College Teachers' Instructional Practices: Exploratory and Confirmatory Factor Analyses

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The purpose of this study was to develop and validate an instrument, the College Teachers' Instructional Practices (CTIP), which was designed to measure college teachers' instructional practices in terms of teacher-centered or student-centered teaching preferences. An initial survey was administered among dental faculty members. Exploratory factor analysis (EFA) was employed to revise the initial scale, and the revised scale was administered among general college faculty members. EFA suggested a two-factor solution of a 9-item scale that measured teacher-student instructional relationship and the purpose of questioning. Confirmatory factor analysis (CFA) supported this solution. Limitations and implications are discussed.

For the past few decades, educators have debated about which pedagogical approach is more effective in encouraging learning: teacher-centered or student-centered. The difference of opinion dates back as far as Dewey (1938) when he asserted that educators teach in ways that are responsive to students' learning needs. This has led to teacher curiosity about whether adopting student-centered teaching approaches would result in more effective learning outcomes.

Constructivists view learning as a process of individualized inquiry that instructors facilitate (Nomishan, Bourbeau, Tessier, & Pollock, 2001). Weimer (2002) argued that compared to traditional teacher-centered learning, learner-centered teaching changes the balance of power, the function of content, the role of the teacher, the responsibility for learning, and the purpose and processes of evaluation. The advantage of student-centered teaching over teacher-centered teaching has been supported by empirical evidence from both qualitative and quantitative studies (Alexander, Daffinrud, Lewis, & Millar, 1995; Argo, 1995; Geimer, Getz, Pochert, & Pullam, 2000; Lord, Travis, Magill, & King, 2002; Orsak, 1990). Evidence has shown that students tend to be more motivated to learn when they perceive learner-centered teaching practices (Rossi, 2009), students receiving student-centered teaching tend to yield better learning outcomes both in knowledge recalling and knowledge construction (Yuen & Hau, 2006), and students tend to learn best in collaborative and engaging learning environments (Pascarella & Terenzini, 2005).

Although student-centered teaching is much advocated, how to successfully implement such teaching approaches remains a challenge for college faculty (Weimer, 2002). Changes in teaching practices are oftentimes limited to isolated classrooms (Murray, Higgins, Minderhout, & Loertscher, 2011). Instructors experience barriers to implementing student-centered teaching practices such as lack of control over curriculum or teaching methods (Gilmore, 2010). Several studies on improving college teaching have pointed out that many college and university faculty members need guidance about teaching (Fuhrman, Fuhrman, & De Lay, 2010; Major & Dolly, 2003; Qualters, 2009; Scott, Lisagor, & Marachi, 2009). One challenge is that many faculty members do not recognize their own teaching preferences and rely on teaching practices that are comfortable to them (Barnes, 1983/1998). To provide effective guidance, it is then necessary to first have a good understanding of the existing teaching practice of college faculty.

Despite the abundance of studies on the importance and necessity of improving college teaching, there has been little research or suggestions about how to conceptualize measuring college teaching practices directly with faculty members. Research about developing and validating standardized instruments to measure higher education faculty's teaching practice in the United States is still scarce. This study aimed to help fill this gap in the existing literature by developing and validating an instrument that measures college instructor's teaching practices regarding teacher-centered and student-centered teaching preferences.

Theoretical Framework

College teaching, similar to K-12 research on teaching effectiveness, is primarily conceptualized as a dichotomous process (Allen, 2004; Hassad, 2009; Huba & Freed, 2000). Theoretically, teaching practices have been seen as consistent with the process-product paradigm of the 1960s and 70s, or with the process-psychological mediators-sociological mediators-product paradigm of the 1970s and beyond (Behar-Horenstein & Morgan, 1995). Similarly, Barr and Tagg (1995) suggested that the teaching paradigms were instruction versus learning. Within the former, the teacher is considered to be the central agent who ensures that students receive information or skills. The latter focuses on methods essential to achieve outcomes (Behar-Horenstein & Morgan, 1995).

One way to construct the dichotomy of college teaching is by conceptualizing teacher-centered teaching and student-centered teaching. The former emphasizes the central role of the instructor in various steps of the teaching-learning process, including course content, evaluation approach, and dynamic between instructor and students. The latter focuses on moving towards a more interactive and collaborative teaching-learning process (Weimer, 2002). Student-centered teaching, or learner-centered teaching, gives the students more power in course-related decision making, focuses on building a strong knowledge foundation and developing learning skills, requires that the instructor act as facilitator rather than being didactic, shifts the responsibility of learning from the instructor to the student, and uses assessment and evaluation as tools to provide constructive feedback (Blumberg, 2009; Weimer, 2002).

Student-centered teaching approaches have been shown to be superior to the traditional teacher-centered teaching methods in that the former tends to yield better learning outcomes in both short-term recall and long-term retention of knowledge (Prince, 2004; Yuen & Hau, 2006). On the other hand, researchers have argued that teacher-centered teaching should also have a major role in improving the quality of college teaching (Bailey, 2008). In this study, we use the framework of teacher-centered vs. student-centered teaching to develop and validate the instrument to measure college teachers' teaching practices.

Purpose of the Study

Lacking a standardized instrument that directly measures postsecondary education faculty members' teaching practices can pose a barrier to faculty members' self-awareness of teaching and to the movement towards student-centered teaching in colleges and universities. This study aimed to help fill this gap in the literature. The purpose of this study was to (1) develop the College Teachers' Instructional Practices (CTIP), a standardized instrument to measure higher education faculty's teaching practices in terms of teacher-centered or student-centered focus of instruction, and to (2) provide preliminary validity support for this instrument. The following research questions were examined:

Research Question 1: What is the internal structure of the College Teachers' Instructional Practices (CTIP)?

Research Question 2: How well do empirical data collected using the CTIP fit the internal structure as mentioned in research question 1?

Methods

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were adopted to examine the internal structure and provide preliminary validity evidence of the instrument. Exploratory factor analysis is a statistical method, which originated in the field of psychology. It is used to identify the underlying structure of a set of measured variables. In a scale, the individual items are called indicators, and the underlying constructs these items measure are called factors. When a correspondence exists between an indicator and a factor, it is said that the indicator loads on that factor. The EFA technique does not require a priori hypotheses about the number of factors or the factor-indicator correspondence (Kline, 2011). Due to its exploratory nature, EFA is widely used by researchers when developing a scale. Researchers first design scale items and collect data using such items. Then EFA is employed to examine how many latent constructs the scale measures and which indicators correspond with which construct(s).

Confirmatory factor analysis, on the other hand, is used to test whether data collected using a certain scale fit the hypothesized internal structure of such scale. Contrary to EFA, CFA requires a priori hypotheses to guide the model building. This means that the researcher tests the internal structure of the scale by fitting data to model that is restricted according to the researcher's hypotheses. The model fit is examined by various fit indices.

Step 1: Development of Instrument

We used an initial scale, Teacher's Behavior Preference Survey, developed by Behar-Horenstein and Anusavice (2006) and the related dataset as the start point of this study. The scale was a 60-item self-report survey that measured teachers' instructional practices and understanding of their own teaching in respect to teacher-centered or student-centered teaching. The items asked about four aspects of teaching preferences, namely classroom milieu, use of questions, assessment, and instructor's roles (Behar-Horenstein & Anusavice, 2006).

The items were on a 5-point Likert scale with 1=highly disagree and 5=highly agree.

The 60-item survey was administered in 2006. E-mails were sent to the associate dean at each of the 66 colleges of dentistry in the United States and Canada to invite faculty members to participate voluntarily. The associate deans were asked to send invitation emails to their faculty members. Sampling was not conducted at either the school level or the individual level. No information was available regarding the total number of faculty in these schools and therefore no response rate was available. Participants included 416 faculty members. Of the respondents, 68% (n=283) were male, 32% (n=133) were female, 85% (n=354) were white, and 15% (n=62) were minorities. Data of three individuals were missing and the total number of cases analyzed was 413.

The second author of this study performed the statistical analyses. *Mplus6* (Muthén & Muthén, 2010) was used to perform the EFA. Several rounds of EFA were conducted. After each EFA, the items with the most problematic factor loadings were deleted. This repeated procedure led to the deletion of 44 items which either loaded on more than one factor, or had factor loadings that were smaller than 0.3. Results suggested an interpretable three-factor solution for the remaining 16 items. Approximate fit indices were used in deciding the model fit and the following recommended cut-off values were adopted: (1) comparative fit index (CFI) of 0.90 (Bentler & Bonett, 1980); (2) root-mean-square error of approximation (RMSEA) of 0.08 (Browne & Cudeck, 1992); and (3) standardized root mean squared residual (SRMR) of 0.08 (Hu & Bentler, 1999). The fit indices were as follows: CFI=0.927, RMSEA=0.069, and SRMR=0.048. All three indices suggested adequate model fit based on the aforementioned cut-off values. The items and their factor loadings are shown in Table 1.

The factors were labeled as follows: (1) Adjustment of Teaching (AT); (2) Assessment (AM); and (3) Use of Questions (UQ). The factor correlations were weak or moderate, ranging from 0.253 to 0.506. The reliability of this 16-item scale as estimated by Cronbach's alpha was 0.835. The reliabilities of each factor's items ranged from 0.714 to 0.718. The correlation of the factors and the reliabilities of the three subscales are reported in Table 2. This scale formed the first version of the CTIP.

Step 2: Exploratory and Confirmatory Factor Analysis of Sample from General Faculty Population

After developing the first version of the CTIP, we tested it on a more general population of college faculty members. We hypothesized that when administered to the general college faculty, the scale would yield the same three-factor internal structure as obtained from the first step.

Table 1. Items and factor loadings of the first version of the CTIP

Item	Label	Factor Loading		
		AT	AM	UQ
1. I change assessment techniques according to the lesson objectives.	AT1	**0.430**	0.123	-0.027
2. I adjust my teaching techniques based on the needs of individuals.	AT2	**0.750**	-0.051	-0.006
3. I adjust my teaching techniques based on students' behavior.	AT3	**0.522**	0.020	0.198
4. I provide feedback to students during guided practice.	AT4	**0.476**	0.093	0.133
5. I use different approaches to teaching depending upon the learning needs of my students.	AT5	**0.794**	-0.010	0.017
6. I use assessment to measure how much and what students have learned.	AM1	-0.007	**0.813**	-0.186
7. I use assessment so that I can evaluate student performance.	AM2	-0.215	**0.686**	0.003
8. I use assessment so that both students and I can understand student performance.	AM3	0.098	**0.631**	0.197
9. I identify the assessment measures that I plan to use before I teach the material.	AM4	0.011	**0.357**	-0.049
10. I typically ask students questions that require them to make predictions.	UQ1	0.089	-0.049	**0.521**
11. When I ask students questions, their answers typically require them to provide a justification.	UQ2	0.208	0.005	**0.437**
12. I ask students questions during class because it helps me monitor what they are learning.	UQ3	0.022	0.275	**0.450**
13. When I teach, I typically ask students hypothetical questions.	UQ4	-0.067	0.004	**0.674**
14. I ask students questions while I teach because I want to see how they think.	UQ5	-0.023	0.117	**0.674**
15. I typically ask students questions that require them to state priorities.	UQ6	0.186	-0.104	**0.430**
16. When I teach, I typically ask students information-seeking questions.	UQ7	-0.029	0.172	**0.309**

Note. AT = Adjustment of Teaching, AM = Assessment, UQ = Use of Questions

Procedure

A random sample of faculty members was selected at a research intensive university in the southeastern United States. A total of 320 faculty members were selected and invited to participate voluntarily in the study. We defined "faculty member" as tenure track faculty, non-tenure track faculty, and instructors whose primary job affiliation was with the university and for whom teaching was part of their contractual duty. This definition excluded adjunct faculty members who held primary jobs in other professions. E-mails inviting and reminding faculty members to participate in the study were sent to the sample. The scale was administered through Survey Monkey, an online survey system protected by password. A link to the survey was provided in the invitation email. Data were collected anonymously.

Participants

From the 320 faculty members who were invited to participate, 172 responses were received. Listwise deletion was used to delete cases with missing data on the items. This yielded a dataset of 146 complete responses and a response rate of 45.6%. Of these responses, one had missing data on the demographic variables. Of the 145 participants who provided demographic information, 45% (n=65) were female and 55% (n=80) were male. The average teaching experience was 18.21 years (n=145). The participants represented all colleges in the university. In terms of highest degree, 89.7% (n=130) of the respondents held doctoral degree, 1.4% held specialist degree (n=2), and 9% (n=13) held master's degree.

Results

EFA was run to identify dimensions of the first version of the CTIP as applied to the sample of college faculty from all disciplines. Eigenvalue, approximate fit indices, rotated factor loadings, and substantive interpretability of the loadings were examined to decide the internal structure of the scale. The rule of eigenvalue >1 (Kaiser, 1960) suggested a five-factor solution. Although the approximate fit indices suggested good model fit (CFI=.993, RMSEA=.039, SRMR=.036), the oblique rotated factor loadings of this solution did not show a clear-cut pattern since some items loaded on more than one factor, while others loaded on none of the factors. Substantively, this solution was not interpretable, either. We then examined the four-factor and three-factor solutions. The approximate fit indices supported both solutions (for the four-factor solution, CFI=.983, RMSEA=.055, SRMR=.047; for the three-factor solution, CFI=.962, RMSEA=.076, SRMR=.063). However, for both solutions, the rotated factor loadings did not show a clear-cut pattern. We then revised the scale taking into

Table 2. Correlations of the factors and reliabilities of subscales of the first version of the CTIP

Factor	AT	AM	UQ
Adjustment of Teaching (AT)	--		
Assessment (AM)	0.367	--	
Use of Questions (UQ)	0.506	0.253	--
Reliability	0.718	0.714	0.714

Table 3. Items and factor loadings of the CTIP

Item	Label	Factor Loading	
		TSIR	**PQ**
1. I provide feedback to students during guided practice.	TSIR	**0.478**	0.227
2. I ask students questions during class because it helps me monitor what they are learning.	PQ	-0.007	**0.836**
3. I identify the assessment measures that I plan to use before I teach the material.	TSIR	**0.610**	-0.083
4. When I ask students questions, their answers typically require them to provide a justification.	TSIR	**0.367**	0.193
5. I adjust my teaching techniques based on students' behavior.	TSIR	**0.612**	0.090
6. I use assessment so that both students and I can understand student performance.	TSIR	**0.778**	0.009
7. I change assessment techniques according to the lesson objectives.	TSIR	**0.848**	-0.178
8. I adjust my teaching techniques based on the needs of individuals.	TSIR	**0.476**	0.141
9. I ask students questions while I teach because I want to see how they think.	PQ	0.113	**0.790**

Note. TSIR = Teacher-Student Instructional Relationship, PQ = Purpose of Questioning

account both the rotated factor loadings and the substantive meaning of the items.

We deleted six items to reduce the scale to a 10-item version. We then ran EFA to examine the internal structure of the 10-item CTIP. The rule of eigenvalue >1 (Kaiser, 1960) suggested a three-factor solution. The approximate fit indices supported the three-factor solution (CFI=.992, RMSEA=.056, SRMR=.037). The chi-square test of model fit of the three-factor solution was statistically insignificant (χ^2 =26.34, p-value=.09), suggesting adequate model fit (Kline, 2011). However, the rotated factor loadings suggested that item 10 was problematic. While it loaded on only one factor, its factor loading was greater than 1.0 (1.042), and its estimated residual variance was negative (-0.037). An improper solution like this may have various causes and oftentimes suggests over-extraction of factors (Kano, 1998; Rindskopf, 1984). The factor correlations of the three-factor solution also suggested over-extraction of factors in that the correlation of factor one with factor two (.509) and of factor one with factor three (.638) were both large according to Cohen's (1988) convention.

To handle the improper solution, we excluded item 10 from the scale and reran the EFA. The analyses yielded a two-factor solution with acceptable model fit. The eigenvalue rule suggested a two-factor solution. The approximate fit indices were as follows: CFI=.979, RMSEA=.074, and SRMR=.05. The correlation between the two factors was medium (.484). The oblique rotated factor loadings provided a clear-cut pattern which was interpretable. Based on these evidences, we elected to accept the two-factor solution. The factors were labeled as follows: Teacher-Student Instructional Relationship (TSIR), and Purpose of Questioning (PQ). The items and the factor loadings are reported in Table 3. The correlation of the factors and the reliabilities of the two subscales are reported in Table 4.

We then ran confirmatory factor analysis (CFA) to validate the findings from the EFA. We used chi-square of model fit, CFI, RMSEA, and weighted root mean square residual (WRMR) to assess model fit. The recommended cut-off value of WRMR is 1.0 (Yu, 2002). The chi-square test of model fit was significant (χ^2 =48.17, p-value=.005). However, the model fit indices suggested good fit of the two-factor solution: CFI=.968, RMSEA=.076, and WRMR=.699. The correlation between factor one and factor two was small (r=0.29). All factor loadings were significant. Model results are reported in Table 5.

Table 4. Correlations of the factors and reliabilities of subscales of the CTIP

Factor	TSIR	PQ
Teacher-Student Instructional Relationship (TSIR)	--	
Purpose of Questioning (PQ)	0.484	--
Reliability	0.755	0.702

Discussion

This study developed the CTIP, a Likert-scale instrument, to measure college and university faculty's teaching practices in terms of teacher-centered and student-centered teaching. It also provided preliminary validity support for this scale. EFA and CFA were conducted to examine the internal structure of the scale. The analyses suggested a two-factor solution of a final version of the CTIP consisting of a 9-item scale. The two dimensions of the scale were labeled as Teacher-Student Instructional Relationship (TSIR) and Purpose of Questioning (PQ).

The importance of instructor's skills of using questions in promoting student's learning outcomes has been widely discussed. Empirical evidence has shown that

Table 5. Model results of CFA

Item	Factor	Factor loading	P-value
1. I provide feedback to students during guided practice.	1	1.000	-
2. I ask students questions during class because it helps me monitor what they are learning.	2	1.000	-
3. I identify the assessment measures that I plan to use before I teach the material.	1	0.869	0.000
4. When I ask students questions, their answers typically require them to provide a justification.	1	0.798	0.000
5. I adjust my teaching techniques based on students' behavior.	1	1.065	0.000
6. I use assessment so that both students and I can understand student performance.	1	1.238	0.000
7. I change assessment techniques according to the lesson objectives.	1	1.105	0.000
8. I adjust my teaching techniques based on the needs of individuals.	1	0.901	0.000
9. I ask students questions while I teach because I want to see how they think.	2	1.168	0.000

proper use of questioning is positively related to student's learning outcomes (Lim, 2011; Mayer et al., 2009). Besides the effectiveness of good questioning skills, questioning has also been examined in terms of how it affects the interaction pattern between instructor and students. Yu (2010) argued that convergent questions allow the instructor to have more control over the interaction with students and tend to demand lower level of thinking and provide less comprehensible input to students than divergent questions. Questioning thus not only serves as a way of evaluation, which examines what students have or have not mastered, but also reflects the power distribution between instructor and students as well as the role of the teacher in the teaching-learning process.

The CTIP's dimension of Purpose of Questioning is important in that it measures instructor's purposes in using questions in class. Different purposes reflect different power structures and respective roles of instructor and students. When the instructor asks questions in order to see what the students have learned, he or she to a large extent controls what and how students should answer. The instructor thus plays a more didactic role. On the other hand, when the purpose of questioning is to examine students' thinking processes, the instructor assumes more of a facilitating role of the teaching-learning process. Similarly, the dimension of Teacher-Student Instructional Relationship reflects the balance of power, the role of the teacher in class, and the purpose of evaluation. All are aspects of student-centered teaching as argued by Weimer (2002).

This study has several limitations. First, the sample size of step 2 was relatively small. Due to the low response rate from faculty members, we were not able to obtain a larger sample to ensure a minimum of 10 observations per item. Although researchers have argued that there is no simple rule of thumb in terms of minimal sample size in factor analysis (MacCallum, Widaman, Zhang, & Hong, 1999), small sample size may lead to unstable solutions. Second, the factor structure obtained from step 2 could be tested on a separate sample of college faculty to provide stronger validity support. Third, the final version of CTIP is a small scale and measures only two dimensions of college teaching practices. Adding subscales that measure other aspects of college instruction could enrich this instrument.

Implications

In light of the findings of this study, we discuss implications for practice and suggestions for future research.

Implications for Practice

Although the scale of the final version of the CTIP is very small, given the sufficient evidence of its validity, this instrument provides a useful assessment tool to assist teaching improvement efforts. It can be used to help faculty members realize their teaching preferences. For example, for faculty members who give students' learning needs a minimal role in their teaching practices, this scale can be used to help them realize this teaching preference and lead to potential improvement. The revelation of existing teaching preferences of faculty members can be instrumental for college and university administrators in designing faculty development programs. With such information, it is easier to focus training and development programs on aspects that need improvement the most. The CTIP can also be used to assess changes in faculty teaching practices before and after training that is designed to improve student-centered teaching.

This study aimed to design an instrument for the general faculty population, rather than only for those from certain academic disciplines. It is argued that different disciplines share the same factors that influence the effectiveness of teaching (Murray & Renaud, 1995/1998). This means that what constitutes effective college teaching is context-free and does not vary systematically from one discipline to one another (Murray & Renaud, 1995/1998). It is therefore reasonable to design an instrument for faculty from all disciplines. The final version of the CTIP was developed with a faculty sample from various academic disciplines. Therefore, it is suitable to be administered among faculty of various disciplines.

Suggestions for Future Research

We suggest two lines of future research based on the results of this study. The first line refers to the further validation of the CTIP. Additional empirical studies will be needed to provide further evidence of reliability and validity of the scale. This means that the CTIP needs to be tested repeatedly to be further validated. It should be administered to different subgroups of faculty members in order to support its generalizability within higher education. For example, it can be tested among faculty members across institution types.

As discussed above, the final version of the CTIP is very limited in its scale. More research is needed to expand the instrument through additional items and subscales, which will form the second line of future research. As a complex practice, college teaching consists of many aspects. For example, effective college teaching requires intellectual excitement and interpersonal rapport (Lowman, 1984/1998). According to Lowman (1984/1998), intellectual excitement refers to the instructor's ability to explain clearly the content to students and to be a positive emotional influence on students. Interpersonal rapport refers to the instructor's skill of communicating with students in certain ways so that students become motivated in learning and enjoy the learning process (Lowman,

1984/1998). While the TSIR is more concerned with the extent to which the instructor refers to students' needs and behaviors when making course-related decisions, interpersonal rapport focuses on the emotional aspects of teacher-student interactions. Future research may develop items that form subscales to measure these aspects of college teaching.

In sum, this study provides a starting point to explore ways of measuring higher education faculty's teaching practices with regard to teacher-centered and student-centered teaching preferences.

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