What affects learner engagement in flipped learning and what predicts its outcomes?

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Abstract
The current popularity of flipped learning may be attributed to its reported successes in bringing about enhanced learner engagement and positive learning outcomes. This study aims to improve our understanding of flipped learning (FL) outcomes by examining factors of learner engagement, academic capability, and epistemological beliefs. Data were collected and statistically analyzed from 231 undergraduate students enrolled in a general biology or general chemistry course at a Korean university implemented with the FL model. The results indicated that learners’ epistemological beliefs influenced neither pre-class nor in-class engagement, but that academic capability did affect both pre-class and in-class engagement. Only content/learning-related outcomes, not generic competencies or satisfaction, were affected by both academic capability and epistemological beliefs. Both pre-class and in-class engagement levels affected most types of FL outcomes except generic competencies, which were only affected by the extent of in-class engagement. Learners’ affective engagement was not influenced by epistemological beliefs, but directly and indirectly affected FL outcomes via behavioral and cognitive engagement. Theoretical and practical implications are discussed along with recommendations.

Introduction
The flipped learning (FL), which blends individualized online pre-class learning with in-class learning activities, has attracted the attention of educational practitioners and scholars over the past decade. In higher education, the FL model has been implemented extensively in a variety of undergraduate and graduate majors, such as natural sciences (eg, Deri, Mills, & McGregor, 2018), social sciences (eg, Wright, Greenfield, & Hibbert, 2017), health sciences (eg, Hanson, 2016; Liebert, Lin, Mazer, Bereknyei, & Lau, 2016), humanities (eg, Chen Hsieh, Wu, & Marek, 2017), and engineering (eg, Pardo & Mirriahi, 2017). The popularity of FL may be attributed to
numerous reports of improved academic performance and enhanced learning outcomes as a result of adopting the FL pedagogy (Molnar, 2017). Studies have documented that learners in FL courses not only learn subject content more effectively but also gain learning abilities such as problem-solving (eg, Al-Zahrani, 2015) and self-directed/self-regulated learning skills (eg, Hao, 2016; Sun, Xie, & Anderman, 2018). Some studies have reported the development of other generic competencies, such as interpersonal skills (eg, Morris, 2016), communication skills (eg, Hao, 2016; Molnar, 2017; Zainuddin & Attaran, 2016), and collaboration skills (eg, Molnar,
Many studies also indicate that learners report more satisfaction with their FL courses than with their traditional courses (e.g., Critz & Knight, 2013; Missildine, Fountain, Summers, & Gosselin, 2013). Previous research has identified diverse outcomes associated with FL courses, which may be summarized into three types: content/learning-related outcomes, generic competencies, and satisfaction.

Studies on the factors that affect FL outcomes reported that learner engagement is one of the most fundamental constructs or variables in attempts to improve students’ academic achievement (Connell, Spencer, & Aber, 1994; Finn & Rock, 1997). Even though learner engagement typically comprises cognitive engagement, behavioral engagement, and affective engagement (Archambault, Janosz, Fallu, & Pagani, 2009; Fredricks, Blumenfeld, Friedel, & Paris, 2005; Fredricks & McColskey, 2012), in a context such as FL, engagement should consider the student’s initial commitment to an online pre-class learning mode (hereafter, pre-class engagement) and subsequent commitment to a F2F in-class learning mode (hereafter, in-class engagement). Such engagement might be affected by their self-perceived understanding on the importance of the two learning modes. As of yet, neither students’ epistemological beliefs nor academic performance have been rigorously studied to discern how these elements enhance learner engagement and learning outcomes toward their learning experiences in FL. Given the considerable findings regarding the benefits of FL pedagogy, and the growing interests in their factors, it is necessary to investigate how pre-class/in-class and behavioral/cognitive/affective engagement is influenced by learner factors like epistemological beliefs and academic capabilities, and how different types of engagement affect content/learning-related outcomes, generic competencies, and satisfaction.

Since epistemological beliefs and academic capability of the learner have been identified as strong determinants of learning performance in online learning environments (Barnard, Lan, Crooks, & Paton, 2008; Blake & Scanlon, 2007), as well as in traditional learning contexts (Cano, 2005; Hofer & Pintrich, 1997), FL provides an instructional approach to measure these determinants in addition to engagement or involvement. Therefore, this study represents an attempt to further improve our understandings of FL outcomes by examining factors that traditional education research has shown to be influential, such as learner engagement, epistemological beliefs, and academic capability.

**Learner engagement**

Engagement is not only the goal of FL, but considered a crucial prerequisite for success. In other words, FL is designed and implemented to more effectively engage learners in meaningful learning activities, and at the same time requires learner engagement for the intended outcomes to be achieved. Education researchers have long maintained that learner engagement is one of the major factors influencing learning outcomes (e.g., Kuh, Gruce, Shoup, Kinzie, & Gonyea, 2008; Pascarella & Terenzini, 2005). Kuh and colleagues (2008) examined the relationship between learner engagement and learning outcomes among 11,000 students with different ethnic and racial backgrounds from 18 institutions, and confirmed that learner engagement was significantly associated with academic success in the same way as the factors of learning persistence and performance. Given the learner-centered nature of FL, it seems self-evident that learner engagement is a critical variable in determining the FL outcomes. Engagement has been also considered to be one of the most significant goals to be attained not only by learners but also by teachers and staff in the process of learning (Bryson & Hand, 2007). Since FL creates new sets of learning modes, each learning mode may require different kinds of learner engagement, suggesting that research on learner engagement in FL would benefit from a multifaceted approach.
Pre-class vs. in-class engagement in FL

In FL, two modes of learning, pre-class and in-class, are based on a distinctly different approach to knowledge and learning. In the pre-class portion of FL, learners are required to autonomously engage in learning online lectures and materials in their own time and pace before engaging in the in-class learning activities. In the in-class learning portion of FL, learners are required to actively participate in learner-centered activities designed to help them construct their own meaning through a deeper process of inquiry and investigation. Studies on FL have proposed ways to engage learners both in individualized pre-class learning and collaborative in-class activities (Bergmann & Sams, 2014; Doi, 2016; Ng, 2016). Diemer, Fernandez, and Streepey (2013) have noted that pre-class engagement and in-class engagement have different learning requirements and outcomes. Since the two modes of learning have unique features and demands, pre-class engagement and in-class engagement need to be segmented and analyzed separately.

Behavioral, cognitive, and affective engagement in FL

In addition to the potential differences in learner pre-class and in-class engagement, differences in engagement may occur at behavioral, cognitive, and affective levels. These levels are a multidimensional construct encompassing behavioral, cognitive, affective dimensions (Appleton, Christenson, & Furlong, 2008; Fredricks & McColskey, 2012). Behavioral engagement entails learner conduct such as following the rules (Finn & Rock, 1997) and involvement in learning activities with effort, persistence, and concentration (Birch & Ladd, 1997). Cognitive engagement involves the level of student investment in thoughtful, strategic, and willing efforts to understand complex ideas or master difficult skills (Fredricks, Blumenfeld, Friedel, & Paris, 2005). Lastly, affective engagement refers to learner feelings, perceptions, attitudes, valuing, and interest in learning (Archambault, Janosz, Fallu, & Pagani, 2009; Fredricks & McColskey, 2012). A growing body of research (eg, Merrill, 2013; Morton, Saleh, Smith et al., 2016; Wang, 2017) proposed the principles of course design or redesign to behaviorally, cognitively, or affectively engage learners in online and face-to-face learning. Preliminary research by Wang (2017) on the interaction of behavioral engagement and achievement in FL settings has shown that behavioral engagement in online problem-solving activities has a significant effect on achievement. Nevertheless, more research is needed on the relationships between each dimension of engagement and different types of FL outcomes, as well as on the path by which each engagement predicts FL outcomes.

Academic capability

In the online pre-class learning portion of FL, the academic capabilities of learners may influence FL engagement and outcomes. Learners are responsible for their own individual learning prior to class, as they are to engage in online lectures outside of the classroom at their own time and pace (O’Flaherty & Phillips, 2015). Due to the autonomous nature of this FL pre-class learning, individual factors can facilitate or obstruct learner engagement (Yacout & Shosha, 2016; Yilmaz, 2017). The impact of self-directed or self-regulated learning ability on the overall success of FL has frequently been explored, with mixed results (Hao, 2016; Lai & Hwang, 2016; Sun et al., 2018). On the other hand, the academic capability of the learner, as represented by the GPA or standardized exam scores (such as the ACT or SAT), has been shown to be a powerful factor affecting success in FL courses.

Epistemological beliefs

A body of education research has long supported the relationship between the engagement and achievement of learners and their epistemological beliefs. Epistemological beliefs range from
absolutist beliefs that knowledge is certain, stable, and handed down by authorities to rather sophisticated beliefs that knowledge is complex, tentative, and actively constructed (Bromme, Kienhues, & Stahl, 2008; Schommer, 1990). Some researchers have argued that epistemological beliefs are closely related to various aspects of learning. Beliefs about knowledge and knowing, for example, shape learners’ conceptions of learning, in turn influencing their motivation in the learning process, use of learning strategies, and metacognition (eg, Cano, 2005; Muis & Franco, 2009; Tsai, Ho, Liang, & Lin, 2011). Learner-centered methods such as those used in FL reflect a more constructive view of learning that emphasizes the learner’s responsibility in learning activities (Carlile & Jordan, 2005; Gosling, 2006). Of course, the epistemological beliefs of learners may vary, leading to different levels of engagement in FL pre-class and in-class learning. Such beliefs, then, may be a predictor of overall learner engagement and learning outcomes (McLaughlin et al., 2013). Nevertheless, little FL research has empirically addressed how epistemological beliefs differentially affect pre-class and in-class engagement and other FL outcomes.

In this study, we aimed to refine current understandings about FL engagement by examining differences in FL engagement dimensions (pre-class/in-class, behavioral/cognitive/affective engagement) and outcomes (content/learning-related outcomes, generic competencies, and satisfaction) in relation to individual learner differences (academic capability and epistemological beliefs). We also investigated the path by which the factors ultimately influenced FL outcomes. We posed four research questions with the research model in Figure 1:

1. How do epistemological beliefs or academic capability affect FL engagement?
2. How do epistemological beliefs or academic capability affect the FL outcomes of content/learning-related outcomes, generic competencies, and satisfaction?
3. How do different dimensions of engagement affect the different types of FL outcomes?
4. What is the path relationship from engagement and learner factors to FL outcomes?

**Methods**

**Participants**

The participants in this study were 231 undergraduate students at a Korean university specializing in sciences and technology. The students were enrolled in a general physics or general...
chemistry course employing the FL model. Of the participants, 58.0% were male ($n = 134$), and 42.0% were female ($n = 97$). Most were freshmen ($n = 199$, 86.1%), with the rest 13.9% upper classmen composed of sophomores ($n = 22$, 9.5%) and juniors and seniors ($n = 10$, 4.3%). The grade point averages (GPA) of the participants were mainly in the 3.0 range ($n = 181$, 78.1%), with 16.0% in the 4.0 range ($n = 37$), and only 5.6% ($n = 13$) in the 2.0 range. The majority of the participants were in the division of general studies (84.4%, $n = 195$), with 9.5% ($n = 22$) in the engineering school, 3.9% ($n = 9$) in the natural sciences, and 2.2% ($n = 5$) in business.

**Procedure**

Data were collected from two 15-week courses during the 2015 fall semester. Each week the students were required to study learning materials posted on the learning management system Blackboard before class, complete a check-up quiz at the beginning of every class, participate in group learning activities, and finally listen to a mini-lecture by the instructor. Learning materials were condensed versions of text and video materials about general physics and chemistry that require the students on average 30 to 60 minutes to learn. The material was developed by two professors with more than 20 years of teaching experience and two teaching assistants with doctoral degrees in physics and chemistry, respectively. At the end of the semester, the students were asked to voluntarily complete a survey which had been first pilot tested with five undergraduate freshman students in order to detect and correct unclear or misleading language. After slight modifications, online and offline forms of the survey were distributed. The response rate was 87.2%.

**Data collection tools**

We used a self-report questionnaire with three sections covering the learner’s: (1) epistemological beliefs, (2) learning engagement, and (3) perceived learning outcomes from their FL course. The students answered questions on a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree. An initial section asked the students to provide demographic information on school year, gender, major, and cumulative GPA.

In order to evaluate students’ epistemological beliefs, we selectively adopted items from a questionnaire developed by Hofer and Pintrich (1997) and translated and validated by Cho (2010). From the five constructs representing epistemological beliefs (certainty of knowledge, simplicity of knowledge, source of knowing, development of knowledge, and justification of knowing), we adopted 25 items from three constructs representing the epistemological beliefs of tentative knowledge, complex knowledge, and relative knowledge. Six of the 25 items represented tentative knowledge (eg, “knowledge is not certain and unambiguous”, “the certain truth can be discovered”); 8 items represented complex knowledge (eg, “knowledge does not deal with one concrete and knowable facts”, “Comprehensive ideas are important”); and 11 items represented relative knowledge (eg, “knowledge is not given down by authority but can be tested”, “The present truth does not have the same meaning to all”). The internal consistency reliabilities for the three sub-constructs were .0729, .760, and .771 respectively, and the internal consistency reliability for the total constructive epistemological beliefs was .825.

In order to measure learners’ engagement in FL, we selected and modified items from the Engagement Scale by Fredricks and colleagues (2005) under the three sub-constructs of behavioral, cognitive, and affective engagement. Behavioral engagement in the pre-class (eg, “I study pre-class lectures and materials regularly”) and in-class (eg, “I do not miss classes”) phases of FL was measured with six items (Cronbach’s $\alpha = .728$). Cognitive engagement in the pre-class (eg, “I ask the professor questions that arise in the pre-class and try to understand before the in-class
phase starts”) and in-class (eg, “I actively ask questions during the FL class”) phases of FL was assessed with three items (Cronbach’s $\alpha = .735$). Affective engagement in the pre-class (eg, “I believe that pre-class learning is important in the overall FL learning experience”) and in-class (eg, “I enjoy in-class learning activities”) phases of FL was measured with five items (Cronbach’s $\alpha = .624$). The internal consistency of all items measuring FL engagement was .821.

We based our assessment of FL outcomes on our synthesis of research on the effects of FL. Accordingly, we measured the participants’ perceived growth in discipline knowledge and learning competencies like problem-solving and self-directed learning; generic competencies such as communication, collaboration, and interpersonal skills; and satisfaction. The internal consistency of the seven items measuring FL outcomes was .702.

Data analyses

Preliminary descriptive statistics and bivariate correlation analysis were conducted to examine participants’ engagement in FL and the perceived outcomes of FL. We then conducted analyses of variance (ANOVA) to test the effects of epistemological beliefs and GPA on both FL engagement (pre-class and in-class engagement) and FL outcomes (discipline knowledge and learning-related outcomes, generic competencies, and satisfaction). Scheffe’s method was used to test post hoc analyses as well. We also conducted hierarchical multiple regression to investigate the effects of engagement in pre-class and in-class on the different types of FL outcomes while controlling for cumulative GPA. To explore the path from influencing factors to FL outcomes, path analysis was performed. The proposed model hypothesizes that epistemological beliefs affect affective engagement, affective engagement affects behavioral and cognitive engagement, behavioral engagement affects cognitive engagement, and that the three types of engagement affect FL outcomes. When needed, effect sizes were calculated and categorized as small (.01), medium (.06), or large (.14) according to the scales set by Cohen (1988).

The model was estimated using AMOS 23.0 (Arbuckle, 2014). Path coefficients were estimated by maximum likelihood estimation. Multiple goodness-of-fit indices for model fit were evaluated. The indices included $\chi^2$, $\chi^2/df$, RMSEA (Root Mean Square Error of Approximation), the Normed Fit Index, Comparative Fit Index, and the Turker Lewis Index. Underlying assumptions of the three statistical analyses were verified with Shapiro-Wilk’s test, Levene’s test, the VIF and tolerance values, Dubin-Watson statistics, the scatter plot of the values of the residuals against the values of the outcomes predicted, and the histogram and normal probability, from which the assumptions of multi-collinearity, linearity, homoscedasticity, and independent residuals were confirmed.

Results

The results of the preliminary analysis of descriptive statistics and the relationships among the variables are presented in Table 1. While in-class engagement was reported as slightly higher than pre-class engagement, the two kinds of engagement were positively inter-correlated ($r = .616, p < .01$). Behavioral, cognitive, and affective engagement also were positively inter-related ($r = .583, .383, .270, \text{all } p < .01$), with behavioral engagement the highest and cognitive engagement the lowest. As for perceived learning outcomes, students reported the greatest achievement in content/learning-related outcomes and the lowest gains in generic competencies. The correlation between content/learning-related outcomes and satisfaction was relatively stronger ($r = .428, p < .01$) than the one between generic competencies and satisfaction ($r = .208, p < .01$). The content/learning-related outcomes and generic competencies were not significantly correlated.
Research Question 1: How do epistemological beliefs or academic capability affect FL engagement?

One-way between-subjects ANOVAs were conducted to compare the effects of learners’ epistemological beliefs on FL pre-class and in-class engagement for three groups of students with three dimensions of epistemological beliefs (constructivist belief level: high, mid, and low). There was no significant effect of learners’ epistemological beliefs on either pre-class engagement ($F(2, 228) = .258, p = .773$) or in-class engagement ($F(2, 228) = 1.112, p = .331$).

In order to investigate the effects of learners’ academic capability on FL pre-class and in-class engagement for high, mid, and low GPA groups, one-way ANOVAs were conducted. Results showed significant effects of learners’ academic capability on both pre-class engagement ($F(2, 228) = 4.361, p = .014$) and in-class engagement ($F(2, 228) = 9.022, p = .000$). Post hoc comparisons using the Scheffé test indicated that pre-class engagement of the low-GPA group ($M = 3.17, SD = .52$) and the mid-GPA group ($M = 3.20, SD = .58$) was significantly different than that of the high-GPA group ($M = 3.51, SD = .59$). The pre-class engagement of the low-GPA group did not differ significantly from that of the mid-GPA group, however. The in-class engagement of the low-GPA ($M = 3.10, SD = .47$) and mid-GPA groups ($M = 3.21, SD = .58$) was also significantly different from that of the high-GPA group ($M = 3.64, SD = .63$), but the difference in the in-class engagement of the low-GPA and mid-GPA groups was not statistically significant.

Table 1 summarizes the effects of learners’ constructivist beliefs and academic capability on pre- and in-class engagement with the effect size $\eta^2$. The effect size of academic capability on in-class engagement was of medium value ($\eta^2 = .073$), which indicates the association between academic capability and in-class engagement is enough to be impactful.

Research Question 2: How do epistemological beliefs or academic capability affect the FL outcomes of content learning, generic competencies, and satisfaction?

We conducted one-way between-subjects ANOVAs to compare the differential effects of epistemological beliefs and academic capability on three types of FL outcomes (content/learning-related outcomes, generic competencies, and satisfaction). On generic competencies, neither constructivist beliefs ($F(2, 228) = .246, p = .782$) nor academic capability ($F(2, 228) = .156, p = .060$) had significant effects. Also, neither constructivist beliefs ($F(2, 228) = .246, p = .782$) nor academic capability ($F(2, 228) = .126, p = .163$) significantly affected satisfaction. On the other hand, content/learning-related outcomes were significant affected by both constructivist beliefs and academic capability. Post hoc analysis showed that the high-beliefs group ($M = 3.86, SD = .63$) had significantly higher content/learning-related than the
mid-beliefs ($M = 3.79, SD = .56$) and low-beliefs groups ($M = .53, SD = .61$), and that the high-GPA group ($M = 4.01, SD = .55$) had significantly higher content and learning-related outcomes than the mid-GPA ($M = 3.70, SD = .61$) and low-GPA groups ($M = 3.46, SD = .62$). Table 3 summarizes the analyses comparing the effect size $\eta^2$; these suggest medium-sized effects of the two variables on content and learning-related outcomes.

Research Question 3: How do different dimensions of engagement affect the different types of FL outcomes?

Multiple regression analyses were conducted to determine the predictive power of the different types of engagement (pre-class/in-class, behavioral/cognitive/affective) on different types of outcomes (total outcomes, content/learning-related outcomes, generic competencies, and satisfaction). For all types of outcomes, a total of eight significant regression equations were found, as shown in Table 4. Both pre-class and in-class engagement were significant predictors of total engagement, with larger values for in-class engagement ($\beta = .394^{***}$) than pre-class engagement ($\beta = .208^{**}$). 36.9% of the variance in total FL outcomes was explained by behavioral ($\beta = .196^{*}$), cognitive ($\beta = .289^{***}$) and affective engagement ($\beta = .292^{***}$). For content/learning-related outcomes, both pre-class and in-class engagement were significant predictors with a larger value for in-class engagement ($\beta = .213^{***}$) than pre-class engagement ($\beta = .246^{**}$). Pre-class engagement was not significant in predicting generic competencies; only in-class engagement was significant ($\beta = .305^{***}$). Behavioral ($\beta = .176^{**}$) and affective engagement ($\beta = .331^{**}$) were significant in predicting content and learning outcomes, whereas only cognitive engagement ($\beta = .315^{***}$) was significant for generic competencies. For satisfaction, affective engagement was the only strong and significant predictor ($\beta = .460^{**}$). As per the explanatory powers ($R^2$) or effect sizes ($f^2$) of the regression models, the first two models ($R^2 = .300, f^2 = .43$) ($R^2 = .369, f^2 = .58$) and the last model ($R^2 = .318, f^2 = .47$) were the three largest.
Table 4: Effects of different dimensions of engagement on different types of FL outcomes

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Independent variable</th>
<th>df</th>
<th>F</th>
<th>p</th>
<th>$R^2$ (Adj. $R^2$)</th>
<th>$f^2$</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total FL outcomes</td>
<td>Pre-class engagement</td>
<td>2</td>
<td>48.804</td>
<td>.000</td>
<td>.300 (.294)</td>
<td>.43</td>
<td>.208**</td>
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<tr>
<td></td>
<td>In-class engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.394***</td>
</tr>
<tr>
<td></td>
<td>Behavioral engagement</td>
<td>2</td>
<td>44.295</td>
<td>.000</td>
<td>.369 (.361)</td>
<td>.58</td>
<td>.196**</td>
</tr>
<tr>
<td></td>
<td>Cognitive engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.289***</td>
</tr>
<tr>
<td></td>
<td>Affective engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.292***</td>
</tr>
<tr>
<td>Learning-related outcomes</td>
<td>Pre-class engagement</td>
<td>2</td>
<td>23.439</td>
<td>.000</td>
<td>.171 (.163)</td>
<td>.21</td>
<td>.213**</td>
</tr>
<tr>
<td></td>
<td>In-class engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.246**</td>
</tr>
<tr>
<td></td>
<td>Behavioral engagement</td>
<td>2</td>
<td>20.674</td>
<td>.000</td>
<td>.215 (.204)</td>
<td>.27</td>
<td>.305***</td>
</tr>
<tr>
<td></td>
<td>Cognitive engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.103</td>
</tr>
<tr>
<td></td>
<td>Affective engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.176**</td>
</tr>
<tr>
<td>Generic competencies</td>
<td>Pre-class engagement</td>
<td>2</td>
<td>18.512</td>
<td>.000</td>
<td>.140 (.132)</td>
<td>.16</td>
<td>.064</td>
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<tr>
<td></td>
<td>In-class engagement</td>
<td></td>
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<td>.331***</td>
</tr>
<tr>
<td></td>
<td>Behavioral engagement</td>
<td>2</td>
<td>13.608</td>
<td>.000</td>
<td>.152 (.141)</td>
<td>.18</td>
<td>.019</td>
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<td></td>
<td>Cognitive engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.315***</td>
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<tr>
<td></td>
<td>Affective engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.123</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>Pre-class engagement</td>
<td>2</td>
<td>18.248</td>
<td>.000</td>
<td>.138 (.130)</td>
<td>.16</td>
<td>.213**</td>
</tr>
<tr>
<td></td>
<td>In-class engagement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.201*</td>
</tr>
<tr>
<td></td>
<td>Behavioral engagement</td>
<td>2</td>
<td>35.254</td>
<td>.000</td>
<td>.318 (.309)</td>
<td>.47</td>
<td>.097</td>
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<tr>
<td></td>
<td>Cognitive engagement</td>
<td></td>
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<td></td>
<td>Affective engagement</td>
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<td>.460***</td>
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</tbody>
</table>

$p < .05; **p < .01; ***p < .001.$
Research Question 4: What is the path relationship from engagement and learner factors to FL outcomes?

A path model tested the hypotheses that behavioral, cognitive, and affective engagement directly and indirectly affected FL outcomes, and that if constructivist beliefs predicted affective engagement. As seen from the path model in Figure 2 and Table 5, students’ behavioral, cognitive, and affective engagement significantly and positively related to FL outcomes; however, there is no significant relationship between constructivist beliefs and affective engagement. Affective engagement affected both behavioral and cognitive engagement. The strengths of the variables affecting FL outcomes were relatively large for affective ($\beta = .29$) and cognitive engagement ($\beta = .29$). The path from behavioral to cognitive engagement was especially significant and strong ($\beta = .52$). In other words, affective engagement supports the behavioral engagement and cognitive engagement of students, but the strongest indicator of success with learning outcomes is behavioral engagement, although affective and cognitive engagement have large impacts as well. This provides some indication that while engagement at different levels is needed by the student, the largest factor of successful learning outcomes is more behavioral aspects that indicate “buy-in” to the flipped model.

The fit of the path model was assessed using the indices $\chi^2$, $\chi^2/df$, RMSEA, NFI, CFI, and TLI, as shown in Table 6. All the indices were above the recommended criteria for good fit (Hu & Bentler, 1999; Kline, 2011).

Discussion and conclusion

This study was conducted to investigate the relationships between learners’ academic capability, epistemological beliefs, different dimensions of engagement (pre-class/in-class, behavioral/cognitive/affective engagement), and different types of FL outcomes (content/learning-related outcomes, generic competencies, and satisfaction). Overall, the results found academic capability greatly benefits learner engagement, which influences learning outcomes when implementing a flipped learning model. While the students’ epistemological beliefs failed to influence pre-class engagement and in-class engagement, academic capability did affect both pre-class and in-class engagement. Furthermore, academic capability and epistemological beliefs did benefit content/learning-related outcomes, but neither factor significantly altered generic competencies or satisfaction. Regarding the relationship between engagement and FL outcomes, both pre-class and in-class engagement were influential for most types of FL outcomes except generic competencies,
which only was affected by in-class engagement. The path analysis showed that learners’ affective engagement was not affected by epistemological beliefs, but that it directly and indirectly influenced FL outcomes via behavioral and cognitive engagement. Behavioral engagement affected FL outcomes directly and indirectly via cognitive engagement, and cognitive engagement directly led to FL outcomes. Theoretical and practical implications are discussed below.

As per the first research question, the results supported the premise that academic capability promotes both of FL pre-class and in-class engagement. The effect size of academic capability was larger for in-class than pre-class engagement. Learners with high- and mid-GPAs were more engaged in both in-class and pre-class learning than those with low GPAs, with the effect somewhat stronger for in-class learning. These results may imply that students’ academic capability plays an important role in their motivation and effort for learning which can be associated with their perceptions regarding difficulty of the subject matter in FL contexts (Bouwmeester, de Kleijn, ten Cate, van Rijen, & Westerveld, 2016; Hao, 2016). Therefore, the autonomous nature of pre-learning in the flipped learning model may benefit students with higher levels of schema in the subject matter, while students with lower levels of prior knowledge struggle to actively comprehend and be engaged in the learning process. Thus, instructional designers and teachers need to consider the student population of the class when deciding to use the flipped learning model. If the class is commonly populated with students with lower prior knowledge of the subject matter, then FL may hinder the engagement for such students. A quality needs analysis should be conducted to ensure the instructional method is appropriate for the target population.

Learners’ epistemological beliefs, however, did not have a significant effect on FL pre-class or in-class engagement. That is, learners’ epistemological beliefs, the perspectives of source, certainty, and complexity of knowledge, did not significantly relate to engagement throughout the FL process, a result consistent with the argument by some researchers that although learner’s epistemic beliefs can be a key factor influencing their conception of learning (Chan & Elliott, 2004;
Chiu, Liang, & Tsai, 2013), their epistemic beliefs do not practically influence their use of learning strategies and ultimate achievement (Cano, 2005; Lee, Lim, & Kim, 2017). In practice, the factor that affected engagement in online and offline learning environments was learning strategies—especially when undergirded by epistemic beliefs—that externalize the superficial-level factor of epistemology into concrete learning strategies (Akyol & Garrison, 2011; Devi et al., 2016; Leug & Kember, 2003; Phan, 2008).

Regarding the second research question on the relationship between epistemological beliefs/academic capability and the FL outcomes of content learning, generic competencies, and satisfaction, both learners’ epistemological beliefs and academic capability were closely associated with content/learning-related outcomes. However, neither epistemological beliefs nor academic capability influenced generic competencies and satisfaction. In other words, learners with more constructivist beliefs and higher GPAs did not really improve generic competencies such as interpersonal relationship, collaboration, and communication skills nor were more satisfied with the FL course. Given that the outcome data were based on self-report, this result must be interpreted as representing learners’ perceptions of their FL outcomes. Whereas they can be aware of their content- or learning-related outcomes as a result of FL, they may not recognize their growth in interpersonal relationship, collaboration, and communication skills following the FL course because FL instructors usually do not inform them of the potential for changes to such generic competencies as a result of FL (Lee & Choi, 2018). In that sense, the validity of the results of the self-reported soft data on learners’ growth of generic competencies may have been compromised to some extent. As with the effect of academic capability and epistemic beliefs on FL satisfaction, a variety of factors such as workload, teamwork, and assessment (Thurmond, Wambach, & Connors, 2002) that fell out of the scope of this study may have had some influence on the results.

With respect to our third research question, total FL outcomes were affected significantly by pre-class and, to an even greater extent, by in-class engagement. Considering the original intent of FL, this finding is desirable in the context of this study, though it may not be easily achieved in the context of an Asian learning culture (Lee & Choi, 2017). On the other hand, the FL courses in this study had been subject to the iterative process of evaluation and improvement for six semesters, so at the time of implementation, the course had stabilized in quality and standards. Other researchers have suggested that stabilization can occur within four semesters, or two years, after the implementation process (Burden, Carlton, Siktberg, & Pavlechko, 2015; Pence, 2016). Among the three types of FL outcomes, whereas content- or learning-related outcomes and satisfaction were affected both by pre-class and in-class engagement with a very similar effect size, the generic competencies were only affected by in-class engagement. Considering the features of the FL design, this result seems highly plausible. Thus, FL in-class activities may help improve generic competencies in the student.

The relationship between the three dimensions of engagement and types of FL outcomes is worthy of special attention. For the total FL outcomes, behavioral, cognitive, and affective engagement alike were significant predictors, with the strongest impact for affective engagement ($\beta = .292$), followed by cognitive ($\beta = .289$) and behavioral engagement ($\beta = .196$). For the content/learning-related outcomes, behavioral engagement ($\beta = .305$) had the strongest influence followed by affective engagement ($\beta = .176$), but cognitive engagement was not a significant predictor. Thus, content/learning-related outcomes can be achieved by attending regular classes with a proper level of effort and positive attitudes toward FL, and that it may not require higher levels of involvement in thoughtful efforts and active cognitive investigations by learners. This finding may be due to the introductory nature of the general biology and general chemistry courses. For more generalizable interpretations, further research must be conducted.
Another interesting result was that cognitive engagement was the only significant predictor for generic competencies. This finding can be interpreted to mean that cognitive engagement in the context of this study was achieved through peer interaction rather than in-class instructor interaction. Considering that only in-class engagement was influential in the growth of generic competencies, the inference that only in-class interaction can promote cognitive engagement seems to be convincing. Affective engagement was the only strong determinant for satisfaction. In order for learners to be satisfied with FL, they need to understand the rationale for the FL design and the value of each component of the process. How much they engaged behaviorally and cognitively actually had little connection to their course satisfaction in the context of this study.

As per the path from epistemic beliefs to engagement to FL outcomes with respect to the fourth research question, constructive epistemic beliefs did not lead to affective engagement, and affective engagement exerted both a direct effect on FL outcomes and indirect effect via behavioral and cognitive engagement. The valid paths were: (1) behavioral, cognitive, and affective engagement → FL outcomes, (2) affective engagement → behavioral engagement → FL outcomes, (3) affective engagement → cognitive engagement → FL outcomes, and (4) affective engagement → behavioral engagement → cognitive engagement → FL outcomes. In sum, learners’ affective engagement was a prerequisite condition for behavioral and cognitive engagement, and cognitive engagement required regular efforts to engage in the learning process, that is, behavioral engagement. In other words, if learners were affectively motivated, their behavioral engagement increased, which then brought about cognitive engagement, which ultimately led to positive FL outcomes. Although little research has centered on the affective factors in FL contexts, there is empirical evidence for the importance of affectively engaging learners (Ben-Eliyahu & Linnenbrink-Garcia, 2013; Linnenbrink-Garcia & Pekrun, 2011). Further investigation of the affective impacts of FL engagement would meaningfully expand the body of the FL literature.

The study has some limitations that can inform future research areas. First, the participants of this study attended an institution specializing in sciences and technology that has been actively pursuing the integration of the FL model into the general education practices for more than five years previous to this study. The results of this study cannot be generalized to all higher education institutions, suggesting the need for more empirical studies in different disciplines and various institutional contexts. Second, this study measured learner engagement and FL outcomes based on self-reported responses. Although self-reported measurement is widely accepted as consistent with actual levels of features in social science research, hard data that directly measure learner engagement and FL outcomes would capture more valid realities. Furthermore, it is necessary to study fundamental relationships between FL outcomes and instructional and administrative environments or characteristics as well as the internal and external factors of a learner. Finally, a more refined approach to affective engagement in FL would benefit the body of FL research. It is hoped that this more refined approach to FL engagement and outcomes will add even more helpful theoretical and practical contributions.

In conclusion, this study generated several practical suggestions related to the finding that engagement was crucial for achieving FL outcomes, and affective engagement—learners’ positive attitudes or valuing toward FL—was most influential. For content and learning-related outcomes, behavioral engagement, such as learners’ persistent effort, mattered most. Generic competencies such as communication skills, for example, seemed to be fostered largely through active involvement in in-class activities. Students with high affective engagement were more satisfied with the FL course. Thus, in practice, FL courses can bring about different types of FL outcomes by putting different weight on the different dimensions of engagement. Since each learning mode of FL may require learner engagement in different ways, educators and instructional designers should...
understand the intertwined mechanisms among cognitive, behavioral, and affective engagement for online pre-class and offline in-class activities. Particularly, learners’ affective engagement needs to be secured through a comprehensive orientation session on the FL model that explains the rationales for each of its components and includes a set of strategies learners can use to engage in regular and persistent learning. Although little research has centered on the affective domains in the FL contexts, there is empirical or scientific evidence to propose their importance for engaging positive school-related and self-regulated behaviors (Ben-Eliyahu & Linnenbrink-Garcia, 2013; Linnenbrink-Garcia & Pekrun, 2002; Pekrun, 2011). Hence, educators and instructional designers who plan to redesign a traditional course to FL need to perform a learner analysis to understand if the instructional method is suitable for the students who enroll in the course. Likewise, educators need to recognize behavioral engagement has an important catalyst for the acceptance of the instructional model and is the strongest indicator of success in terms of learning outcome. Therefore, educators and instructional designers should carefully design learning activities that cognitively engage learners with more in-depth tasks that guide learners to achieve the desired FL outcomes. Finally, learners’ academic capability was a significant factor for engagement and outcomes, suggesting the need to consider this factor when designing an FL course, particularly in regard to the in-class group learning activities.

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Statements on open data, ethics, and conflict of interest
a Data from this research can be collected from contacting the corresponding author. The authors do not have access to a university repository.
b There was no IRB process for this study since the university didn’t have an IRB committee at that time. Although there was no IRB process, the students were informed that the data of their activities and responses to surveys would be collected and analyzed for the research. Before the study, the participants were guaranteed they could discontinue their participation at any time during the study with no ramifications to their grades or relationship with their professor. In addition, they signed an informed consent before the course began. The data did not ask for any self-identifying information to assure anonymity of the student. All data were kept on a password-protected device that is only accessible to the lead author.
c There is no potential conflict of interest related to this study.

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