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RESEARCH ARTICLE

The mediating role of self-regulation on harmonious passion, obsessive passion, and knowledge management in e-learning

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Abstract Few studies have investigated whether harmonious passion (HP) and obsessive passion (OP) make a distinctive contribution to explaining individual differences in knowledge management through self-regulation in e-learning contexts. This study aimed to identify four types of passion (internal HP, external HP, internal OP, and external OP) in e-learning and, further, to examine the relationships between different types of passion, self-regulation, and knowledge management in e-learning. The participants were 1209 college students. Three 4-point Likert scales were employed to measure the concerned variables and structural equation modeling was employed to examine the proposed model. The findings revealed that the four types of passion were interrelated and that the proposed model was a good-fit model. Specifically, self-regulation mediated the influence of passion on knowledge management in e-learning. However, HP and OP predicted self-regulation and knowledge management in the opposite way, and HP played a more crucial role than OP in e-learning. The result in this study not only support the two-dimensional model of passion but also suggest that the four types of passion, though positively correlated, interact in ways that have different effects on college students' self-regulation and knowledge management in e-learning.

Keywords e-Learning · Harmonious passion · Knowledge management · Obsessive passion · Self-regulation

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Introduction

e-Learning involves obtaining educational resources or participating in online or offline learning activities through computers or internet interfaces; it may include pure e-learning or blended learning that integrates e-learning and traditional classes. In an increasingly volatile world, the innovation of technologies has improved the quality of learning by creating a rich and dynamic environment in which individuals may learn through different virtual interfaces based on their needs (Yılmaz 2012). Knowledge management (KM), which includes the competences of knowledge acquisition and storage, knowledge application, knowledge sharing, and knowledge creation (Ungaretti and Tillberg-Webb 2011; Yeh 2015), has therefore become an essential ability for effective learning in this technological world. As Songhao et al. (2011) suggested, people who live in this technological society have to be able to acquire, accumulate, share and utilize knowledge through the selection of various learning materials. Past research has also found that KM competences are positively related to technological innovation (i.e., product and process innovation) (Lee et al. 2013). Therefore, understanding the factors that influence KM in an e-learning society is important for educating the young generation.

Motivation is known to be a crucial factor for learning. Traditionally, researchers divide motivation into external and internal motivation. More recently, psychologists (Vallerand et al. 2003, 2007) proposed a similar but more integrated concept, namely passion, to describe motivation based on different psychological mechanisms of internalization. They defined passion as a desire or inclination one has toward an activity that one would invest time and energy in and posited that different ways of internalizing would result in different types of passion. Accordingly, they proposed a dualistic model of passion, which includes harmonious passion (HP) and obsessive passion (OP); this model aids in the understanding of the cognitive processes of motivation in learning under a specific context. Although some researchers have suggested that passion is critical to KM abilities (e.g., Antal and Richebé 2009; Sié and Yakhlef 2009), few empirical studies have addressed the relation between the two types of passion and KM in e-learning environments.

Due to the rapid growth of a hypermedia environment, researchers have also become interested in learners' self-regulation in the context of e-learning (Hu and Driscoll 2013; Liaw and Huang 2013). Findings (Hu and Driscoll 2013; Jeske et al. 2014; Siadaty et al. 2012) have suggested that learners in a new learning environment, such as e-learning and web-based environments, require more proactive learning attitudes and strategies to build knowledge. Individuals with greater self-regulation ability tend to actively participate in the learning process through their behaviors, motivation, and metacognition (Lee et al. 2009). Good self-regulated learners are therefore assumed to be able to better utilize their KM skills to manage their own learning. Moreover, according to self-determination theory (SDT) and the definitions of HP and OP, HP should contribute to self-regulation, whereas OP should be detrimental to self-regulation (Deci and Ryan 2000; Stoeber et al. 2011).

To date, little attention has been paid to understanding the mechanisms of how different types of passion influence KM in the context of e-learning. Based on Vallerand et al. (2003) dualistic model of passion, we further suggest that in an e-learning environment, both HP and OP can be influenced by internal and external factors. This study therefore tried to clarify four types of passion in e-learning: internal HP, external HP, internal OP, and external OP. Moreover, given that self-regulation can be an important mediator between passion and KM, this study aims to investigate the mediating effects of self-

regulation on the relationship of dualistic passion (HP and OP) and KM in e-learning through structural equation modeling (SEM).

Theories of passion

Passion and related concepts

Passion is viewed as a strong desire people have toward an activity that they like and find important (Vallerand et al. 2003). Findings have suggested that passion helps boost people's engagement in the activities they are interested in (Mack 2007). Passion is related to, but different from motivation, curiosity, lifelong learning, self-efficacy, and just love of learning.

Although motivation and passion are closely related (Feist 2016), Vallerand (2012) had tried to clarify the difference between motivation and passion. Motivation is the hypothetical construct used to describe the internal and/or external forces that produce the initiation, direction, intensity, and persistence of behavior. From this viewpoint, people are passive organisms who merely react to internal or external stimuli. On the contrary, theorists of passion consider the individual as an active organism striving for effective interactions with the environment in order to have a meaningful life. As Vallerand (2012) stated, "A passion entails a special relationship with an activity that one loves. However, contrary to intrinsic motivation, it is essential that this activity be meaningful for the person and part of one's identity to be a passion." (p. 47) From this point of view, a tennis player may be motivated to play tennis because of curiosity or just love to learn it, but it is the passion he or she has that tennis becomes part of his or her life (Vallerand 2012); moreover, passion may be especially important for the relatively few activities that make us thrive in our lives (e.g., to be a professional tennis player) for passion includes reflection, curiosity, enthusiasm, and commitment (Rankine 2012), and self-judged meaningfulness (Vallerand 2012).

As for the relationship of passion, curiosity, and lifelong learning, it is suggested that a spirit of curiosity about certain subject is essential for pursuing that subject as a career, but hard work and disciplines are also required (Glaveanu 2011) and passion can be an important mediator during this process. Theoretical and empirical research show that intensity of affect and engagement are important aspects of passion (Cardon et al. 2009; Renzulli et al. 2006; Vallerand et al. 2003). Individuals who are passionate usually tend to engage in a particular activity for a lengthy period of time (Kaiser et al. 2007)

Finally, passion may influence the actions taken and the time spend in learning, and further, helps enhance self-efficacy. However, in the long-term, a high level of self-efficacy may strengthen the passion in learning as well. Self-efficacy is important to human self-development and adaptation (Bandura 2012); it refers to beliefs in one's capabilities to execute the actions required to produce given outcomes (Bandura 1977). According to Bandura (1977), self-efficacy is composed of outcome expectations and efficacy expectations. These two components influence the actions taken during learning. When people have a high outcome expectation, they should be more passionate in working toward the goals. However, only passion itself is not adequate to achieve goals; whether effective strategies are taken is critical.

Dualistic model of passion

Vallerand (2012) pointed out that "no motivational theory at the time could explain how your love for a given activity can have either some adaptive or some deleterious effects on your life." (p. 47). Accordingly, Vallerand et al. (2003) proposed the dualistic model of passion to compensate for the inadequate of motivation. In this model, HP and OP were identified based on how the activity is internalized into one's identity (Vallerand et al. 2003). HP emanates from an autonomous internalization of the activity (Carbonneau et al. 2008); when individuals freely accept an activity as important without feeling compelled to do it, their internalization produces a motivational force to be involved in the activity willingly. In contrast, OP results from a controlled internalization in which individuals feel compelled and forced to engage in the activity (Carbonneau et al. 2008; Zhang et al. 2014).

Therefore, HP is usually positively associated with flow during activity engagement; individuals with HP are able to decide when to and when not to flexibly engage in an activity. Moreover, individuals with this type of passion can be fully involved in the task at hand and have positive outcomes during and after engaging in a task (Carbonneau and Vallerand 2013). On the contrary, OP is related to the lack of attainment of an individual's needs that produce interpersonal pressure, which may lead to a false or ego-invested self. The ego-invested construction serves to protect an individual's self-worth, and the participation with the activity becomes a substitute for self-worth. As a result, the individual may feel compelled to engage in the activity rather than intrinsically motivated (Mageau et al. 2009). Therefore, OP is more likely to result in negative outcomes because individuals with OP tend to feel that they are controlled by their activities.

A two-dimensional model of passion

Although Vallerand et al. (2003) proposed innovative categories of passion in the dualistic model of passion, they did not clearly define the indices of HP and OP. Previous studies have found that internal or intrapersonal factors, such as curiosity, interest, and internal need for self-improvement (Bathgate et al. 2013; Bonk et al. 2015), boost one's passion for learning. They have also found that individuals are more likely to learn skills that are helpful for them to become successful in their future. In addition, learners' satisfaction and motivation for skill transfer contribute to their passion in e-learning; when people feel that they are growing or accomplishing something, they may view themselves as more productive and involved (Zia-ur-Rehman and Shahzadi 2014). In the same vein, it is suggested that intrinsic motivation drives learners' enthusiasm for acquiring knowledge; individuals who feel supportive and encouraged in an environment may have a better inherent desire to obtain new knowledge (Hildrum 2009; Blakiston 2011). On the other hand, external or interpersonal factors may have great influences on students' passion in the context of e-learning. It has been noted that interactions via media enhance one's passion for learning (Stavros et al. 2014). It has also been found that there are high correlations between sense of teaching presence, reflecting the interactions between e-learners and instructors, and flow in corporate e-learning (Joo et al. 2013). Moreover, qualitative study findings reveal that a collaborative and high quality interactive web environment contributes to learners' creation of knowledge and new ideas (Tan and Lam 2014). Along the same lines, it has been found that through external stimuli, learners' curiosity and attention are aroused and their flow experience is increased during the process (Lee et al. 2014). Therefore, in the

context of e-learning, passion can be influenced by internal/intrapersonal as well as external/interpersonal factors.

Based on the categorization of passion by the dualistic model of passion (Vallerand et al. 2003), the key concepts of SDT, which show that the autonomous and the controlled motivations result from different internalizations of the environment (Deci and Ryan 2008), as well as the aforementioned factors that influence passion in e-learning environments (e.g., Bonk et al. 2015; Hildrum 2009; Blakiston 2011; Lee et al. 2014; Stavros et al. 2014), we propose a two-dimensional model of passion that includes the dimension of the locus of control (internal versus external) and internalization drives (HP versus OP). The following four types of passion in e-learning are identified in the model (see Fig. 1): (1) Internal HP: This refers to the harmonious and controllable passion that is derived from self-determined enjoyment and satisfaction while interacting with the engaged activity. (2) External HP: This refers to the harmonious and controllable passion that is derived from self-determined enjoyment and satisfaction while interacting with others. (3) Internal OP: This refers to excessive and uncontrollable passion toward the engaged activity, which is derived from internally compelled forces, such as impulsive and ego-centric thinking, while interacting with the engaged activity. (4) External OP: This refers to excessive and uncontrollable passion toward the activity, which is derived from externally compelled forces, such as pressures and obligation, while interacting with others.

Passion and KM in e-learning

Ragab and Arisha (2013) analyzed 350 published articles over the last decade and suggested that KM plays an important role in information technology. Knowledge management is regarded as a systematic process in which learners interact with the environment and actively construct knowledge; it is commonly described as the competencies of knowledge acquisition and storage, knowledge application, knowledge sharing, knowledge utilization, knowledge internalization, and knowledge creation, (Chatti 2012; Lee et al. 2005; Ungaretti and Tillberg-Webb 2011; Yeh 2012; Yeh et al. 2012; Yılmaz 2012). Recently, passion is regarded as a prerequisite for a successful engagement in knowledge work, as it serves as a type of emotion in KM in order to achieve a more comprehensive understanding of knowledge work (Coleman and Guo 2013). In the environment of e-learning, not only the passion toward learning content, but also the passion toward

Drive of internalization / Locus of control	Harmonious (Self-determinate)	Obsessive (Compelled)
Internal (Intrapersonal)	**Internal HP**	**Internal OP**
External (Interpersonal)	**External HP**	**External OP**

Fig. 1 A two-dimensional model of passion

learning vehicles are crucial to KM and learning outcomes. Individuals' passion in specific subject may not be sufficient to motivate them to learn and sustain their learning; the tools and approaches they use to learn may also affect their passion in learning. Harandi (2015) has confirmed that e-learning is a crucial element that affects students' motivation and students are more likely to be more motivated when applying e-learning. Moreover, Kim and Frick (2011) have also identified self-directed e-learning as an important predictor of student tendency to learn. E-learning, although serves as a tool but not a final pursuit, can boost individuals to sustain their passion in certain activities or subjects.

Some study findings and theories have suggested a positive relationship between a general positive passion and KM. For example, Sié and Yakhlef (2009) claimed that passion is a significant contributor to knowledge acquisition; it serves as an internal motive for people to acquire and transfer knowledge. Moreover, they found that passion emerges as a feature that gives meaning to knowledge exchange and sharing. In the same vein, empirical studies have found that passionate teachers were willing to share their knowledge with students (Akoorie et al. 2011; Hobbs 2012); passionate people tend to describe sharing knowledge as something enjoyable, which involves creating something new (Antal and Richebé 2009; Santoro et al. 2012). These findings suggest that passion functions as an internal motive for KM. However, how different types of passion exert effects on KM is unclear. Based on the aforementioned literature on passion, we assume that HP would have a positive influence on KM whereas OP would have a negative influence on KM in e-learning environments.

The relationships among passion, self-regulation, and KM in e-learning

Self-regulation and KM in e-learning

Self-regulation is described as a process that helps learners construct their learning activities by utilizing related cognitive and behavioral strategies (Zimmerman 1990). Self-regulated learning strategies involve methods aimed at acquiring knowledge, including organizing and transforming it, keeping records and monitoring them, and environmental structuring (Zimmerman 2004; Zimmerman and Martinez-Pons 1988). When self-regulating, individuals' attention and emotions enable them to guide and concentrate on their goal-directed activities across changing circumstances and over time without distraction (Luszczynska et al. 2004). It therefore predicts a better quality of learning outcomes (Milliano et al. 2012).

As for the relationship between self-regulation and KM, it has been suggested that self-regulated learners are intentional learners who frequently use strategies that directly seek to acquire knowledge or skills to meet a higher level of success (Cleary 2006). Empirical research has also shown that individuals who are oriented toward self-regulation processes in their learning show greater knowledge acquisition and are able to develop a more elaborate knowledge network through self-regulation (Peters 2012; Eilam and Reiter 2014; Zumbrunn and Bruning 2013). Notably, it has been found that when learning with hypermedia in a web-based environment, learners' understanding of complex topics is enhanced if they are trained to regulate their learning (Azevedo and Cromley 2004; Hu and Driscoll 2013). These findings suggest that learning with self-regulation would lead to superior KM in e-learning environments.

Mediating role of self-regulation on passion and KM in e-learning

In this study, we suggest that self-regulation may serve as a mediator between passion and KM in e-learning. Passion is a style of learning attitude that may be viewed as a motivational factor that influences people's engagement and their tendency to strive to go beyond their present state of knowledge (Liaw and Huang 2013; Sié and Yakhlef 2009), while self-regulation functions as a catalyst that assists learners toward better achievement (Hu and Driscoll 2013). Liaw et al. (2007) pointed out that e-learning offers an anywhere and anytime environment that learners have more opportunities to be active and self-regulated. The convenience, flexibility and autonomy of e-learning allows learners to guide themselves and organize their own study schedule, which may let them become more engaged in the subject they are interested in and sustain their passion in certain activities.

According to the SDT (Deci and Ryan 2000), self-determinate people are highly self-regulated; they seek to satisfy their basic needs of autonomy, competence, and relatedness to others in order to achieve better outcomes (Deci and Ryan 2000). Such a tendency is in accordance with HP in the dualistic model of passion (Vallerand et al. 2003; Vallerand et al. 2007). In addition, empirical studies have found that HP is positively related to autonomous motivation (Stoeber et al. 2011). Accordingly, passion may influence self-regulation during e-learning. However, passion alone may not be sufficient for bringing about good learning outcomes if learners do not figure out ways to effectively monitor their learning process. Self-regulated learning comprises the following three elements: the use of self-regulated learning strategies, the responsiveness to self-oriented feedback about learning effectiveness, and the interdependent motivational processes. Self-regulation also relates to the ability of setting goals for learning as well as the ability to monitor and regulate learning processes (Azevedo and Cromley 2004). Therefore, self-regulated learners tend to be more active in their learning and proactively seek out information when needed, which enables them to be self-aware and knowledgeable in their approach to learning (Zimmerman 1990).

Accordingly, self-regulation may play an important mediating role that boosts the influence of passion toward KM in an e-learning environment. However, people with HP may have enhanced abilities of self-regulation that further facilitate KM, while people with OP may have impeded self-regulation, therefore resulting in worse KM during e-learning.

Hypotheses of this study

The argument that passion in e-learning includes four types of passion (internal harmonious passion, external harmonious passion, internal obsessive passion, and external obsessive passion) has been supported by a large sample study (Yeh et al. 2011). In the study, the researchers also found that internal harmonious passion (internal HP) and external harmonious passion (external HP) were highly correlated and may be converged into one variable. A similar pattern was found between internal obsessive passion (internal OP) and external obsessive passion (external OP). Accordingly, we employed HP and OP, instead of all four types of passion, as latent variables in the path model analysis in this study.

To date, although research on passion has gathered evidence demonstrating that passion is critical to learning and that self-regulation strategies may enhance it remains unclear whether HP and OP make a distinctive contribution to explaining individual differences in KM through self-regulation in e-learning contexts among college students. This study

aimed to resolve this issue and hypothesized that HP (including internal HP and external HP) and OP (including internal OP and external OP) would interactively influence KM directly as well as influence KM indirectly through self-regulation in e-learning environments. However, the two types of passion would carry different effects on KM. Specifically, HP would carry positive influences, whereas OP would carry negative influences throughout the influence paths (see Fig. 2 for the hypothesized model).

Method

Participants

A total of 1209 undergraduate ($n = 1003$) and graduate students ($n = 206$), including 593 males (49.05%) and 616 females (50.95%), participated in the study. Their ages ranged from 16 to 46 years (M = 21.88 years; SD = 4.13 years). The participants reported that they spent 1.82 h (SD = 0.83 h) per day on average doing e-learning activities.

Instruments

The inventory of passion in e-learning (IPE) (Yeh et al. 2011) was employed to measure learners' HP and OP in an e-learning context. The IPE was developed based on the dualistic model of passion (Vallerand et al. 2003), the key concepts of SDT (Deci and Ryan 2008), and related literature of passion in e-learning environments (e.g., Bonk et al. 2015; Hildrum 2009; Blakiston 2011; Lee et al. 2014; Stavros et al. 2014). The IPE is a 4-point Likert scale with response options ranging from 1 (strongly disagree) to 4 (strongly agree). With a total of 20 items, the IPE includes four factors: internal HP (8 items), external HP (4 items), internal OP (5 items) and external OP (3 items). Example items were as follows: "I often use e-learning because it helps me keep up with the newest information." (Internal HP); "When using e-learning interfaces, I often learn by interacting with others; they help stimulate my thoughts through different perspectives." (External HP); "I have a hard time controlling my impulses for using e-learning." (Internal OP); and "Usually, I interact and discuss with others through e-learning interfaces to submit assignments." (External OP). An exploratory factor analysis indicated that 51.465% of the total variance was explained.

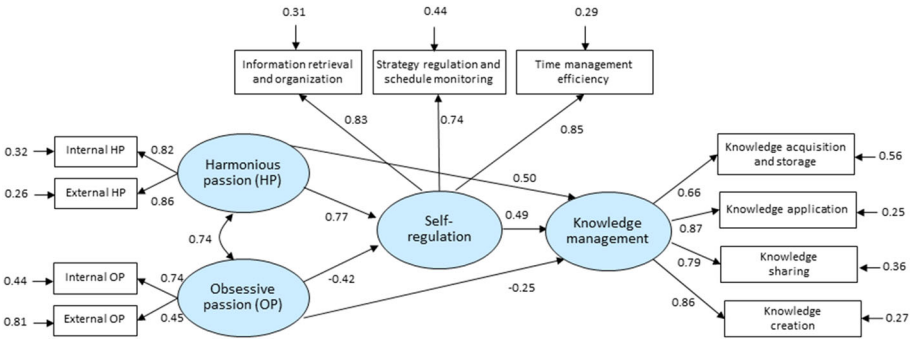

Fig. 2 Path model of passion, self-regulation, and KM in e-learning

The total Cronbach's α coefficients for the IPE and the four factors were 0.896, 0.885, 0.818, 0.843, and 0.605, respectively (see Appendix 1). In addition, a confirmatory factor analysis (CFA) indicated that IPE had good validity: χ^2 ($N = 1647$) = 1407.011 ($p < 0.001$), goodness-of-fit (GFI) = 0.917, adjusted goodness-of-fit (AGFI) = 0.894, root-mean-square error of approximation (RMSEA) = 0.068, root-mean-square residual (RMR) = 0.029, normed fit index (NFI) = 0.916, normed fit index (NFI) = 0.916, comparative fit index (CFI) = 0.925, and incremental fit index (IFI) = 0.925 (Yeh et al. 2011).

The inventory of self-regulation in e-learning (ISRE) (Yeh and Lin 2015) was administered to assess the participants' levels of self-regulation in an e-learning context. The ISRE was developed by integrating common e-learning experiences and theories of self-regulated learning strategies (Zimmerman 2004; Zimmerman and Martinez-Pons 1988). With a total of 16 items, the ISRE is composed of three factors: information retrieval and organization (6 items), strategy regulation and schedule monitoring (7 items), and time management efficiency (3 items). Example items are "When engaging in e-learning, I can adjust the methods I use to search resources to find useful information." and "When engaging in e-learning, I plan my learning time." The total Cronbach's α coefficients of the ISRE and the three factors were 0.924, 0.882, 0.872, and 0.793, respectively (see Appendix 2). Responses to each item were on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). A CFA analysis indicated that ISRE had good construct validity: χ^2 ($N = 1647$) = 898.412 ($p < 0.001$); GFI = 0.933, AGFI = 0.906, RMSEA = 0.071, and RMR = 0.017; NFI = 0.935, CFI = 0.941, and IFI = 0.941.

The inventory of knowledge management in e-learning (IKME) (Yeh 2015), with a total of 22 items, consists of four factors: knowledge acquisition and storage (7 items), knowledge application (6 items), knowledge sharing (5 items), and knowledge creation (4 items). The IKME was developed by integrating common e-learning experiences and theories of knowledge management (Chatti 2012; Lee et al. 2005; Ungaretti and Tillberg-Webb 2011; Yeh 2012; Yeh et al. 2012; Yılmaz 2012). Example items include "In an e-learning environment, I am use to actively joining e-learning communities (e.g., Bulletin board system (BBS), Facebook, etc.) to acquire important and updated information." and "In an e-learning environment, I am used to using collaborative interfaces (e.g., Google or Wiki interfaces) to share my experiences or knowledge." The total Cronbach's α coefficients of the IKME and the four subscales were 0.942, and 0.886, 0.897, 0.827, and 0.878, respectively (see Appendix 3). Responses to each item were on a 4-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). A CFA analysis indicated that the IKME had good construct validity: χ^2 ($N = 1647$) = 2590.141 ($p < 0.001$); GFI = 0.872, AGFI = 0.840, RMSEA = 0.085, and RMR = 0.026; NFI = 0.935, CFI = 0.942, and IFI = 0.942.

Procedures

All participants had to register to become a member before they could fill out the inventories online. Then, a definition of e-learning and instructions for the study were provided. After a consent form was completed, the participants finished the inventories. Gift vouchers with values of approximately USD 17, USD 10, and USD 3.5 as well 4G USBs were provided as rewards through a lottery process.

Table 1 Descriptive statistics and internal consistency coefficients of the latent variables

	Mean	SD	1	2	3	4
1. Harmonious passion (HP)	2.70	0.31	1.00			
2. Obsessive passion (OP)	2.38	0.43	0.50***	1.00		
3. Self-regulation (SR)	3.11	0.36	0.40***	0.15***	1.00	
4. Knowledge management (KM)	3.12	0.40	0.45***	0.12***	0.60***	1.00

*$p < 0.05$, **p <0 .01, ***$p < 0.001$

Results

Preliminary analyses

On average, the participants engaged in e-learning for 1.82 h ($SD = 0.83$ h) per day. The time they spent on e-learning per day was closely related to their internal HP ($r = 0.305$, $p < 0.001$) and external HP ($r = 0.265$, $p < 0.001$) and was less related to internal OP ($r = 0.124$, $p < 0.001$), external OP ($r = 0.062$, $p = 0.031$), self-regulation ($r = 0.137$, $p < 0.001$), and KM ($r = 0.163$, $p < 0.001$).

Although more undergraduates than graduates participated in this study, there were no differences between the two groups concerning the four types of passion, self-regulation, or KM ($F(1, 1206) = 1.305$, 0.282, and 0.802, respectively; ps > 0.05). Moreover, the participants from the 10 different schools did not perform differently concerning the four types of passion, self-regulation, or KM ($F(1, 1199) = 1.093$, 0.292, and 0.613, respectively; ps > 0.05).

The descriptive statistics for the major variables in the proposed path model are presented in Table 1. An inspection of the mean scores found that the participants had above-average degrees of HP, OP, self-regulation, and KM (higher than 2.0 on a four-point scale). The inter-correlations among the variables revealed that self-regulation was strongly related to KM ($r = 0.60$, $p < 0.001$). Moreover, although OP was positively correlated with self-regulation and KM (rs $= 0.12$ and 0.15, ps < 0.001), harmonious passion had stronger relationships with self-regulation and KM (rs $= 0.40$ and 0.45, ps < 0.001) than OP with the same two variables. Interestingly, HP and OP were highly correlated ($r = 0.60$, $p < 0.001$).

Inspecting the internal consistency coefficients of the latent variables in the proposed model (see Table 2), we found that internal HP and external HP were highly correlated ($r = 0.71$, $p < 0.001$), whereas the relationship between internal OP and external OP was less strong ($r = 0.33$, $p < 0.001$). Except for the relationships between internal OP and "Information retrieval and organization" and "Knowledge acquisition and storage" as well as the relationships between external OP and "Time management efficiency" and "Knowledge acquisition and storage", all correlations were significant.

Table 2 Internal consistency coefficients of the latent variables

	1	2	3	4	5	6	7	8	9	10	11
1. IHP	1.00										
2. EHP	0.71***	1.00									
3. IOP	0.42***	0.50***	1.00								
4. EOP	0.26***	0.31***	0.33***	1.00							
5. SR1	0.35***	0.24***	0.02	0.08*	1.00						
6. SR2	0.36***	0.37***	0.21***	0.12***	0.60***	1.00					
7. SR3	0.35***	0.27***	0.07*	0.05	0.71***	0.63***	1.00				
8. KM1	0.31***	0.18***	− 0.06	0.03	0.54***	0.31***	0.44***	1.00			
9. KM2	0.40***	0.36***	0.11***	0.09**	0.52***	0.47***	0.50***	0.56***	1.00		
10. KM3	0.39***	0.46***	0.24***	0.14***	0.35***	0.49***	0.36***	0.46***	0.71***	1.00	
11. KM4	0.40***	0.36***	0.09*	0.07*	0.49***	0.43***	0.46***	0.60***	0.73***	0.69***	1.00

Note IHP Internal harmonious passion, *EHP* External harmonious passion, *IOP* Internal obsessive passion, *EOP* External obsessive passion, *SR*1 Information retrieval and organization, *SR*2 Strategy regulation and schedule monitoring, *SR*3 Time management, *KM*1 Knowledge acquisition and storage efficiency, *KM*2 Knowledge application, *KM*3 Knowledge sharing, *KM*4 Knowledge creation

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Analyses of the proposed path model

Goodness-of-fit of the proposed path model

To test the proposed path model, structural equation modeling (SEM) was conducted with AMOS 21 to examine the relationships between HP, OP, self-regulation, and KM in an e-learning environment. To investigate the goodness-of fit of the proposed model, three indices suggested by Bagozzi and Yi (1988) were employed: preliminary fit criteria, global measures of fit, and the fit of the internal structure of the model. The relationships between passion, self-regulation, and KM are shown in Fig. 2.

The absolute fit measures revealed that the model was not a good fit: χ^2 ($N = 1209$) = 572.787 ($p < 0.001$); However, the χ^2 coefficient is sensitive to sample size, so as the sample size increases, the chances of rejecting a model increase (Bagozzi and Yi 1988); therefore, the other indices should be considered when making an overall judgment (Hair et al. 2006). In the present study, AGFI (0.836) and RMSEA (0.108) were acceptable; CFI (0.921), GFI (0.906), NFI (0.916), RFI (0.921) and IFI (0.922) were all above 0.90; and RMR (0.013) was below 0.05. These results suggest that the proposed model is a good fit based on the general agreement proposed by researchers (e.g., Hu and Bentler 1999; Wang et al. 2011).

Table 3 The factor loadings, standard errors, item reliability, composite reliability, and average variance extracted of the variables in the proposed model

Variable	Factor loading	Standard error	*t*	item reliability (R2)	composite reliability	average variance extracted
Harmonious passion (HP)					0.83	0.71
IHP	0.82	0.03	20.02***	0.68		
EHP	0.86	–		0.75		
Obsessive passion (OP)					0.53	0.38
IOP	0.74	0.16	11.11***	0.55		
EOP	0.45	–		0.20		
Self-regulation					0.85	0.65
SR1	0.83	–		0.69		
SR2	0.74	0.04	26.94***	0.55		
SR3	0.85	0.04	30.69***	0.72		
Knowledge management					0.88	0.64
KM1	0.66	–		0.43		
KM2	0.87	0.05	25.29***	0.76		
KM3	0.79	0.06	23.50***	0.62		
KM4	0.86	0.05	23.98***	0.73		

Note – Not estimated, *IHP* Internal harmonious passion, *EHP* External harmonious passion, *IOP* Internal obsessive passion, *EOP* External obsessive passion; *SR*1 Information retrieval and organization, *SR*2 Strategy regulation and schedule monitoring, *SR*3 Time management, *KM*1 Knowledge acquisition and storage efficiency, *KM*2 Knowledge application, *KM*3 Knowledge sharing, *KM*4 Knowledge creation

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Fit of the internal structure of the model

The following four criteria (Bagozzi and Yi 1988) were employed to examine the fit of the internal structure of the proposed model in this study. The findings revealed that (1) the individual item reliability of all indicators ranged from 0.20 to 0.75; (2) the latent variable composite reliabilities of HP, OP, ISRE, and IKME were 0.83, 0.53, 0.85 and 0.88, respectively; (3) the average variance extracted from the latent variable ranged from 0.38 to 0.88; and (4) the factor loading of the estimated parameter ranged from 0.45 to 0.87. Overall, the results indicate that the proposed model had a good fit for the internal structure (see Table 3).

Analyses of direct effects, indirect effects, and explained variance

All of the direct effects were significant. The direct effects of HP on self-regulation and KM were 0.77 and 0.50, respectively; the direct effects of OP on self-regulation and KM were − 0.42 and − 0.25; and the direct effect of self-regulation on KM was 0.49. The indirect effects of HP and OP on KM were 0.38 and the − 0.21, respectively. The correlation between HP and OP was 0.74. Finally, the total effects of HP and OP on KM were 0.88 and − 0.46 (see Table 4).

Moreover, the SEM analysis revealed that the residual variance of self-regulation was 0.28, indicating that HP and OP explained 72% of the variance in self-regulation; the residual variance of KM was 0.55, indicating that HP, OP, and self-regulation jointly explained 45% of the variance in KM (see Fig. 2).

Discussion

The main purposes of this study were (1) to construct concrete indices for the measurement of passion in e-learning environments by building on the dualistic model of passion and (2) to investigate the relationships between harmonious passion (HP), obsessive passion (OP), self-regulation, and knowledge management (KM) in e-learning environments among college students. To achieve the first goal, we proposed a two-dimensional model of passion by adding the dimension of locus of control (internal versus external) to the dualistic model of passion (Vallerand et al. 2003) and interpreting it with the integration of self-determination theory (Deci and Ryan 2000, 2008) and factors that influence passion in

Table 4 Direct, indirect, and total effects of the revised model

Paths between variables	Direct effect	Indirect effect	Total effect
HP— > Self-regulation	0.77***		0.77***
OP— > Self-regulation	− 0.42***		−0.42***
Self-regulation— > KM	0.49***		0.49***
HP— > KM	0.50***	0.38***	0.88***
OP— > KM	− 0.25***	− 0.21***	− 0.46***

***$p < 0.001$

e-learning. We found that the four types of passion proposed (internal HP, external HP, internal OP, and external OP) were positively correlated, which is consistent with previous findings (Wang et al. 2011; Philippe et al. 2010); however, we found that external OP had a lower positive correlation with the other three variables compared with the other correlations. Moreover, the preliminary analyses showed that most participants reported higher scores in HP than in OP, and the time they spent per day on e-learning was more related to their internal HP and external HP than internal OP and external OP, suggesting that HP, especially internal HP, strongly influences and predicts college students' willingness to engage in e-learning.

To achieve the second goal of this study, a path model was examined through SEM. The results suggest that HP is more predictive of self-regulation and KM than OP. Moreover, although all four types of passion were correlated and predictive of self-regulation and KM in e-learning, HP and OP influenced self-regulation and KM in the opposite directions. While HP positively influenced self-regulation and KM, OP negatively influenced self-regulation and KM. These findings are in accordance with how HP and OP are internalized (Philippe et al. 2010). However, these findings are contradictory to Vallerand et al. (2008) findings that both HP and OP were important catalysts and motivational forces for boosting positive outcomes. Bell and Kozlowski (2002) claimed that the nature of technology is that it offers learners the opportunities for control over their learning. In the same vein, Mayer (2014) declared that motivation in multimedia is the internal state that initiates, maintains, and energizes the learner's effort to engage in learning processes. Other researchers have also proposed that passion is associated with higher levels of absorption in learning (Stoeber et al. 2011) and that it helps learners dedicate themselves fully to their learning activities, thereby supporting them to persist and achieve their goals (Vallerand et al. 2007). HP refers to a strong autonomous inclination a person has to be involved in an activity in which the person is in control of the activity and therefore brings about flexibility to engage in the activity, whereas OP entails a strong desire to engage in an activity as if the activity controls the person (Carbonneau and Vallerand 2013; Philippe et al. 2010; Stoeber et al. 2011). Accordingly, college students with high levels HP are more capable of controlling, regulating, and managing their e-learning behavior. Therefore, the type of motivation or passion that affects e-learning should ideally be HP (both internal and external) rather than OP.

Most importantly, the SEM analysis in this study reveals that the proposed model is a good-fit model. In other words, self-regulation plays an important mediation role between passion and KM. This means that college students with harmonious passion are more likely to self-regulate their learning, which in turn facilitates their knowledge management. In contrast, obsessive passion is more likely to decrease self-regulation and, further, to impede effective KM. In the ubiquitous e-learning environment, learners need to navigate their learning resources in the knowledge-explosive environment; KM helps speed up students' learning processes based on their own preferences (Lau and Tsui 2009). Learners who are strong self-regulators are more likely to be aware of their learning strategies, monitor their learning processes, and adjust their goals, which leads to an increase in their efforts and success (Huie et al. 2014; Isaacson and Fujita 2006; Kornell and Metcalfe 2006). Learners with better self-regulation abilities are therefore competent in knowledge acquisition and storage, knowledge application, knowledge sharing, and knowledge creation in e-learning environments. Moreover, the findings in this study are in line with the self-concordance model of self-regulation (Sheldon and Elliot 1999), which claims that individuals who pursue personal goals for autonomous reasons are more willing to put effort into achieving their goals and thus satisfy their

needs (Gillet et al. 2014; Sheldon and Elliot 1999). Such motivational belief is regarded as the crucial factor that facilitates self-regulation behavior (Buhrau and Sujan 2014, 2015; Roeser and Peck 2009). On the other hand, researchers (Stenseng et al. 2015) have found that OP was related to poorer self-regulation. Accordingly, HP and OP may predict self-regulation and KM as inverses of each other, and HP indirectly influences KM through self-regulation, which helps college students to proactively monitor their learning during e-learning experiences.

Conclusions, suggestions, and limitations

The findings in this study not only support the two-dimensional model of passion proposed in this study but also add to the literature on the dualistic model of passion by focusing on both internal and external perspectives, especially in the context of e-learning. Moreover, this study suggests that the four types of passion proposed (internal HP, external HP, internal OP, and external OP), though positively correlated, interact in ways that have different effects on college students' self-regulation and KM in e-learning. Few studies have investigated the relationship between self-regulation and knowledge management in an e-learning environment; their positive relationship as well as the mediating role of self-regulation on passion and knowledge management found in this study shed light on instructional design and development. In this digital society, enhancing college students' HP to encourage self-regulation on their own learning is crucial for fostering lifelong learning and self-development, which would further help them to thrive in today's constantly changing world.

Accordingly, enhancing HP as well as decreasing OP (especially external OP) and transforming OP into HP to further enhance the ability of self-regulation and knowledge management should be taken into account when e-learning activities or environments are

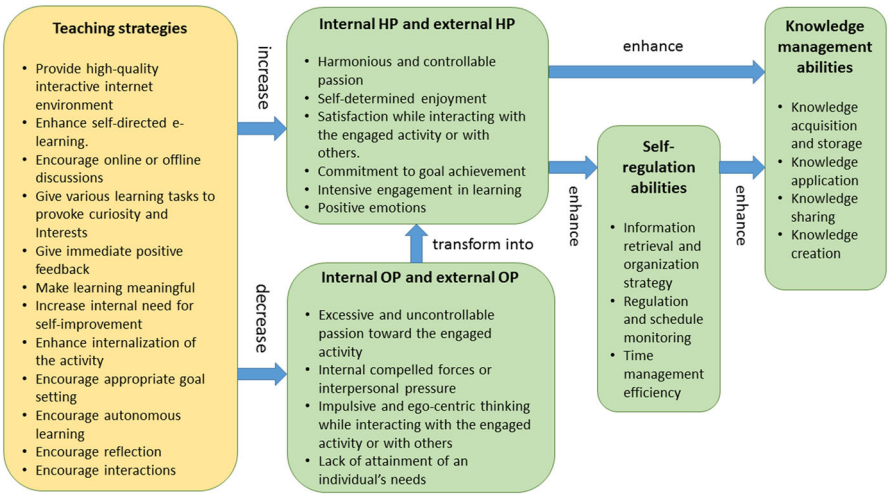

Fig. 3 A framework for enhancing HP, OP, and abilities of self-regulation and knowledge management in an e-learning environment

designed to cultivate self-regulated and competent knowledge-management college students. Specific teaching strategies are suggested in Fig. 3. HP is characterized by senses of harmonious and controllable passion, self-determined enjoyment, satisfaction while interacting with the engaged activity or with others, commitment to goal achievement, intensive engagement in learning, and positive emotions. On the other hand, OP is characterized by senses of excessive and uncontrollable passion toward the engaged activity, internal compelled forces or interpersonal pressure, impulsive and ego-centric thinking while interacting with the engaged activity or with others, and lack of attainment of an individual's needs. Instructors are encouraged to provide high-quality interactive internet environment by integrating the suggested teaching strategies to strengthen such HP senses but to decrease or diminish such OP senses.

Although this study includes a large sample, it is still an investigative study. Further studies should examine the path model proposed here through experimental instruction or training courses. Moreover, the inventories were completed online, and although the participants were invited using formal documentation and their qualifications were examined, there are still risks that some participants may nonetheless be unqualified. However, in such a large sample, a few special cases may not have a significant influence on the results. Nevertheless, validation with another sample is required to confirm the results found in this study.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Appendix 1

See Table 5.

Table 5 The inventory of passion in e-learning (IPE)

No	Factors and test items	Factor loading			
		1	2	3	4
Internal harmonious passion (Cronbach's $\alpha = 0.885$)					
1	I often use e-learning because it helps me keep up with the newest information	0.719			
5	I often learn through e-learning interfaces because they provide learning materials that match my competencies and meet my needs	0.703			
9	I often use e-learning because it is a lot of fun	0.690			
13	I often collect data or do research through e-learning interfaces because they provide rich information that is immediately accessible	0.685			
16	I often use e-learning because it allows me to determine and select only the learning materials I need	0.682			
18	In order not to fall behind, I use e-learning frequently because it helps me acquire updated information	0.653			
19	I often interact and discuss material with others through e-learning interfaces to enhance my learning efficiency	0.535			
20	In order not to miss new information, I spend a lot of time browsing information using the e-learning interfaces with which I am familiar	0.507			
Internal obsessive passion (Cronbach's $\alpha = 0.843$)					
2	I feel uneasy when I do not fulfill my e-learning requirements right after I get out of bed		0.815		
6	I feel like life is boring if I do not use e-learning interfaces that day		0.806		
10	I have to use the e-learning applications every day, regardless of how busy or how tired I am, or I will feel empty that day		0.750		
14	I have a hard time controlling my impulses for using e-learning		0.623		
17	When I have important tasks to complete, I try to spend less time using e-learning, but my self-control often fails		0.475		
External harmonious passion (Cronbach's $\alpha = 0.818$)					
3	When using e-learning interfaces, I often learn by interacting with others; they help stimulate my thoughts through different perspectives			0.649	
7	I often help others solve problems through e-learning interfaces; doing so gives me a feeling of achievement			0.539	
11	I enjoy sharing my knowledge or viewpoints through e-learning interfaces			0.535	
15	I participate in interactions and discussion in e-learning interfaces so my performance will be as good as that of others			0.489	
External obsessive passion (Cronbach's $\alpha = 0.605$)					
4	Usually, I interact and discuss with others through e-learning interfaces to submit assignments				0.666
8	I usually use e-learning only under the pressure of upcoming deadlines for submitting assignments				0.661
12	My friends often learn through e-learning interfaces, so I feel forced to use them as well				0.421

Note Cronbach's α coefficient of the IPE was 0.896

$N = 1017$

Appendix 2

See Table 6.

Table 6 The inventory of self-regulation in e-learning (ISRE)

No	Factors and test items	Factor loading		
		1	2	3
When engaging in e-learning				
Information retrieval and organization (Cronbach's $\alpha = 0.882$)				
15	I save important information or links to help me gain deep insight into the contents	0.759		
13	I think about what e-learning interfaces may provide the information I need	0.754		
14	I pay attention to the related links shown in the e-learning interfaces	0.727		
5	I pay attention to associations between the information I am searching for and the learning tasks I need to complete	0.663		
4	I first consider the scope of the information that I need	0.611		
2	I am good at screening and integrating important information	0.534		
Strategy regulation and schedule monitoring (Cronbach's $\alpha = 0.872$)				
16	I can adjust the methods I use to search resources to find useful information		0.702	
9	I can adjust my criteria for choosing e-learning interfaces to find those that make me feel more comfortable when learning		0.668	
12	I can adjust my time management methods to obtain the best learning outcome		0.636	
3	I can adjust the learning methods I employ to efficiently achieve my learning goals		0.632	
6	I am good at using a variety of strategies (e.g., changing key words or changing interfaces) to obtain the information I need		0.608	
1	I create learning goals for each learning stage		0.607	
7	I can adjust my search scope and methods to complete learning tasks on time		0.554	
Time management efficiency (Cronbach's $\alpha = 0.793$)				
10	I plan my learning time			0.575
8	I try to figure out the features and functions of the e-learning interface I am using			0.474
11	I pay attention to my learning efficiency during each time slot			0.449

Note Cronbach's α coefficient of the ISRE was 0.924

$N = 1017$

Appendix 3

See Table 7.

Table 7 The inventory of knowledge management in e-learning (IKME)

No	Factors and test items	Factor loading			
		1	2	3	4
In an e-learning environment, I am used to…					
Knowledge acquisition and storage (Cronbach's $\alpha = 0.886$)					
1	Downloading static information (e.g., words and figures) from the reviewed websites	0.831			
5	Acquiring information through search engines (e.g., Google, Yahoo, etc.)	0.798			
9	Saving the reviewed websites (e.g., adding the websites to My Favorites)	0.754			
13	Downloading dynamic information (e.g., videos) from the reviewed websites	0.723			
17	Organizing My Favorites so I can search information conveniently	0.681			
20	Actively joining e-learning communities (e.g., Bulletin Board System (BBS), Facebook, etc.) to acquire important and updated information	0.512			
22	Categorizing information and saving it to my computer	0.467			
Knowledge application (Cronbach's $\alpha = 0.897$)					
2	Providing related information or experiences to support my own arguments		0.664		
6	Employing integrated and internalized knowledge to solve problems		0.664		
10	Employing self-knowledge to help others solve everyday problems		0.650		
14	Analyzing or evaluating problem-solving alternatives proposed by others		0.639		
18	Employing static information (e.g., words or pictures) to help express my opinions		0.627		
21	Clearly pointing out the core problems and systematically stating the main points of the problem		0.584		
Knowledge sharing (Cronbach's $\alpha = 0.827$)					
3	Expressing self-opinions via dynamic information (e.g., video or Flash)			0.699	
7	Using collaborative interfaces (e.g., Google or Wiki interfaces) to share my experiences or knowledge			0.642	
11	Employing converted knowledge to form creative products			0.601	
15	Providing solutions for problems			0.560	
19	Actively joining or creating e-learning communities (e.g., BBS, Facebook, etc.) to increase my opportunities for interactions			0.477	
Knowledge creation (Cronbach's $\alpha = 0.878$)					
4	Producing creative ideas through interactions with others				0.672
8	Integrating and internalizing discussed information				0.621
12	Producing innovative ideas via knowledge integration				0.593
16	Revising self-concepts or ideas through interactions with others				0.589

Note Cronbach's α coefficient of the IKME was 0.942

$N = 1017$

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