A Validation Study of the Learning Errors and Formative Feedback (LEAFF) Model: Socio-emotional and Motivational Predictors of Handling Academic Errors

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Abstract

In response to a lack of theoretical frameworks on how to integrate student mistakes or errors systematically into teaching and assessment, the Learning Errors and Formative Feedback (LEAFF) model is proposed. Conducted with undergraduate students at a large research-intensive university, the present study empirically investigated, using structural equation modeling (SEM), a series of core variables in the LEAFF model: students’ trust in teachers, achievement goals, attitudes towards mistakes, transparency of their mistakes, and perception of feedback. The results yielded general confirmation of the hypothesized relationships among key variables in the LEAFF model. Most importantly, students’ trust of teacher had an indirect effect on student behaviors of handling errors and their assessment outcomes through other variables. However, the study also found that mastery goal orientation was unrelated to affective feelings and cognitive beliefs towards errors after controlling for the effect of performance goal orientation.
A Validation Study of the Learning Errors and Formative Feedback (LEAFF) Model: Socio-emotional and Motivational Predictors of Handling Academic Errors

In many academic environments, including formative learning contexts, students are often chastised for making mistakes. It is therefore not surprising that many students implicitly adopt the mindset that mistakes are to be avoided at all costs – even in formative learning situations. However, negative attitudes towards mistakes could seriously impede students’ willingness to explore new problem solving strategies, and to accept feedback in order to address errors and opportunities for learning. Surprisingly, the educational psychology literature is lacking in theoretical frameworks that focus on how to integrate student mistakes or errors systematically into teaching and assessment. In response to this research gap, Leighton, Chu and Seitz (2013) proposed the Learning Errors and Formative Feedback (LEAFF) model, which outlines the relationships among several categories of variables, designed to facilitate students’ understanding of the value of their mistakes for learning purposes.

The LEAFF model (see Figure 1) is designed to promote safe and trusting classroom environments so that students display their learning errors\(^1\) and reveal their most genuine learning performances on assessments for evaluation and feedback. Teachers can then provide better formative feedback and maximize students’ receptivity and uptake of that feedback. However, the socio-emotional and motivational variables and their relationships in the LEAFF model has not been examined in empirical studies. Thus, in the present study, we attempted to investigate relationships among the key variables in the LEAFF model, that is, students’ trust in teachers, achievement goals, attitudes towards mistakes, transparency of their mistakes, and perception of feedback, within the

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\(^1\) Learning errors are defined as aberrations in the acquisition of complex knowledge or skills by means of experience, practice, study, or via an instructor (Leighton et al., 2013).
LEAFF model using Structural Equation Modeling (SEM).

In the next section, the LEAFF model is briefly described (for a full description, see Leighton et al., 2013). Then, the participants and the measures for measuring the key variables in the LEAFF model are introduced, followed by the results of the SEM analysis. Subsequently, we discuss the findings of this study and provide possible explanations for some inconsistencies between the hypothesized relationships in the LEAFF model and empirical results. Finally, the limitations of the present study are summarized and future research directions are pointed out.

The Learning Errors and Formative Feedback (LEAFF) Model

The LEAFF model (see Figure 1) is designed to integrate student learning and assessment within an inclusive context of student socio-emotional perceptions and experiences (see also Chu, Babenko, Cui, & Leighton, 2014). As shown in Figure 1, the LEAFF model involves three parts. The first part of the model involves the learning environment – that is, the instructional climate or culture created within the classroom. To create positive learning environments, it is hypothesized that teachers need to build student-teacher trust. Examples of observable behaviors include discussing with students the instrumental value of learning errors, encouraging them to be innovative in their thinking, adapting instruction to individual learners and providing feedback based on formative assessment outcomes. By having teachers implement these behaviors, it is expected that students will feel more at ease or safer within the instructional climate than if these behaviors were not implemented.

Related to the first part of the model, the second part focuses on learner perceptions – that is, the views students develop about learning based on what they see in the learning environment. It is hypothesized that learner perceptions may take the form of mental models (Johnson-Laird, 1983). Mental models are simplified representations for filtering and understanding the world in the service
of guiding behavior, making plans and generating explanations of performances. Although mental models are not dissimilar from schemas in guiding behavior, mental models are more dynamic and flexible than schemas, shifting in response to incoming social and emotional information (Johnson-Laird, 1983). These mental models provide the evidentiary basis for the personal algorithms individuals employ to navigate through the external world, including the classroom-learning environment. The second part is the core of the LEAFF model and thus the focus of this empirical study. The following subsections discuss several key variables in learners’ mental models.

**Students’ Trust in Teachers**

Trust is a socio-emotional construct (Leighton et al., 2013; Pekrun, Goetz, Titz, & Perry, 2002) and yet it was once primarily defined in behavioural (see Deutsch, 1958; Zand, 1971), communicative (see Rotter, 1967), and cognitive terms (see Frost, Stimpson, & Maughan, 1978). Since 1990s, trust has been gradually analyzed and understood as consisting of social and emotional components. For example, Mishra (1996, p. 265) defines trust as “one party’s willingness to be vulnerable to another party based on the belief that the latter party is (a) competent, (b) reliable, (c) open, and (d) concerned.”

Trust is significantly influenced by the social context in which it is embedded. In academic contexts, students’ trust in teachers can be regarded as students’ willingness to be vulnerable (i.e., be open and willing to display their learning errors) to teachers based on the beliefs that teachers can be supportive of their learning. According to the LEAFF model, it is hypothesized that students who are willing to display their learning errors in assessment will benefit from formative feedback and deeper learning.

**Achievement Goals**
Another hypothesis derived from the LEAFF model is that students' evaluation of their learning environment will influence their achievement goals. Achievement goal theory, which has developed within a social-cognitive framework, focuses on how students think about themselves, their tasks, and their performance (Ames, 1987). In particular, two achievement goals are described in goal theories: the goal to develop ability (i.e., the mastery goal), and the goal to demonstrate ability or to avoid the demonstration of lack of ability (i.e., the performance goal) (Midgley et al., 1998). A mastery goal is an approach motivational orientation while a performance goal includes both approach and avoidance orientations (Dweck & Leggett, 1988, Nicholls, 1989, Elliot & Harackiewicz, 1996). Mastery-oriented students work hard to increase their knowledge and skill whereas performance-oriented students strive to gain favorable judgments and avoid unfavorable judgments of their competence (Midgley et al., 1998).

In the LEAFF model, it is hypothesized that students who evaluate their learning environment as safe and trust their teachers, are more likely to develop mastery goals. In contrast, students who evaluate their environment as unsafe and distrust their teachers are more likely to develop performance goals. Further, it is expected that students who develop mastery goals will exhibit more positive attitudes towards mistakes than students who develop performance goals.

**Attitudes towards Mistakes**

Goal orientation may influence students’ attitudes towards mistake. Attitude has been defined in various ways, starting with the conventional definition “an attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor” (Eagly & Chaiken, 1993, p. 1) to the operational definition as “a relatively enduring organization of beliefs, feelings, and behavioral tendencies towards socially significant objects, groups, events or symbols” (Hogg &
 Vaughan 2005, p. 150). Although there is no universally accepted definition of attitude with over 30 proposed definitions (Rao, 2004), researchers agree that attitude is not unidimensional and the tripartite model endures with decades of research (Rosenberg & Hovland, 1960; Breckler, 1984). In the tripartite model, attitude is defined as a construct comprising affective, behavioral and cognitive components. Therefore, in discussions about how to measure attitudes, the common practice is to identify three attitudinal components: affect, behavior and cognition (Rosenberg & Hovland, 1960; Breckler, 1984). Specifically, affect is often used to denote a broad variety of positive and negative emotions (Pekrun & Linnenbrink-Garcia, 2014). In relation to attitudes towards mistakes, affect refers to feelings towards learning errors, behavior refers to the actions a student might take when or after a mistake is made during learning, and cognition refers to the evaluation of making mistakes, for example, beliefs in the value of making mistakes on an assessment.

**Transparency**

Transparency has been scarcely studied in education. In organization and management studies it is defined as “the perceived quality of intentionally shared information from a sender” (Schnackenberg & Tomlinson, 2014, p. 5), referring to openness in communication. In the LEAFF model, it refers to openness to one’s learning errors in academic settings. Students who have negative attitudes towards mistakes may ignore or hide their errors on exams or assignments, respectively, and avoid opportunities for seeking feedback and addressing mistakes. Students may also avoid class discussions or other public-type of assessment opportunities that could expose their lack of understanding and learning errors. Thus, seeking methods to explicitly increase transparency may be valuable in helping teachers create the conditions for providing relevant formative feedback to students.
Perception of Feedback

Students are described as “active makers and mediators of meaning within a particular learning context” (Higgins, Hartley, & Skelton, 2002, p. 53) and their responses to grades, including feedback, will vary. Attention to students’ perceptions of feedback continues to be lacking in higher education (Dowden, Pittaway, Yost, & McCarthy, 2013). In fact, studies on how learners view feedback and how their views influence learning outcomes are rare (see Strijbos, Narciss, & Dünnebier, 2010). In the LEAFF model, students’ perception of feedback is classified as taking the form of formative or feckless. Feedback can promote real learning if perceived as formative but yield shallow learning if perceived as feckless.

The third part of the LEAFF model focuses on learning outcomes – that is, formative and summative assessment performances. Measured learning outcomes are hypothesized to be stronger when learners develop mental models (perceptions) of a learning environment that involves observations considered to be positive. Learners with mental models that reflect positive observations are expected to be more engaged in the learning process, feel more content at school, and be more open to learning errors than those students with negative perceptions (see Leighton & Bustos Gomez, 2014; Chu & Leighton, 2014). According to the LEAFF model, when the learning environment is designed to promote trust between teachers and students, learners’ mental models will contain fewer defensive algorithms – such as the avoidance or neglect of difficult assignments or the lack of participation in class activities for fear of looking bad. Over time, it is hypothesized that such defensive algorithms erode formative and summative learning outcomes because they disable opportunities for engagement, intellectual innovation and receptivity to feedback. According to the LEAFF model, trust is an especially important variable because it grounds student learning in a
pedagogical alliance with the teacher. Without this pedagogical alliance, perceptions of the learning environment are bound to be negative.

**General Hypotheses in the Present Study**

The LEAFF model outlines key relationships among socio-emotional constructs. Specifically, when students evaluate the learning environment as safe, they are more likely to develop mastery goals and positive attitudes towards mistakes. Mastery goal orientations and positive attitudes towards mistakes are expected to yield more transparent student performance, meaning that students are likely to show and recognize what they do not know in class discussion, assignments or even tests. This transparency should open opportunities of receiving formative feedback that is viewed as relevant and thus used to improve learning. On the contrary, when students evaluate the learning environment as unsafe, they are more likely to develop performance goals and negative attitudes towards mistakes, which lead to more opaque performance in assessment. The opaqueness shut down the opportunities of receiving valuable feedback that can be used to improve learning.

**Methods**

**Participants and Procedures**

Two hundreds and seven undergraduate students at a large research-intensive university participated in this study. There were 40 (19.2%) male students and 162 (80.2%) female students. The average age was 23.1 years. All students were enrolled in a four-year bachelor’s program. Participants were invited to complete an online survey delivered using SurveyMonkey.® They consented by actively choosing to begin and complete the survey, which included a series of subscales selected to measure key LEAFF model variables, and background questions (i.e., gender, age, and GPA of the current year) presented at the end of the survey. The subscales used in this study are described next.
Measures

**Trust in Teachers.** The Student Trust in Faculty (STF) scale (see Table 1) (Forsyth, Adams, & Hoy, 2011) was selected because it measured aspects of students’ trust in teachers and the scale was developed from a research literature that informed aspects of the LEAFF model. Wording in some of the items was revised slightly to adapt the scale to the university sample. Participants in the present study responded to the items using a four-point Likert scale ranging from 1 – Strongly disagree, 2 – Disagree, 3 – Agree and 4 – Strongly agree. According to Forsyth et al. (2011), the STF has high reliability (Cronbach’s alpha = 0.90), and its validity was indicated by its significant correlation with students’ academic efficacy, student identification with school, and language arts achievement.

**Mastery Goal Orientation.** The Mastery Goal Orientation subscale (see Table 2), which is one of the Patterns of Adaptive Learning Scales (PALS) (Midgley et al., 2000), was selected as it is reflective of aspects of mastery goal orientation. The PALS has been widely used to measure relationships between students’ motivation, affect, behavior, and their views on the learning environment. Participants responded to these items using a five-point Likert scale ranging from 1 – Not at all true, 3 – Somewhat true, to 5 – Very true. According to Midgley et al. (2000), the Mastery Goal Orientation subscale has high reliability (alpha=0.86), and good construct validity.

**Performance Goal Orientation.** The Performance Goal Orientation subscale was selected (see Table 3) as it is reflective of aspects of performance orientations; for example, items 1-5 measure a performance-approach goal orientation while items 6-9 measure a performance-avoid goal orientation. This subscale is also part of the PALS. Participants responded to these items using a five-point Likert scale ranging from 1 – Not at all true, 3 – Somewhat true, to 5 – Very true. According to Midgley et al. (2000), the Performance-Approach Goal Orientation items and Performance-Avoid Goal Orientation
items have respectively high and moderate reliability (alpha=0.86 and 0.75), and good construct validity.

**Attitudes Towards Mistakes.** The *Attitudes Towards Mistakes Inventory* (ATMI, see Table 4) (Leighton, Tang, & Guo, 2015) was used in the present study. The ATMI encompasses three subscales, which are designed to measure the affective, behavioral, and cognitive components associated with attitudes towards mistakes. Participants were instructed to respond to each item by thinking about their academic experiences in three types of academic settings (i.e., classes, assignments and exams). Responses were made on a five-point Likert-type scale, ranging from 1 – Strongly disagree, 3 – Somewhat agree, to 5 – Strongly agree. According to Leighton et al. (2015), the affect, behavioral and cognitive subscales of ATMI have adequate reliability with alphas of .815, .724, and .760 respectively, and an emerging empirical base for its validity as indicated by significant correlations with academic self-efficacy, self-esteem, and self-reflection subscales.

**Transparency.** A subscale of 5 items was developed for measuring students’ views on transparency about their mistakes (see Table 5). A subscale was developed given that a review surfaced no available instrumentation for measuring this construct. The subscale was designed to measure *mistake-exposing and mistake-hiding behaviours* such as discussing one’s own mistakes with others taking steps to conceal them. Participants responded to these items using a five-point Likert scale ranging from 1 – Strongly disagree, 3 – Somewhat agree, to 5 – Strongly agree.

**Perception of Feedback.** The *Perception of Feedback Scale* (Ali, Rose, & Ahmed, 2015) was used to measure students’ perception of feedback (see Table 6). Participants responded to these items using a five-point Likert scale ranging from 1 – Strongly disagree, 3 – Somewhat agree, to 5 – Strongly agree. The Perception of Feedback Scale had an alpha of 0.76, and its construct validity was
examined using principal component analysis. Since the items of the Perception of Feedback Scale involve various detailed aspects of feedback, an item to measure students’ overall perception of feedback was also included.

**Results**

Before conducting the SEM analysis, we first computed alpha coefficients for all the scale measures, and the results are presented in Table 7. All the measures had moderate to high reliability with the exception of Perception of Feedback, which had a coefficient alpha of .453. Thus, these items were not used as indicators in the SEM analysis. Instead, the single item developed by the authors for measuring students’ general or overall perception of feedback was used.

Before conducting the SEM analysis, factor indicators were constructed by parceling the original scale items. Parceling has more advantages such as improving model data fit and reducing bias in structural parameter estimation than directly using original items as indicators (Bandalos, 2002; Little, Cunningham, Shahar, & Widaman, 2002). The detailed information about each parcelled indicator is presented in Appendix. In order to test the measurement validity of the parcelled items, a CFA was conducted. The CFA model fitted the data well: Chi Square=254.721, degree of freedom=221, p=.0593, RMSEA=.027, CFI=.986, SRMR=.047. As shown in Table 8, the loadings of indicators were all above .6 except the third indicator of transparency (.472). Overall, the results supported the measurement validity of the parcelled indicators.

Finally, the SEM analysis was conducted to examine the relationships among the relevant variables depicted in the LEAFF model. Based on the hypotheses underlying the LEAFF model, several structural models were tested and the best fitting structural diagram was selected and is

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2 In order to check the appropriateness of the parcelled indicators, we also conducted a corresponding path analysis using the original scale scores. Since the path analysis results were consistent with the SEM results, we had evidence to support the validity of our parceling.
presented in Figure 2. Each circle in Figure 2 represents a latent variable. Two latent variables, GPA and Perception of Feedback had one indicator each. Their indicators were not used directly as observed variables because it was considered unrealistic to assume these indicators were free of measurement errors. Thus, as recommended by Hayduk and Littvay (2002), we assigned 20% of their variances as error variance.

The SEM model shown in Figure 2 fit the data well - Chi-Square=258.531, $d_f=211, p=.012$; RMSEA=.031, CFI=.978, and SRMR=.057. All the links in the model were statistically significant. Consistent with the hypotheses derived from the LEAFF model, trust was positively linked to mastery goal orientation ($b=.571, p<.001$), and negatively linked to performance approach goal orientation ($b=-.255, p<.01$), and performance avoidance goal orientation ($b=-.223, p<.01$). Performance avoidance goal orientation was also positively and significantly linked to the affective ($b=.903, p<.001$) and cognitive components ($b=.456, p<.001$) of attitudes towards mistakes, even after controlling for the effect of mastery goal and performance approach goal orientation. Performance approach goal orientation was negatively related to the affective component of attitudes towards mistakes ($b=-.324, p<.01$) after controlling mastery goal orientation and performance avoidance goal orientations. Mastery goal orientation was unrelated to the affective and cognitive aspects of attitudes towards mistakes after controlling for the effect of other goal orientations.

Next, the results indicate that the affective aspect of attitudes towards mistakes was significantly and negatively associated to students’ transparency about their mistakes ($b=-.588, p<.001$), and transparency in turn was positively associated with the behavioral aspect of attitudes towards mistakes.

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3 In the SEM model, some indicators had minor residual correlations, indicating that some of the measurement models were not truly unidimensional. However, the focus of the SEM was on the structural relations among the constructs, not the purity of unidimensionality of every construct. Therefore, the correlated errors will not be further discussed.
(.216, p<.05), which was positively associated with GPA (.243, p<.01). The total indirect effect of trust on GPA was also tested using the biased corrected bootstrap confidence interval. The result showed that trust had a significant indirect effect on GPA (95% bias corrected bootstrap confidence interval\(^4\) = .018 to .137). Mastery and performance avoidance goal orientation also had significant indirect effect on GPA (.030 to .227; -.068 to .000 respectively).

Students’ transparency about their mistakes was found to be positively related to perception of feedback (.279, p<.01), and perception of feedback was positively related to trust (b=.515, p<.01). The indirect effect from transparency to trust was also significant: 95% bias corrected bootstrap confidence interval = .039 to .251. The percentages of variance explained (i.e., \(R^2\) squares) for each latent variable are reported in Table 9. The model explained 35% of the variance of positive behaviors associated with students’ handling of mistakes, and 6% of the variance of GPA.

**Discussion**

Overall, the SEM results were consistent with the hypotheses derived from the LEAFF model.

Student trust was positively related to mastery goal orientation, and negatively related to performance goal orientations (both approach and avoidance goals). These findings indicate students who trust their teachers tend to have higher mastery goal orientation whereas those who do not have higher performance goal orientations. Research on achievement goals (e.g., Poortvliet, Janssen, Van Yperen, & Van de Vliert, 2007) also suggest that relative to mastery goals, performance goals is less beneficial for open communication that is crucial for developing students trust in teachers.

After controlling the effects of other variables, the higher the performance avoidance goal orientation, the more negative emotions (e.g., anxiety, worries) students felt about their mistakes, and

\(^4\) If the 95% confidence interval does not cover 0, then it indicates the indirect effect is significant.
the more likely they appeared to adopt biased belief about mistakes such as *successful students make fewer mistakes during learning than struggling students*; the higher the performance approach goal orientation, the more positive emotions (e.g., confidence, safety) students felt about their mistakes. It was also found that after controlling for the effect of performance goal orientations, mastery goal orientation was no longer related to the affective and cognitive components associated with attitudes about mistakes. These findings are inconsistent with and beyond the hypotheses derived from the LEAFF model, as the model suggests that mastery goals are associated with display of learning errors and performance goals are associated with avoidance of learning errors. The results in the present study provide more detailed explanations on what and how achievement goals cause the display or avoidance of learning errors. Specifically, performance-avoidance oriented students often have worries that they have to work hard to prevent others from thinking they are not smart, which make themselves more subject to negative emotions associated with learning and assessment and less likely to display their learning errors. On the other hand, performance-approach oriented students strive to excel and they tend to work hard and have better test performance (Elliot, McGregor, & Gable, 1999), which can increase self-perceptions and augment self-esteem (Urdan, 2004). Thus, they are more likely to display their errors because they still feel confident and safe when making mistakes in academic contexts.

Further, the results showed that students who exhibited positive affect associated with attitudes towards mistakes tended to be transparent in their learning errors, and this transparency led to positive behaviors dealing with errors and positive perception of feedback. This finding suggests that transparency on learning errors may play a mediating role between affective and behavioral components of attitudes towards mistakes. The mediating effect of transparency between affective and
behavioral components suggests mediators can be considered when modeling the relationship between affect and behavior when affect is used to predict students’ behavior in academic settings.

Finally, the results showed that positive perception of feedback increased students’ trust in teachers. The reciprocity of the relationships among these variables confirms the expectations outlined in the LEAFF model, indicating trust has an indirect effect, via goal orientations, affective and cognitive aspects of attitudes towards mistakes, on students’ transparency in their performance. In turn, students’ transparency has an indirect effect, via perception of feedback, on students’ trust. In other words, we observe a cycle in which the variation of a certain variable spreads through a loop and impacts the original variable, thus reinforcing the initial variation (Sterman, 2000).

In short, our results indicate that the students’ trust in teachers, achievement goal orientation and affective factor of attitudes towards mistakes are strong predictors of students’ academic behaviors of handling mistakes and their assessment outcomes in the corresponding structural model for the LEAFF model. These findings accent the important impact of socio-emotional and motivational variables in students’ learning and academic behaviors.

**Conclusion**

As noted by Durlak, Weissberg, Dymnicki, Taylor, and Schellinger (2011, p. 419), “there is no standardized approach in measuring social and emotional skills, there is a need for theory-driven research that not only aids in the accurate assessment of various skills but also identifies how different skills are related…” In light of this statement by Durlak et al. (2011), our aim was to investigate a theoretical model – the LEAFF model – that incorporated socio-emotional variables, assessment and achievement. The results of this study provided empirical support for the LEAFF model, and at the same time yielded some interesting but unexpected findings that should lead to future empirical work.
In particular, future studies can focus on the relationships between the affective aspects of attitudes towards mistakes and achievement goals to further validate the findings in the present study. With more empirical work, the LEAFF model can be further enriched to better present the role of socio-emotional variables in assessment and achievement.

Despite the strength of this theory-driven research, there is some room for improvement. First, the scale for assessing transparency on mistakes needs to be further refined to increase its reliability. This scale was developed by the authors because there was no available instrument for measuring this theoretical construct. However, the reliability of the scale was moderate, and thus requires further refinement. Second, the scale for assessing students’ Perception of Feedback also needs further study. Although our literature review led us to this instrument for measuring perception of feedback given its strict criteria (i.e., high relevance and representative in content; moderate to high reliability), the Perception of Feedback scale ultimately had to be discarded given its low reliability in the present study. Third, the results of this study may not generalize to other cultural and age groups given that the sample was drawn from a particular western university. There is currently too little research on cultural variations in the effects of socio-emotional variables to determine whether the results of the present study are representative. Future research that includes more characteristic subgroups is needed.

Although large-scale, empirical studies have investigated the effects of student motivation and attitudes on academic achievement (e.g., Pekrun & Perry 2014; Shechtman, DeBarger, Dornsife, Rosier & Yarnall, 2013), socio-emotional variables such as the ones identified in the LEAFF model have not received substantial attention for their effects on student assessment outcomes. Overall, this study reveals the need to continue investigating the impact of social, emotional, and cognitive-regulating variables in student learning and achievement.
References


universal interventions. *Child development, 82*(1), 405-432.


Table 1

Trust in Teachers Items

Item Sources: STF

1. Instructors are always ready to help at this university.
2. Instructors at this university are easy to talk to.
3. Students are well cared for at this school.
4. Instructors at this university always do what they are supposed to.
5. Instructors at this university really listen to students.
6. Instructors at this university are always honest with me.
7. Instructors at this university do a terrific job.
8. Instructors at this university are good at teaching.
9. Instructors at this university have high expectations for all students.
10. Instructors at this university DO NOT care about students. ®*
11. Students at this university can believe what instructors tell them.
12. Students learn a lot from instructors at this university.
13. Students at this university can depend on instructors for help.

Note: ®* means the responses to the item need to be reversed when conducting psychometric analysis.

Table 2

Mastery Goal Orientation Items

Item Sources: PALS

1. It’s important to me that I learn a lot of new concepts this year.
2. One of my goals in class is to learn as much as I can.
3. One of my goals is to master a lot of new skills this year.
4. It’s important to me that I thoroughly understand my class work.
5. It’s important to me that I improve my skills this year.

Table 3

Performance Goal Orientation Items
Item Sources: PALS

Approach
1. It’s important to me that other students in my class think I am good at my class work.
2. One of my goals is to show others that I’m good at my class work.
3. One of my goals is to show others that class work is easy for me.
4. One of my goals is to look smart in comparison to the other students in my class.
5. It’s important to me that I look smart compared to others in my class.

Avoidance
6. It’s important to me that I don’t look stupid in class.
7. One of my goals is to keep others from thinking I’m not smart in class.
8. It’s important to me that my teacher doesn’t think that I know less than others in class.
9. One of my goals in class is to avoid looking like I have trouble doing the work.

Table 4
Items and Scales for the ATMI

Affect (feelings) Subscale
1. When I make mistakes in group discussions, I am afraid that others look down upon me.
2. If I make mistakes in group discussions, I don’t want others to notice them.
3. When I make mistakes answering classroom questions, I am overwhelmed with embarrassment.
4. I seldom feel bothered by the mistakes I make in group discussions. ®*
5. When I make mistakes answering classroom questions, I still feel confident about my ability. ®*
6. When I make mistakes in class, I worry that other students may laugh at me.
7. When I make mistakes answering classroom questions, I become anxious.
8. When I make mistakes answering classroom questions, I feel humiliated.
9. When I make mistakes answering classroom questions, I am mortified.
10. When I make mistakes answering classroom questions, I am not disappointed with my answer. ®*
11. I feel safe in group discussions even if I make mistakes. ®*

(Positive) Behavior Subscale
12. When I make mistakes on my assignment, I am quite curious about where I went wrong.
13. When I make mistakes on an exam, I feel motivated to study harder.
14. If I make mistakes on my assignment, I will redo it.
15. When I see mistakes on an exam, I meet the instructor to review the errors.
16. When I make mistakes on an exam, I find similar exercises to practice.
17. When I make mistakes on my assignment, I try to find out why by checking the class notes.
18. When I make mistakes on my assignment, I compare my answers with the examples in the class notes.
19. When I make mistakes on my assignment, I review what was discussed in class.

Cognition (beliefs) Subscale

20. I believe successful students make fewer mistakes during learning than others.
21. I believe it is smart to avoid making mistakes during learning.
22. I believe making mistakes is not an efficient way to learn academic materials.
23. I believe I do not learn much from making mistakes in learning.
24. I believe I gain knowledge from making mistakes. ®*
25. I believe making mistakes is a necessary part of learning. ®*
26. I make mistakes on my assignment because I am not smart enough.

Table 5
Transparency Items

Item Sources:

1. I usually discuss my errors on my exams with others.
2. I will admit and correct my errors on my exams immediately.
3. I usually avoid talking about my errors on my exams.
4. I try to hide my errors on my exams from my classmates and/or my friends.
5. I like to discuss my errors on my assignments with my classmates.

Table 6
Perception of Feedback Items

Item Sources:

1. The feedback is always provided promptly at the expected time.
2. I find the feedback helps me improve.
3. I am happy with the amount of feedback I receive.

4. I always agree with the feedback I receive.

5. I feel the feedback is a one-way dialogue rather than a two-way process.

6. I would like to receive more oral feedback on my work.

7. I feel I need guidance on how to best use the feedback to improve.

8. I tend to spend more time reading over feedback when I don’t agree with the awarded mark.

9. I often find the feedback comments upsetting.

10. The feedback I receive is usually detailed enough for me to improve.

11. The feedback always includes examples of ‘good’ and ‘bad’ bits in my work.

12. The feedback always includes examples of how to improve my work.

13. I feel assignments are repeated enough times for the assignment-specific feedback to be useful.

14. *Overall, the feedback I receive is valuable for my learning.

Note: * means this item was created by authors of the paper.

Table 7
Measures Reliability

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<th>Mastery goal</th>
<th>Performance goal</th>
<th>Affect cognition</th>
<th>Behavior</th>
<th>Transparency</th>
<th>Percepcion of Feedback</th>
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Table 8
CFA Indicator loadings

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Table 9
R-Square for each latent variable in SEM

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Figure 1. The Learning Errors and Formative Feedback (LEAFF) Model.
Figure 2. SEM of the LEAFF Variables

***p<0.001, **p<0.01, *p<0.05.
Appendix

Parceled indicators for each latent variable

<table>
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<tr>
<th>Factor</th>
<th>Parcel</th>
<th>Item</th>
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| Affect      | 1      | • When I make mistakes in group discussions, I am afraid that others look down upon me.  
          |        | • When I make mistakes answering classroom questions, I am overwhelmed with embarrassment.  
          |        | • I seldom feel bothered by the mistakes I make in group discussions.  
          |        | • When I make mistakes answering classroom questions, I still feel confident about my ability.  
          | 2      | • When I make mistakes in class, I worry that other students may laugh at me.  
          |        | • When I make mistakes answering classroom questions, I become anxious.  
          |        | • When I make mistakes answering classroom questions, I feel humiliated.  
          |        | • When I make mistakes answering classroom questions, I am mortified.  
          | 3      | • If I make mistakes in group discussions, I don’t want others to notice them.  
          |        | • When I make mistakes answering classroom questions, I am not disappointed with my answer.  
          |        | • I feel safe in group discussions even if I make mistakes.  
| Cognition   | 1      | • I believe it is smart to avoid making mistakes during learning.  
          |        | • I believe making mistakes is not an efficient way to learn academic materials.  
          | 2      | • I believe I do not learn much from making mistakes in learning.  
          |        | • I believe I gain knowledge from making mistakes.  
          |        | • I believe making mistakes is a necessary part of learning.  
          | 3      | • I believe successful students make fewer mistakes during learning than others.  
          |        | • I make mistakes on my assignment because I am not smart enough.  
| Positive Behavior | 1 | • When I make mistakes on my assignment, I am quite curious about where I went wrong.  
          |        | • If I make mistakes on my assignment, I will redo it.  
          |        | • When I make mistakes on an exam, I find similar exercises to practice.  
          | 2      | • When I make mistakes on an exam, I feel motivated to study harder.  
          |        | • When I see mistakes on an exam, I meet the instructor to review the errors.  
          |        | • When I make mistakes on my assignment, I try to find out why by checking the class notes.  
          | 3      | • When I make mistakes on my assignment, I compare my answers with the examples in the class notes.  
          |        | • When I make mistakes on my assignment, I review what
<p>| Transparency | 1 | When I make mistakes in group discussions, I usually discuss my errors with others. |
| Transparency | 1 | When I make mistakes on my exam, I try to hide them from my classmates and/or my friends. |
| Transparency | 2 | When I make mistakes answering classroom questions, I will admit and correct them immediately. |
| Transparency | 2 | When I make mistakes in group discussions, I usually avoid talking about them. |
| Transparency | 3 | When I make mistakes on my assignment, I like to discuss them with my classmates. |
| Trust | 1 | Instructors in my university are always ready to help. |
| Trust | 1 | Instructors in my university always do what they are supposed to. |
| Trust | 1 | Students learn a lot from instructors in my university. |
| Trust | 1 | Students can depend on instructors in my university for help. |
| Trust | 2 | Instructors in my university are easy to talk to. |
| Trust | 2 | Students are well cared for by instructors in my university. |
| Trust | 2 | Instructors in my university really listen to students. |
| Trust | 2 | Instructors in my university do a terrific job. |
| Trust | 2 | Instructors in my university are good at teaching. |
| Trust | 3 | Instructors in my university are always honest with me. |
| Trust | 3 | Instructors in my university have high expectations for all students. |
| Trust | 3 | Instructors in my university DO NOT care about students. |
| Trust | 3 | Students can believe what instructors tell them |
| Mastery goal | 1 | It’s important to me that I learn a lot of new concepts this year. |
| Mastery goal | 1 | One of my goals is to master a lot of new skills this year. |
| Mastery goal | 2 | One of my goals in class is to learn as much as I can. |
| Mastery goal | 3 | It’s important to me that I thoroughly understand my class work. |
| Mastery goal | 3 | It’s important to me that I improve my skills this year. |
| Performance approach goal | 2 | One of my goals is to look smart in comparison to the other students in my class. |
| Performance approach goal | 2 | One of my goals is to show others that I’m good at my class work. |
| Performance approach goal | 3 | It’s important to me that I look smart compared to others in my class. |
| Performance avoidance goal | 1 | It’s important to me that I don’t look stupid in class. |
| Performance avoidance goal | 1 | One of my goals is to keep others from thinking I’m not smart in class. |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>2</td>
<td>• It’s important to me that my teacher doesn’t think that I know less than others in class.</td>
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<tr>
<td>3</td>
<td>• One of my goals in class is to avoid looking like I have trouble doing the work.</td>
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