Deci, Vallerand, Pelletier, & Ryan, 1991; Rotgans & Schmidt, 2011). The more choices the individual has to personalize their task, the larger the increase in interest (Fredricks et al., 2004). Autonomy also allows the individual to set the appropriate challenge or pace for a task, which can lead to engagement (Fredricks et al., 2004). Furthermore, choice can induce feelings of meaningfulness as there is more familiarity and belonging when individuals have chosen aspects of their task and know what to expect; the gained control allows the user to steer aspects of the task into a more relevant domain (Fredricks et al., 2004).

Psychological safety and support

The second environmental factor that influences learner engagement is psychological safety and support. Psychological safety occurs when an individual feels secure in a setting or environment (Kahn, 1990). Individuals need to feel safe to fail without being penalized in a negative way as an environment which contributes to poor psychological safety inhibits task engagement (May et al., 2004). Safety can be facilitated using simulated training in which the risks are low (Alonso-Tapia & Pardo, 2006) and support can be facilitated through positive instructor relationships. Students who perceive their instructor relationship as supportive (e.g. teacher responds in a fair manner with positive attitudes) are more likely to be engaged and are more motivated to achieve (Alonso-Tapia & Pardo, 2006; Appleton et al., 2006; Skinner et al., 2008). Individuals who feel the instructor sees them as a low-ability student are more likely to avoid challenge, which can result in lowered self-confidence and engagement (Kanfer & Ackerman, 1989).

Learning interventions

These individual, task and environmental factors provide an opportunity to intervene to increase learner engagement. We identified 10 learning interventions that (1) can be utilized to effectively target the influencing factors within the modern educational environment through mediums such mobile devices or online learning and (2) have been empirically validated to improve learner engagement across multiple learning platforms. The learning interventions are presented in Table 2 and discussed further below, followed by best practice implementation guidance for practitioners.

Metacognitive intervention

The first instructional strategy is metacognitive intervention. Metacognitive activity occurs when individuals "actively monitor their progress, determine where problems exist, and adjust their learning strategies accordingly" (Schmidt & Ford, 2003, p. 406). Metacognitive interventions "increase the

Table 2. Engagement Inducing Learning Interventions

Intervention	Supporting references
Metacognitive intervention	Cleary and Zimmerman (2012); Schmidt and Ford (2003); Kohler (2002);
Challenge level/skill optimization	Plass, Homer, and Kinser (2015); Sampayo-Vargas et al. (2013); Bauer et al. (2012); Engeser and Rheinberg (2008)
Goal clarity	Bolkan et al., (2016); Limperos et al. (2015); Beenen and Rousseau (2010); Seidel et al. (2005)
Feedback	Wollenschläger et al., (2016); Hattie and Timperley (2007)
Autonomous self-regulated learning	Leiker et al. (2016); Gillard et al. (2015); Cleary and Zimmerman (2012); Rotgans and Schmidt (2011); Issenberg et al. (2005)
Personalization	Bernacki and Walkington (2014); Ginns and Fraser (2010); Hidi and Renninger (2006); Fives and Manning (2005);
Experiential learning	Winsett et al. (2016); Hmelo-Silver et al. (2007); Stull and Mayer (2007); Lewis and Williams (1994)
Game-based learning	Admiraal et al. (2011); Rieber and Noah (2008); Salen and Zimmerman (2004); Garris and Ahlers (2001)
Interactivity and multimedia	Miele and Scholer (2017); Pedra et al. (2015); Blasco-Arcas et al. (2013); Noe et al. (2010); Adams et al. (2008)
Meaningful learning	Gidena and Gebeyehu (2017); Charsky and Ressler (2011); Eppler (2006); Ausubel (1963)

frequency and accuracy of learners' assessments of their [metacognitive] knowledge'' (Schmidt & Ford, 2003, p. 406) and are typically facilitated by using self-reflection prompts (e.g. prompts by instructor or simulator) that encourage learners to actively think about the strategies they are using to learn (Kohler, 2002; Schmidt & Ford, 2003). Therefore, metacognitive interventions present the opportunity to influence how individuals interact with tasks factors of goals and feedback. Metacognitive interventions can lead to increased self-efficacy, task value, and more efficient use of learning time (Kohler, 2002; Schmidt & Ford, 2003), which can lead to increased engagement.

The effectiveness of metacognitive interventions depends on a learner's self-efficacy, goal orientation, and interest (Cleary & Zimmerman, 2012). For example, individuals low in performance avoidance orientation (i.e. NOT afraid of performing poorly) have been shown to benefit, while, individuals high in performance avoidance orientation (i.e. afraid of performing poorly), were negatively impacted by the metacognitive intervention (Schmidt & Ford, 2003).

Challenge level optimization

The second instructional intervention is challenge optimization, and as the name implies, targets the task factor of challenge. Optimizing the challenge of a learning activity to an individual's skill level involves identifying what level of difficulty provides adequate challenge without overwhelming learners or diminishing confidence in their ability to perform (Engeser & Rheinberg, 2008). Optimizing challenge to one's skill level by altering learning activity difficulty or providing and adjusting scaffolding (e.g. including hints that diminish as knowledge increases) has been found to increase flow, self-efficacy and learning (Plass et al., 2015; Sampayo-Vargas, Cope, He, & Byrne, 2013). However, those with low openness and high neuroticism have been shown to not perform well under increasing challenge and perform best with consistent challenge (Bauer, Brusso, & Orvis, 2012).

Goal clarity

The third instructional intervention is goal clarity, and targets the task factor of goals. Goal clarity is achieved when the goals of the learning activity are transparent to, and understood by, the learner throughout the learning activity (e.g. verbally referred to by the instructor or delivered via a mobile device; Seidel, Rimmele, & Prenzel, 2005). Goal clarity can be provided by adding elements such as summaries and overviews at the beginning and end of a lesson or a video on the topic to be covered in class for the student to view on their mobile device prior to the lesson (Limperos, Buckner, Kaufmann, & Frisby, 2015). Goal clarity has been shown to result in higher motivation and learning improvements (Bolkan, Goodboy, & Kelsey, 2016; Seidel et al., 2005) especially for learners with little experience that are in short term learning situations (Beenen & Rousseau, 2010). However, Bolkan et al., (2016) found that for highly motivated individuals, increasing goal clarity resulted in significant improvements to test scores, but for individuals with low motivation, there was no significant increase in test scores.

Effective feedback

The fourth instructional strategy is effective feedback, and as the name implies, targets the task factor of feedback. Feedback occurs when information is provided to the learner that aims at reducing the gap between the individual's current knowledge on the topic and the desired learning outcome (Hattie & Timperley, 2007). Feedback works hand in hand with goal clarity as feedback contains task performance, process, or improvement information provided to help a learner reduce the gap between learning goals and current performance (Wollenschläger et al., 2016). Process level feedback (i.e. feedback on the individual's methods for completing the task) has resulted in improved learning strategies, effort and learning outcomes. (Hattie & Timperley, 2007; Wollenschläger et al., 2016). Feedback which is not clear and does not match the learners level of understanding is likely to exacerbate

negative outcomes, lead to a learner having a negative self-image, and lead to poor performance (Hattie & Timperley, 2007).

Autonomous self-regulated learning

The fifth instructional strategy, autonomous self-regulated learning, is typically facilitated by offering choice regarding what learning opportunities to engage in (i.e. individual selection of assignments) and when to pursue learning opportunities (e.g. allowing students to work at their own pace without deadlines; Gillard, Gillard, & Pratt, 2015). Autonomous self-regulated learning influences the environmental factor of autonomy and can result in increased motivation to learn, engagement in the learning activity, as well as improvements in achievement, performance, and retention (Cleary & Zimmerman, 2012; Gillard et al., 2015; Rotgans & Schmidt, 2011). Offering autonomy allows individuals to repeat the task until learning is achieved (Issenberg et al., 2005; Rotgans & Schmidt, 2011), regulate the difficulty (Leiker et al., 2016), and achieve mastery (Gillard et al., 2015). Individuals with low understanding (Rotgans & Schmidt, 2011), experience, and beliefs (i.e. self-efficacy, value, interest,) may not benefit from highly autonomous self-regulated learning environments.

Personalization

The sixth instructional intervention is personalization and provides the opportunity to influence the individual factor of interest. Personalization in a learning context focuses on tailoring learning content to the student's current interests and knowledge (e.g. online math problems that include sports aspects for a sports-loving student; Bernacki & Walkington, 2014). Personalization can increase engagement, interest, effort and learning, (Fives & Manning, 2005; Ginns & Fraser, 2010; Hidi & Renninger, 2006). Personalization can be achieved through content manipulation (i.e. tailoring problems to topics of interest or creating puzzles or games related to the lesson and can lead to increased interest (Hidi & Renninger, 2006)).

Experiential learning

The seventh instructional strategy is experiential learning and can be used to target the task factor of meaningfulness. Experiential learning can be defined as "learning from experience or learning by doing … [and] first immerses learners in an experience and then encourages reflection about the experience to develop new skills, new attitudes, or new ways of thinking" (Lewis & Williams, 1994, p. 5). For instance, having engineering students build a structure in a simulated online environment (learning by doing) or by providing students with a case study and requesting a solution (problem-based learning) are examples of experiential learning. Experiential learning can result in higher-level engagement in live and online classrooms and can facilitate cognitive engagement between learning opportunities (Hmelo-Silver, Duncan, & Chinn, 2007; Winsett, Foster, Dearing, & Burch, 2016). Further, learning through experience can help foster a mastery goal orientation and lead to higher knowledge gains, retention and understanding (Hmelo-Silver et al., 2007; Stull & Mayer, 2007;). However, for novices, learning by doing can be too cognitively demanding, and take away from the learning experience; if the learning material is too complex, learning by doing should be utilized once the learner has acquired a base understanding (Stull & Mayer, 2007).

Game-based learning

The eighth instructional intervention, game-based learning, targets the task factor of enjoyment and consists of "a system in which players engage in an artificial conflict, defined by rules, resulting in a quantifiable outcome" (Salen & Zimmerman, 2004, p. 11). To achieve this, learning activities can be "gamified" by adding incentives and gaming qualities (e.g. math game where players who click the

correct answer shoot down alien ships). Game-based learning has the potential to increase knowledge, performance, self-efficacy, motivation, enjoyment, engagement levels and flow (Admiraal, Huizenga, Akkerman, & Ten Dam, 2011; Garris & Ahlers, 2001). However, game-based learning can result in decreased knowledge gains if students become hyper-focused on how to beat the game (Rieber & Noah, 2008).

Interactivity and multimedia

The ninth instructional strategy, use of interactivity and multimedia, influences the individual factor of interest. Interactivity occurs when a system dynamically communicates with an individual or allows participation via feedback, adaptation, control, or multimedia (e.g. providing student clickers to answer in-class questions and displaying responses to assist discussion). Interactivity can also be achieved by adding more complex mediums such as animations, simulations, or live environments (Adams et al., 2008). Adding interactive elements can increase flow, learning, motivation, interest, enjoyment, engagement and attention, understanding, performance, and mastery, (Adams et al., 2008; Blasco-Arcas, Buil, Hernández-Ortega, & Sese, 2013). Utilizing virtual environments (e.g., a virtual reality headset) to create immersive learning opportunities in which students feel spatially, emotionally, sensorially, and cognitively present in an artificial environment, may increase flow and learning (Noe et al., 2010). Blended learning, which incorporates both online and in-person learning, has also been shown to contribute to increased engagement (Noe et al., 2010), as the variability in the learning environment can lead to immersion and enjoyment (Miele & Scholer, 2017). Conversely, interactivity can be hindered if interactive elements are not implemented appropriately and the student does not know how to interact with the technology or becomes distracted by features (Adams et al., 2008; Pedra, Mayer, & Albertin, 2015).

Meaningful learning

The tenth instructional strategy, meaningful learning, occurs when connections are created between new knowledge and existing knowledge structures, to enhance memory retention (Ausubel, 1963). Meaningful learning, and as the name implies, targets the task factor of meaningfulness. For example, an instructor may provide material on the concepts in the upcoming class and their relation to past material. Meaningful learning can be achieved through explanations, examples, problems or assignments by presenting mnemonics, metaphors, or advanced organizers, either online, via mobile devices or in the classroom. Meaningful learning tactics can increase an individual's motivation, engagement, understanding, recall, transfer of knowledge and achievement, (Eppler, 2006; Gidena & Gebeyehu, 2017). However, care must be taken in implementing meaningful learning strategies because in some environments (e.g. simulation or game-based) individuals prefer to learn through the more enjoyable means and it may actually decrease motivation (Charsky & Ressler, 2011).

Guidance for practitioners

Based on the Applied Model of Engagement and the learning interventions identified, we provide the following recommendations to educational practitioners:

- *Deliver self-reflective prompts*: As a leaner engages in a learning activity, provide them with self-reflection prompts that encourage learners to consider strategies they may have used and why they were/were not effective. Such a technique has been shown to increase knowledge and skill gains (Schmidt & Ford, 2003). This can be achieved via instructor verbal prompts or via mobile application push notifications, either during or after class.
- *Adapt training based on learner progress*: Evaluate a learner's progress utilizing mobile or online assessments, adjust future lesson content commensurate with their ability. For example,

provide scaffolding where learners struggle and greater challenge where learners exhibit mastery, as adapting the task based on the individuals skill has shown to result in high learning gains (Sampayo-Vargas et al., 2013).

- *Provide clear learning goals*: Include lesson goals or advanced organizers that include explicit learning and/or performance objectives. These can be provided electronically via online applications prior to class to cue the student to specific learning objectives on which they should focus during the learning activity. Presenting goals online has shown to increase perceived and actual learning (Limperos et al., 2015).
- *Provide process level feedback*: Provide learners with feedback regarding their learning progress and what steps they can take to better achieve learning goals. For example, assess learner progress with post-lesson, mobile application or online queries and provide tailored feedback regarding wrong answers, why they are wrong and strategies for better grasping the concepts. Providing more thorough feedback has been shown to lead to improved mastery and strategies (Hattie & Timperley, 2007).
- *Provide choice regarding learning opportunities*: When possible, give learners the opportunity to decide what learning opportunities to engage in and when/where to pursue learning opportunities. For example, offer anytime online learning activities to allow leaners the flexibility to engage on their own schedule. Such techniques have been shown to allow learners to achieve mastery and improved performance (Issenberg et al., 2005).
- *Personalize content to topics of learner's interest*: Survey learners on their interests and goals, and incorporate those aspects into learning activities. For example, utilize online or mobile polling applications to query students regarding their interests and course goals, and tailor worked examples and assignments to these areas of interest. Personalization has shown to be effective at increasing interest and meaningfulness (Bernacki & Walkington, 2014).
- *Offer opportunities to learn by doing*: Allow a class to learn by hands-on experience applying learning concepts. Incorporate problem or project-based learning by setting up virtual project teams and having students collaborate virtually on project deliverables. Such techniques have been shown to increase engagement, knowledge gains, and mastery (Hmelo-Silver et al., 2007).
- *Integrate gaming elements into learning activities*: Add incentives or scoring systems to otherwise simple tasks to motivate students. For example, create teams for a quiz activity, have teams respond utilizing polling applications on students' mobile devices and present a leader board with team scores. Gaming elements such as incentives and scoring systems have been shown to lead to engagement, knowledge, and motivation (Admiraal et al., 2011).
- *Infuse learning environments with interactivity*: Add interactive elements and multimedia to lectures and online lessons by incorporating animations, videos, audio or dynamic responses. For example, use online chat technology where students can ask questions anonymously during a lecture via their mobile devices. Similar techniques have been shown to lead to engagement, mastery, and enjoyment (Adams et al., 2008).
- *Relate learning concepts to learners' previous knowledge*: Present personal metaphors, mnemonics, or reference previous lessons to help learners build connections between current and new knowledge structures. For example, having students engage in online forums where students share how the topic related to a personal experience. Meaningful learning techniques that create connections have been shown to lead to increased engagement and understanding (Eppler, 2006).

Conclusion

Through the merging of foundational training science theory with modern technology, educators have the opportunity to maximize learner engagement both inside and outside of the classroom to increase learning. Rather than striving to disconnect students from the digital world, educators have the opportunity to integrate learning within the student's hand-held world.

Mobile applications and online learning platforms can be utilized to target individual, task and environmental factors that have been shown to influence how likely a learner is to become engagement in learning content. From utilizing mobile devices to push notifications to promote metacognitive activity, remind students of goals, and provide feedback on current class performance, to leveraging these devices to incorporate interactivity, gaming elements and choice, mobile devices provide a unique window into the learners mind. This paper aims to support practitioners in understanding the critical factors that influence learner engagement and interventions that can be utilized, with mobile and online learning technology, to target these factors in the modern educational environment.

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References

Adams, W. K., Reid, S., LeMaster, R., McKagan, S. B., Perkins, K. K., Dubson, M., & Wieman, C. E. (2008). A study of educational simulations part I-engagement and learning. *Journal of Interactive Learning Research*, *19*(3), 397–419.

Admiraal, W., Huizenga, J., Akkerman, S., & Ten Dam, G. (2011). The concept of flow in collaborative game-based learning. *Computers in Human Behavior*, *27*(3), 1185–1194.

Alonso-Tapia, J., & Pardo, A. (2006). Assessment of learning environment motivational quality from the point of view of secondary and high school learners. *Learning and Instruction*, *16*(4), 295–309.

Amry, A. B. (2014). The impact of whatsapp mobile social learning on the achievement and attitudes of female students compared with face to face learning in the classroom. *European Scientific Journal, ESJ*, *10*(22), 157–164.

Appleton, J. J., Christenson, S. L., Kim, D., & Reschly, A. L. (2006). Measuring cognitive and psychological engagement: Validation of the student engagement Instrument. *Journal of School Psychology*, *44*(5), 427–445.
Ausubel, D. G. (1963). Cognitive structure and the Facilitation of meaningful verbal Learning1. *Journal of Teacher Education*, *14*(2), 217–222.
Bauer, K. N., Brusso, R. C., & Orvis, K. A. (2012). Using adaptive difficulty to optimize videogame-based training performance: The moderating role of personality. *Military Psychology*, *24*(2), 148.
Baumann, S. L. (2012). Motivational interviewing for emergency nurses. *Journal of Emergency Nursing*, *38*(3), 254–257.
Beenen, G., & Rousseau, D. M. (2010). Getting the most from MBA internships: Promoting intern learning and job acceptance. *Human Resource Management*, *49*(1), 3–22.
Bernacki, M. L., & Walkington, C. (2014). *The impact of a personalization intervention for mathematics on learning and non-cognitive factors*. EDM (Workshops).
Blasco-Arcas, L., Buil, I., Hernández-Ortega, B., & Sese, F. J. (2013). Using clickers in class. The role of interactivity, active collaborative learning and engagement in learning performance. *Computers & Education*, *62*, 102–110.
Bolkan, S., Goodboy, A. K., & Kelsey, D. M. (2016). Instructor clarity and student motivation: Academic performance as a product of students' ability and motivation to process instructional material. *Communication Education*, *65*(2), 129–148.
Charsky, D., & Ressler, W. (2011). "Games are made for fun": lessons on the effects of concept maps in the classroom use of computer games. *Computers & Education*, *56*(3), 604–615.
Choi, J. I., & Hannafin, M. (1995). Situated cognition and learning environments: Roles, structures, and implications for design. *Educational Technology Research and Development*, *43*(2), 53–69.
Cleary, T. J., & Zimmerman, B. J. (2012). A cyclical self-regulatory account of student engagement: Theoretical foundations and applications. In S. Christenson, A. Reschly, & C. Wylie (Eds.), *Handbook of research on student engagement*. Boston, MA: Springer.
Cook, D. A., & Artino, A. R. (2016). Motivation to learn: An overview of contemporary theories. *Medical Education*, *50*(10), 997–1014.
Csikszentmihalyi, M. (1997). *Finding flow: The psychology of engagement with everyday life*. New York, NY: Basic Books.
Deci, E. L., Vallerand, R. J., Pelletier, L. G., & Ryan, R. M. (1991). Motivation and education: The self-determination perspective. *Educational Psychologist*, *26*(3-4), 325–346.
De Manzano, Ö, Theorell, T., Harmat, L., & Ullén, F. (2010). The psychophysiology of flow during piano playing. *Emotion*, *10*(3), 301–311.
Durik, A. M., & Harackiewicz, J. M. (2007). Different strokes for different folks: How individual interest moderates the effects of situational factors on task interest. *Journal of Educational Psychology*, *99*(3), 597.
Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologist*, *41*(10), 1040.
Engeser, S. (ed.). (2012). *Advances in flow research*. New York, NY: Springer Science & Business Media.
Engeser, S., & Rheinberg, F. (2008). Flow, performance and moderators of challenge-skill balance. *Motivat Emot*, *32*(3), 158–172.
Eppler, M. J. (2006). A comparison between concept maps, mind maps, conceptual diagrams, and visual metaphors as complementary tools for knowledge construction and sharing. *Information Visualization*, *5*(3), 202–210.
Fives, H., & Manning, D. K. (2005). *Teachers' strategies for student engagement: Comparing research to demonstrated knowledge*. Annual Meeting of American Psychological Association, Washington, DC.
Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research*, *74*(1), 59–109.
Garris, R., & Ahlers, R. (2001). *A game-based training model: Development, application, and evaluation. Interservice/Industry Training, Simulation & Education Conference*, Orlando, FL.
Gidena, A., & Gebeyehu, D. (2017). The effectiveness of advance organizer model on students' academic achievement in learning work and energy. *International Journal of Science Education*, *39*(16), 2226–2242.
Gillard, S., Gillard, S., & Pratt, D. (2015). A Pedagogical study of intrinsic motivation in the classroom through autonomy, mastery, and Purpose. *Contemporary Issues in Education Research*, *8*(1), 1–6.
Ginns, P., & Fraser, J. (2010). Personalization enhances learning anatomy terms. *Medical Teacher*, *32*(9), 776–778.
Gully, S., & Chen, G. (2010). *Individual differences, attribute-treatment interactions, and training outcomes*. New York: Routledge.
Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, *77*(1), 81–112.
Hidi, S., & Baird, W. (1988). Strategies for increasing text-based interest and students' recall of expository texts. *Reading Research Quarterly*, *23*(4), 465–483.
Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist*, *41*(2), 111–127.
Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark. *Educational Psychologist*, *42*(2), 99–107.
Howard, J. R. (2015). *Discussion in the college classroom: Getting your students engaged and participating in person and online*. San Francisco, CA: John Wiley & Sons.
Issenberg, B., McGaghie, S., Petrusa, W. C., Lee Gordon, E. R., & Scalese, D., & J, R. (2005). Features and uses of high-fidelity medical simulations that lead to effective learning: A BEME systematic review. *Medical Teacher*, *27*(1), 10–28.

Kahn, W. A. (1990). Psychological conditions of personal engagement and disengagement at work. *Academy of Management Journal*, *33*(4), 692–724.
Kanfer, R., & Ackerman, P. (1989). Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition. *The Journal of Applied Psychology*, *74*, 657–690.
Keller, J., & Landhäußer, A. (2012). The flow model revisited. In *Advances in flow research* (pp. 51–64). New York, NY: Springer.
Kohler, D. B. (2002). The effects of metacognitive language learning strategy training on lower-achieving second language learners, ProQuest Information & Learning.
Landhäußer, A., & Keller, J. (2012). Flow and its affective, cognitive, and performance-related consequences. In *Advances in flow research* (pp. 65–85). New York, NY: Springer.
Leiker, A. M., Bruzi, A. T., Miller, M. W., Nelson, M., Wegman, R., & Lohse, K. R. (2016). The effects of autonomous difficulty selection on engagement, motivation, and learning in a motion-controlled video game task. *Human Movement Science*, *49*, 326–335.
Lewis, L. H., & Williams, C. J. (1994). Experiential learning: Past and present. *New Directions for Adult and Continuing Education*, *1994*(62), 5–16.
Limperos, A., Buckner, M. M., Kaufmann, R., & Frisby, B. (2015). Online teaching and technological affordances: An experimental investigation into the impact of modality and clarity on perceived and actual learning. *Computers & Education*, *83*, 1–9.
Ling, R. (2012). *Taken for grantedness: The embedding of mobile communication into society*. Cambridge, MA: MIT Press.
May, D. R., Gilson, R. L., & Harter, L. M. (2004). The psychological conditions of meaningfulness, safety, and availability and the engagement of the human spirit at work. *Journal of Occupational and Organizational Psychology*, *77*(1), 11–37.
McHaney, R. (2011). *The New digital Shoreline: How Web 2.0 and Millennials Are Revolutionizing higher education*. Sterling, VA: Stylus Publishing.
Miele, D. B., & Scholer, A. A. (2017). The Role of Metamotivational monitoring in motivation regulation. *Educational Psychologist*, *53*(1), 1–21.
Nakamura, J., & Csikszentmihalyi, M. (2002). The concept of flow. In C. R. Snyder, & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 89–105). New York: Oxford University Press.
Noe, R. A., Tews, M. J., & McConnell, D. (2010). Learner engagement: A new perspective for enhancing our understanding of learner motivation and workplace learning. *Acad Manage Anal*, *4*(1), 279–315.
Pedra, A., Mayer, R. E., & Albertin, A. L. (2015). Role of interactivity in learning from engineering animations. *Applied Cognitive Psychology*, *29*(4), 614–620.
Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). Foundations of game-based learning. *Educational Psychologist*, *50*(4), 258–283.
Renninger, K. A. (1992). Individual interest and development: Implications for theory and practice. In *The role of interest in learning and development* (pp. 361–395). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
Rieber, L. P., & Noah, D. (2008). Games, simulations, and visual metaphors in education: Antagonism between enjoyment and learning. *Educational Media International*, *45*(2), 77–92.
Rotgans, J. I., & Schmidt, H. G. (2011). Cognitive engagement in the problem-based learning classroom. *Advances in Health Sciences Education*, *16*(4), 465–479.
Salas, E., & Cannon-Bowers, J. A. (2001). The science of training: A decade of progress. *Annual Review of Psychology*, *52*(1), 471–499.
Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Cambridge, MA: MIT press.
Sampayo-Vargas, S., Cope, C. J., He, Z., & Byrne, G. J. (2013). The effectiveness of adaptive difficulty adjustments on students' motivation and learning in an educational computer game. *Computers & Education*, *69*, 452–462.
Schmidt, A. M., & Ford, J. K. (2003). Learning within a learner control training environment: The interactive effects of goal orientation and metacognitive instruction on learning outcomes. *Personnel Psychology*, *56*(2), 405–429.
Scornavacca, E., Huff, S., & Marshall, S. (2009). Mobile phones in the classroom: If you can't beat them, join them. *Communications of the ACM*, *52*(4), 142–146.
Seidel, T., Rimmele, R., & Prenzel, M. (2005). Clarity and coherence of lesson goals as a scaffold for student learning. *Learning and Instruction*, *15*(6), 539–556.
Sheng, H., Nah, F., & Siau, K. (2005). Using wireless technology to facilitate learning: A grounded theory approach. *AMCIS 2005 Proceedings*, (p. 307).
Sinatra, G. M., Heddy, B. C., & Lombardi, D. (2015). The challenges of defining and measuring student engagement in science.
Skinner, E., Furrer, C., Marchand, G., & Kindermann, T. (2008). Engagement and disaffection in the classroom: Part of a larger motivational dynamic? *Journal of Educational Psychology*, *100*(4), 765.
Stacy, E. M., & Cain, J. (2015). Note-taking and handouts in the digital age. *American Journal of Pharmaceutical Education*, *79*(7), 107.
Stull, A. T., & Mayer, R. E. (2007). Learning by doing versus learning by viewing: Three experimental comparisons of learner-generated versus author-provided graphic organizers. *Journal of Educational Psychology*, *99*(4), 808.

Tessier, J. T. (2014). Eliminating the textbook: Learning science with cell phones. *Journal of College Science Teaching*, *44*(2), 46–51. Retrieved from https://search-proquest-com.portal.lib.fit.edu/docview/1628222739?accountid=27313

Ullén, F., de Manzano, Ö, Almeida, R., Magnusson, P. K., Pedersen, N. L., Nakamura, J., … Madison, G. (2012). Proneness for psychological flow in everyday life: Associations with personality and intelligence. *Personality and Individual Differences*, *52*(2), 167–172.

Winsett, C., Foster, C., Dearing, J., & Burch, G. (2016). The impact of group experiential learning on student engagement. *Academy of Business Research Journal*, *3*, 7–17.

Wollenschläger, M., Hattie, J., Machts, N., Möller, J., & Harms, U. (2016). What makes rubrics effective in teacher-feedback? Transparency of learning goals is not enough. *Contemporary Educational Psychology*, *44*, 1–1.