AC 2007-3040: VALIDATING MEASURES OF FUTURE TIME PERSPECTIVE FOR ENGINEERING STUDENTS: STEPS TOWARD IMPROVING ENGINEERING EDUCATION

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Validating measures of future time perspective for engineering students: Steps toward improving engineering education

In recent years, engineering education has undergone a marked increase in research devoted to understanding student academic outcomes and persistence [1-2]. Researchers have demonstrated that although many engineering educators believe high attrition rates among engineering students are evidence that weaker students are being weeded-out, this conception is flawed [3]. Rather, the grade distributions of students who drop out are statistically similar to those who persist, and many students who drop out of the sciences report doing so due to poor instruction [4]. Accordingly, this line of research has sparked an interest in improving the quality of education engineering students receive by improving instruction through increased understanding of student learning and motivation [3].

From a motivation perspective, some of the most important steps students take toward a career in science and engineering (S & E) are in choosing the right coursework, experiences, and mentors to get them there. Over the past few years, researchers have amassed a substantial body of knowledge regarding how students think about their personal futures. They argue if we want to understand why students choose one career path over another, and why they choose to persevere or abandon that path, we must understand how students conceptualize their futures [5]. Current research on the representation of personal futures has focused on three areas 1) basic neurological and developmental research on the perception of time, 2) understanding the intersection of psychological illness and time perception, and 3) achievement motivation and students conceptualizations of their personal futures. Although, educational research has determined that students' personal thoughts about the future do affect their academic performance, researchers have not yet delved deeply into how students on particular trajectories conceptualize their future paths. In particular, educational researchers know very little regarding how post-secondary students conceptualize their future in S & E. Research still lacks basic groundwork concerning students' representations of the future as well as models that are specific to S & E. In order to move forward with these research goals, measurement instruments that assess engineering students' conceptions of the future need to be tested and validated.

Basic models of future conceptualization refer to the construct of *Future Time Perspective* (FTP). Simply put, FTP is a personal, individual structured representation of the future [6-9]. Research on post-secondary students' FTP has focused on its dispositional [10] and situational [11] aspects. Dispositional facets of FTP are those characteristics of time perspective that change little over time and remain relatively stable across contexts.

Dispositional aspects of FTP include *connectedness* (tendencies to link the present and future), *speed* (how manageable the future seems), and *distance* (the perception of length between present and future events). For example, if an engineering student perceives a strong relationship between success in school and the acquisition of a job in the future, then that student espouses a high level of connectedness between present tasks and future possible scenarios. Moreover, if the same student perceives a future career as coming very quickly in time, that student would score high on the speed construct. In the same scenario, if the student perceives the future as very far away, then that student perceives a high level of distance between the present and the future.

A situational construct within FTP is students' Perceptions of Instrumentality (PI). Situational components of FTP are context specific and change across time and domains. PI is the perception that a particular activity is critical for the achievement of a valued future goal. PI for student learning has two dimensions – endogenous instrumentality and exogenous instrumentality. Endogenous instrumentality is the perception that learning particular information in a class will be useful to achieving a future goal. Conversely, exogenous instrumentality is the perception that performance in a particular class, that is attainment of some type of external reward such as a grade, is instrumental to a achieving a future goal. PI is dependent upon both a specific activity and the students' dispositional tendencies to make connections between the present and the future [6]. However, dispositional and situational aspects of FTP each account for a unique amount of variance in academic success. For example, there is evidence that *connectedness*, a dispositional aspect of FTP, is related to academic success [10]; yet, PI, a situational aspect of FTP, accounts for more variance in academic achievement than dispositional aspects [12]. Thus, although students' dispositional perspective of time is important, the impact of context is equally if not more deciding.

The central role that FTP plays in students' motivation to learn and academic persistence highlights many unanswered questions about engineering students' perspective of time, as well as the need for measures of FTP within the realm of engineering education where improving the quality of students' education has become increasingly important. Therefore, this investigation was conducted to establish valid measures of dispositional and situational FTP for post-secondary engineering students. This study was conducted to examine the reliability and validity of the Future Time Perspective Scale (FTPS) [13] and the

Perceived Instrumentality Scale (PI) [14]. A priori, three dimensions were hypothesized to underlie the FTPS, and two dimension were proposed for the PI. Additionally, three types of validity were examined. Convergent and discriminant validity for the FTPS and the PI were examined by analyzing their correlational relationship with the Time Orientation Scale (TOS) [15], an established measure of students' past, present, and future time orientation. Moreover, the predictive validity of the FTPS and the PI was tested by examining their correlational relationship with the Student Perception of Classroom Knowledge-building scale (SPOCK) [16], an established measure of student study strategies.

Methods

Participants

171 engineering students from multiple sections of an introductory engineering class at a large southwestern university were recruited to participate in the study; 91 completed the online survey for a 53% response rate. Over 70% of the participants were male and in their first year at the university. The majority (90%, n =80) are or plan to become engineering majors.

Procedure

Data for the current study were collected via an online survey constructed using popular web-based data collection software. Scales were randomized within this software. Because the target sample of the study consisted of undergraduate students enrolled in multiple sections of an introductory engineering course, research assistants visited each of the course sections and informed the students about the research opportunity. Then, all students enrolled in the courses were emailed a link to the survey and urged to respond. Students were offered a random one-in-ten chance to win twenty dollars as incentive for participation. Data for the study were collected in the online software, downloaded into and organized in Excel, and then recoded and analyzed in SPSS.

Scales

The Future Time Perspective Scale (FTPS). The FTPS was administered to assess three dimensions of future orientation: connectedness, speed, and distance. The three subscales contain both positively and negatively worded items, and participants responded to a Likert-type scale ranging from 1 indicating "strongly disagree" to 5 indicating "strongly agree." The connectedness subscale consists of 12 items, such as, "What might happen in the long run should not be a big consideration in making decisions now," and, "I should be taking steps today to realize future goals." The speed subscale consists of three items such as, "I need to feel rushed before I can get going." The distance subscale consists of five items such as, "In general, six months seems like a very short period of time," and "Half a year seems like a long time to me."

The Future Time Perspective Scale for Engineers (FTPSE). The FTPSE was also administered. Measured on the same scale as the FTPS, the FTPSE consists of the FTPS connectedness scale reworded to address students' future engineering career. For example, the FTPS connectedness item, "What might happen in the long run should not be a big consideration in making decisions now," was changed to read, "What might happen in the long run in my engineering career should not be a big consideration in making decisions now." The item, "I should be taking steps today to realize future goals," was changed to, "I should be taking steps today to realize future engineering goals."

Perceptions of Instrumentality (PI). The PI scale was administered to determine perceived instrumentality of a particular college course selected by the participant. The scale contains eight positively- and negatively-worded items, and participants responded to a Likert-type scale ranging from 1 indicating "strongly disagree" to 5 indicating "strongly agree." Two types of items comprise the PI scale. One type of item evaluates the perceived instrumentality of *learning* from the course, such as, "I will use the information I learn in the class selected above in other classes I will take in the future." The second type of item measures perceived instrumentality of the *grade* earned in the class, such as, "The grade I get in the class selected above will not affect my ability to continue on with my education."

Time Orientation Scale (TOS). The TOS was used to measure students' tendencies to focus upon past, present, or future events. The 15 items on the TOS include items that represent past orientation ("I often wish I could return to things as they used to be"), present orientation (I try to live one day at a time"), and future orientation ("I am able to resist temptation when there is work to be done"). Students responded on a 7-point Likert-type scale ranging from "not true" to "very true."

Student Perceptions of Classroom Knowledge-building (SPOCK). The SPOCK subscales were administered to assess students' perceptions of their own knowledge building and intentional learning behavior. Three subscales were utilized. The first subscale focused on classroom *knowledge-building*. This 14-item subscale assessed students' tendencies to make meaning from and construct their own understanding of classroom material. An example of a knowledge-building item is "As I study the topics in this class, I try to think about how they relate to the topics I am studying in other classes." The second subscale assessed the *extent of teacher directedness*. An example of one of the nine items from this subscale is, "In this class, I rely on my instructor or classmates to tell me what to do." The final SPOCK subscale assessed the level of *collaborative learning*. An example of one of the five items in the subscale is, "In this class, my classmates and I actively work together to complete assignments." The students responded on a 5-point Likert-type scale ranging from "almost always" to "almost never." The items on the SPOCK are classroom-specific, and participants were asked to focus on one class when completing the SPOCK.

Results

Analysis

An item analysis for each scale was conducted on the data to test the underlying assumptions of our factor analyses. Then, the internal consistency of the subscales was examined. Factor analyses were performed on the FTPS and the PI scales, and a principal components analysis (PCA) was performed on the FTPSE. The results confirmed the hypothesized number of factors for all three scales. Finally, a correlation matrix was constructed to examine correlations between the separate subscales for the FTPS, FTPSE and the PI in comparison to the TOS and the SPOCK. As hypothesized, examples of convergent, discriminant, and predictive validity were established for all scales.

Item Level Analysis

Descriptive statistics for the items that composed our hypothesized factors were analyzed (Table 1). Cronbach's alphas for each of the subscales were calculated and all reliabilities were within acceptable limits. However, problems with two particular items were discovered during the item level analysis. Removing item 14 from the FTPS distance scale increased the Cronbach's alpha from .81 to .85. Also, removing item 7 from the PI exogenous subscale raised the Cronbach's alpha from .69 to .73. These items were not removed from their scales for their respective factor analyses. All other item-total statistics, including inter-item correlations, were theoretically consistent and indicated that all other items contributed to the subscales.

Internal Consistency

FTPS principal axis analysis. Based on the FTPS literature, we hypothesized a three-factor solution. We also hypothesized that our factors were correlated. Therefore, we chose to conduct a principal axis factor analysis with an oblique rotation, and we set a three-factor solution consistent with our a priori hypothesis. The three-factor solution yielded theoretically interpretable results, a sound factor structure, and accounted for 58.17% of the cumulative scale variance. Furthermore, consistent with our hypothesis, the three factors were moderately correlated. Items and factor loadings are presented in Table 2.

FTPSE principal component analysis. To construct the FTPSE, we modified one dimension of the FTPS to be contextually relevant to engineering majors. Because we chose a single dimension for the subscale, we hypothesized a one-factor solution. Items for the FTPSE proved to be internally reliable, and a one-factor principal components solution was theoretically interpretable and accounted for 47.26% of the cumulative scale variance. These results were consistent with our hypothesis that FTPSE has one underlying dimension.

PI principal axis analysis. Based on the PI literature, we hypothesized a two-factor solution. We also hypothesized the factors for the PI would be correlated; as a result, we chose a principal axis analysis with an oblique rotation and a set two-factor solution. This analysis yielded a two-factor solution that was consistent with our theoretical hypothesis. The two factors accounted for 70.56% of the cumulative scale variance. The factors were weakly correlated. Items and factor loadings are reported in Table 3.

Convergent and Discriminant Validity

To establish the convergent and discriminant validity of the FTPS, FTPSE, and PI subscales, we conducted Bivariate correlations between these scales and a previously established subscale designed to measure students future time orientation. Evidence of convergent and discriminant validity were found for FTPS and FTPSE connectedness subscales, as well as the PI endogenous subscale. Inter-subscale correlations are presented in Table 4. As hypothesized, the FTPS and FTPSE connectedness subscales, as well as the PI endogenous subscale, were significantly positively correlated with the future subscale of the TOS. Furthermore the FTPSE, FTPS distance, FTPS speed, and PI endogenous were each negatively correlated to the TOS past subscales. Contrary to our hypothesis, a significant negative relationship was not found between the FTPS connectedness and TOS past subscales.

Predictive Validity

The FTPS, the FTPSE, and the PI were shown to be internally consistent and related in expected ways to established measures of future time orientation. Our next step was to determine if these scales were related to an important outcome variable. As expected, the FTPS, the FTPSE connectedness, PI endogenous subscales were significantly correlated with the knowledge- building subscale of the SPOCK. The PI endogenous subscale was also found to be significantly positively correlated with the SPOCK teacher directedness subscale.

Discussion

The results of this investigation revealed the FTPS and the PI measurement instruments can be used as reliable and valid measures of engineering students' future time perspective. All of the hypothesized subscales proved to be internally reliable. Principal axis analyses for the FTPS and the PI confirmed the number of hypothesized dimensions as identified in the literature surrounding both scales [10-11], and the FTPSE (the subscale of the FTPS modified to be contextually relevant for engineering students) demonstrated a single-factor principal components solution. Finally, evidence of convergent, discriminant, and predictive validity were established for subscales of interest in all three measurement instruments.

Item analysis

Item 14 in the FTPS distance subscale and item 7 from the PI endogenous subscale hindered the internal reliability of their respective subscales and loaded poorly on their respective factors. Item 14 reads, "It often seems like the semester will never end." As compared to the other distance items in the scale which delineate very specific time frames, this particular item is less rigid and is susceptible to subjective interpretation. Presumably, in the future, this item should be rewritten or replaced so as to reflect the same six-month time period as the other four items in the subscale. Item seven of the PI endogenous subscale also decreased the internal consistency of its respective factor. This item reads, "I must pass MAE 100 in order to reach my academic goals." As this is the only item in the endogenous subscale that does not directly address students' grades, and it factored poorly with the other items in the subscale, this item also should be rewritten or replaced to more accurately reflect the broader meaning of its respective latent factor.

Internal consistency and external validity

All three subscales of interest -- the FTPS, the FTPSE, and the PI – proved to be reliable and internally-consistent measures. The results of the factor analysis and principal components analysis confirmed the hypothesized number of factors for all three scales. Furthermore, evidence exists for three types of validity – convergent, discriminant, and predictive – for each subscale of interest through examination of correlation matrices with other established scales. The significant positive correlations between the TOS future subscale, the connectedness subscale for the FTPS, the FTPSE, as well as the PI endogenous subscale indicated convergent validity. That is, as is evidenced by the significant correlations, both scales measure students' future time orientation in distinct but similar ways. Furthermore, the significant negative correlations between the FTPSE, FTPS distance and speed, the PI endogenous subscale, and the TOS past subscale indicated discriminant validity. One point of interest is the lack of a significant negative correlation between the FTPS connectedness subscale and the TOS past subscale, as compared to the significant negative relationship between the FTPSE and the TOS past subscale. Presumably the significant negative linear relationship between the FTPSE and the TOS is due to the contextual nature of the FTPSE. The FTPSE is worded to be contextually relevant to students' future careers as engineers. Contextualized measures of student motivation have been found to be better predictors of students' performance [17]. As expected, the FTPSE, the measure of connectedness specifically designed for engineering students, demonstrated stronger predictive, discriminant, and convergent validity. These findings suggest a need for other contextualized measures of student FTP.

FTP and engineering education

Finally, evidence of predictive validity was established for all three measurement instruments of interest. The connectedness subscale of the FTPS, the FTPSE, and the PI endogenous subscale, were significantly correlated with the knowledge-building SPOCK subscale. These significant positive correlations indicate that students who had strong connectedness between their present academic tasks and their possible futures as engineers, as well as high perceived endogenous instrumentality for learning in their present engineering course, were more likely to employ knowledge-building strategies to learn the information required in their introductory engineering course. Moreover, the PI endogenous subscale was also significantly positively correlated with the SPOCK teacher directedness subscale. This means students with high perceived instrumentality for learning in their engineering courses were statistically more likely to indicate high teacher directedness in their classroom. Students who are new to engineering, and see the information in their first engineering course as important to their future goals may look to their instructor for direction. This is a reasonable strategy for the first year undergraduate student; however, if students are not actively encouraged to develop self-direction over time, these students may have difficulty as students are expected to take on more responsibility for their learning. Longitudinal research on student directedness, teacher directedness, and PI is non-existent in engineering education. The next step of this research program will be to track students' need for direction, independence, and motivation through the course of their development in post-secondary education settings.

The results of this validation study are promising because they point to a new area of motivation research in the field of engineering education. Improving the quality of instruction provided in the field of engineering, a realm of study notorious for high attrition rates, has become an important line of research over the last 15 years [1-2]. Declining interest in the field of engineering among high school students, reports of student dissatisfaction with the quality of their engineering instruction, and academic persistence rates for engineering students below 50% in the U.S. have prompted new interest in understanding what attracts students to careers in science and engineering and what teaching strategies can maintain interest in those careers. Validating and testing accurate measures of students' FTP can ultimately lead to meaningful contributions in this area of study. Future research will reveal how well FTP predicts important outcome variables such as academic persistence and study strategies among engineering students as well as how other well-established psychological constructs such as self-efficacy and work engagement interact with FTP. In the end, larger and more comprehensive models of motivation can be constructed that will provide insight not only into the structure of FTP as a motivational construct, but also into interventions and steps that can be taken to help improve the quality of engineering education and the engineering student experience.

References

[1] French, B.F., Immekus, J.C., and Oakes, W.C., "An examination of Indicator of Engineering Students' Success and Persistence," *Journal of Engineering Education*, Oct., 2005, pp. 419-425.

[2] Zhang, G., Anderson, T.J. , Ohland, M.W., and Thorndyke, B.R.,"Identifying Factors Influencing Engineering Student Graduation: A Longitudinal and Cross-Institutional Study," *Journal of Engineering Education,* Vol. 93, 2004, pp. 313–320.

[3] Felder, R.M., Brent, R., "Understanding Student Differences," *Journal of Engineering Education*, Jan., 2005, pp. 57–72.

[4] Seymour, E., and Hewitt, H., *Talking about Leaving: Why Undergraduates Leave the Sciences*, Boulder, Colo.,: Westview Press, 1997.

[5] Packard, B. W. l., and Nguyen, D., "Science career-related possible selves of adolescent girls: a longitudinal study," *Journal of Career Development,* Vol 29, No. 4, 2003, pp. 251-263.

[6] Husman, J., and Lens, W., "The role of the future in student motivation," *Educational Psychologist,* Vol. 34, No. 2, 1999, pp. 113-125.

[7] Lang, F. R., and Carstensen, L. L., "Time counts: Future time perspective, goals, and social relationships," *Psychology & Aging,* Vol. 17, No. 1, 2002, pp. 125-139.

[8] Malka, A., and Covington, M. V., "Perceiving school performance as instrumental to future goal attainment: Effects on graded performance," *Contemporary Educational Psychology,* Vol. 30, No. 1, 2005, pp. 60-80.

[9] Zimbardo, P. G., and Boyd, J. N., "Putting time in perspective: A valid, reliable individual-differences metric," *Journal of Personality and Social Psychology,* Vol. 77, No. 6, 1999, pp. 1271-1288.

[10] Shell, D. F., and Husman, J., "The multivariate dimensionality of personal control and future time perspective beliefs in achievement and self-regulation," *Contemporary Educational Psychology,* Vol. 26, No. 4, 2001, pp. 481-506.

[11] Simons, J., Dewitte, S., and Lens, W., "Wanting to have vs. wanting to be: The effect of perceived instrumentality on goal orientation," *British Journal of Psychology,* Vol. 91, No. 3, 2000, pp. 335-351.

[12] Malka, A., and Covington, M. V., "Perceiving school performance as instrumental to future goal attainment: Effects on graded performance," *Contemporary Educational Psychology,* Vol. 30, No. 1, 2005, pp. 60-80.

[13] Husman, J. & Shell, D. F., "Beliefs and perceptions about the future: A conceptualization and measurement of future time perspective (abstract)," *International Journal of Psychology,* Vol. 31, p. 4496.

[14] Husman, J., Derryberry, W. P., Crowson, H. M., and Lomax, R., "Instrumentality, task value, and intrinsic motivation: Making sense of their independent interdependence," *Contemporary Educational Psychology,* Vol 29, 2004, pp. 63-76.

[15] Lasane, T. P., and Jones, J. M., "When Socially Induced Temporal Myopia Interferes with Academic Goal-Setting," Journal of Social Behavior and Personality, 2000, Vol. 15, No. 5, pp. 75-86.

[16] Shell, D. F., Husman, J., Turner, J. E., Cliffel, D. M., Nath, I., and Sweany, N., "The Impact of Computer Supported Collaborative Learing Communities on High School Students' Knowledge Building, Strategic Learing, and Perceptions of the Classroom," Journal of Educational Computing Research, Vol. 33, No. 3, 2005, pp. 327-349.

[17] Bong, M., "Within-Grade Changes in Korean Girls' Motivation and Perceptions of the Learing Environment Across Domains and Achievement Levels," Journal of Educational Psychology, Vol. 97, No. 4, 2005, pp. 656-672.

Table 1.

Descriptive statistics and factor correlations for all collapsed subscales

				Factor Correlations		
FTPS Factors	*M*	*SD*	α	1.	2.	3.
1. Speed	2.69	.90	.81	--		
2. Distance	3.20	.76	.81	.15	--	
3. Connectedness	4.01	.58	.89	.39**	.38**	--
PI Factors				1.	2.	
1. Endogenous	3.69	.95	.94	--		
2. Exogenous	3.60	.77	.69	.09	--	
FTPSE Factor				1.		
1. Connectedness	4.11	.68	.88	--		

Note. **p<.01

Table 2.

Summary of items and factor loadings for final principle axis analysis with oblique rotation for the FTPS.

Items	Factor Loadings		
	1.	2.	3.
6. One shouldn't think too much about the future	**.80**	.14	.43
9. It is important to have goals for where one wants to be in five or ten years	**.78**	.14	.16
4. One should be taking steps today to help realize future goals	**.72**	.30	.16
20. I don't think too much about the future	**.72**	.25	.51
10. I don't like to plan for the future	**.70**	.22	.62
5. It's not really important to have future goals for where one wants to be in five or ten years	**.69**	.12	.18
12. Planning for the future is a waste of time	**.68**	.26	.38
15. I have been thinking a lot about what I am going to do in the future	**.65**	.18	.50
16. It's really no use worrying about the future	**.61**	.31	.34
13. What will happen in the future is an important consideration in deciding what action to take now	**.61**	.34	.13
1. What might happen in the long run should not be a big consideration in making decisions now	**.47**	.26	.14
18. What one does today will have little impact on what happens ten years from now	**.47**	.29	.18
7. Half a year seems like a long time to me	.37	**.84**	.24
17. March seems like a long way off	.33	**.83**	.33
3. April seems very near	.28	**.82**	-.05
2. In general, six months seems like a very short period of time	.15	**.69**	-.11
14. It often seems like the semester will never end	.26	**.33**	.27
19. I need to feel rushed before I can really get going	.37	.15	**.77**
11. I always seem to be doing things at the last moment	.25	-.05	**.71**
8. I find it hard to get things done without a deadline	.24	.17	**.71**

Note. N=88

Table 3.

Summary of items and factor loadings for final principle axis analysis with oblique rotation for the FTPS.

Items	Factor Loadings	
	1.	2.
6. I will use the information I learn in MAE 100 in the future	**.96**	.10
1. I will use the information I learn in MAE 100 in other classes I will take in the future	**.88**	-.02
2. What I learning in MAE 100 will be important for my future occupational success	**.86**	.11
4. I will not use what I learn in MAE 100	**.86**	.20
5. What grade I get in MAE 100 will not be important for my future academic success	.11	**.83**
3. The grade I get in MAE 100 will not affect my ability to continue on with my education	-.17	**.64**
8. The grade I get in MAE 100 will affect my future	.14	**.64**
7. I must pass MAE 100 in order to reach my academic goals	.26	**.36**

Note. *N*=89

Table 4.

Inter-scale correlation matrix

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. FTPSconn	--										
2. FTPSspd	.45**	--									
3. FTPSdist	.44**	.28*	--								
4. FTPSEconn	.84**	.28*	.44**	--							
5. PIend	.21	.01	.08	**.34****	--						
6. PIexo	.15	-.01	-.03	-.02	.15	--					
7. TOSpast	-.23	**-.29***	**-.36****	**-.30***	.07	.09	--				
8. TOSfuture	**.57****	**.57****	**.32****	**.50****	.14	.04	-.15	--			
9. SPKcollab	.15	.09	.13	.20	.02	-.20	-.27*	-.01	--		
10. SPKknowbld	**.48****	.21	.23	**.55****	**.64****	.02	-.10	**.44****	.26*	--	
11. SPKteachdirect	-.02	-.17	-.02	.06	**.32****	.10	.10	-.08	-.08	.14	--

Note. $N = 70$

* p < .05

** p < .01