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The Effect of Engineering Academics' Work Engagement on CI Triggered Professional Development

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Abstract:

This study aims to explore how engineering academics' work engagement influences the extent to which critical incidents (CI) exert effect on their professional development through the mediation of perception and critical reflection of CI. Informed by transformative theory, Structural Equation Modelling (SEM) was employed to examine the mechanism of engineering academics' work engagement contributing to the effect of CI on professional development. It was found that engineering academics' work engagement had some direct positive impact on CI triggered professional development, but the corresponding indirect positive impact was predominant, which was realized through chain mediation of CI perception and CI reflection; and the former had significant impact on the latter; CI perception and CI reflection also had their respective direct positive effect on CI triggered professional development. It is concluded that engineering academics' work engagement is a significant predictor of critical incident impact on their professional development mediated by CI perception and CI reflection.

Keywords: *engineering academics, work engagement, critical incidents, professional development.*

I. INTRODUCTION

In the era of knowledge economy, university-industry partnership has increasingly become a widely recommendable initiative in that academics, especially engineering academics, play crucial role in knowledge transfer, technology support and talents cultivation/ engineer training in a wide range of engineering industries. Throughout the evolution and development of engineering industries, academics have contributed their efforts by defining engineering management and underscoring its importance[1-2] , reviewing the challenges and problems concerning its education[3], foreseeing its future development trend[4], facilitating engineering managers' continuing professional development[5], proposing innovative development model[6] and interpreting the reconstruction process of engineering academics' identity [7]. Despite the fact that engineering academics have constantly made extraordinary contribution to the field of engineering industries both theoretically and practically, yet there is no special research on engineering academics' professional development mechanism. Kennedy [8] divided the goals of various teacher

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development models into three categories: transmissive, malleable, and transformative. The three categories of teacher development models point to teachers' professional autonomy and initiative ability moving towards a gradual increase trend, which is the most comprehensive and influential conceptualization result of all teacher development models in the world. His research has indicated the general development track and future development direction of teacher professional development in the international perspective. The internal factors influencing the faculty to become the agent of professional development have always been explored to promote autonomy and transformation of academics. It has documented that the higher the autonomy of professional development, the greater the opportunity for transformative learning [9]. For this reason, the international research orientation of faculty professional development has shifted to in-depth research with academics as the agents of learning. The professional development of academics at domestic and foreign universities has shown a trend of social participation in learning community, which is reflected in the increasing popularity of many conceptions: community of practice, community of learning, social network of teaching and learning, etc.[10]. Though diversified professional development models have emerged [11-14] to explore the effective approaches to accelerating academics' professional learning, but scant attention has been paid to the critical incidents(CI, hereafter) which engineering academics have experienced in their career development and have substantially triggered their professional development.

In the context of on-going deep reform of higher education in China, the construction of first-class universities and first-class disciplines urgently needs to absorb international advanced experience to accelerate effective professional development to foster transformative academics. The goal of it "is to open up alternatives, introduce new ways of thinking about teaching--a goal that is potentially transformative[15]". Transformative learning as the goal of academics professional development is fundamentally different from other types of learning because it is the deepest learning resulting in remarkable change in habit of mind and in view of points, which is aligned with mindset transformation required by the current in-depth mind transformation in higher education sector. As a powerful tool and technique, critical incidents have attracted wide attention in teacher education practice and theoretical exploration because of their unique contribution to the arousing and elevating of reflectivity of pre/in-service teachers.

In pedagogical context, critical incidents are incidents that occur unexpectedly and trigger radical changes in ideas, attitudes, emotions, and behaviors of teachers from different sectors and have been believed to be effective in enhancing teachers' professional development through individual and group reflection[16-22]. In recent years, it has become an effective entry point and research tool for professional development of teachers at home and abroad. However, most of them are speculative research for the improvement orientation of primary and secondary school teaching practice, but there is no empirical research on the mechanism of professional development of engineering academics in relation to critical incidents. How do engineering academics perceive the role of critical incidents in their professional development? How do they reflect on these critical incidents? What drives their perception of and reflection on critical incidents? What is the effect of the perception and reflection on the impact of critical incidents on their professional development? How do they interact with each other? To date, these

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questions remain unanswered. To answer them, this study, based on the exploratory interviews with 80 Chinese engineering academics from various engineering disciplines of 20 universities of science and engineering in China about their real experiences of critical incidents, developed the scales of CI perception, CI reflection, and CI impact on professional development to explore the mechanism of engineering academics' work engagement on CI triggered professional development, and empirical tests were conducted on the model before implications for engineering academics' professional development were offered.

II. CONCEPTUAL MODEL

Transformative learning is stimulated by critical incidents, which include a single event or a series of events that bring a greater emotional impact to adults. These events drive adults to reflect on the assumptions they take for granted, which not only triggers a change in the knowledge system, but also triggers a change in the deep-rooted belief system such as world outlook, outlook on life, and value system[5].

Transformative learning usually involves the following four processes: first, seeking evidence to maintain one's existing perspectives; second, experiencing critical incidents or participating in social activities to recognize the limitations of existing views of points; then transforming perspectives through arguments with others and critical reflection; and finally take action to change the habit of mind[23-24]. According to Mezirow[25], people interpret experience in three ways of reflection: content reflection, process reflection and premise reflection. Content reflection is the examination of the "what" of a problem. Process reflection concerns the "how" of the problem, namely, the rethinking of the way people solve problems to see whether there is something wrong with the way people think about it. Premise reflection is the questioning of the problem itself, which is about the "why" aspects of the problem. "It is premise reflection that has the potential to lead to transformation of our meaning perspectives. Critical self-reflection on teaching and education can be a starting point for continuing, self-directed professional development[26]." "Transformative learning takes place when this process leads people to open up their frame of reference, discard a habit of mind, see alternatives, and thereby act differently in the world[27] ."

According to transformative learning theory, critical incidents are the triggers for engineering academics to change their views and actions through discourse and critical self-reflection. Discourse with others deepens the understanding of these incidents. The deepening of the knowledge of critical incidents will naturally lead engineering academics to make conscious critical reflection. Some researcher has pointed out that whether an educational and teaching event can become a critical incident to promote the professional development of teachers is not determined by the nature of the event itself, but depends on the emotion, attitude, experience and cognitive structure of teachers[22]. In fact, through exploratory interviews with academics, we found that academics' perceptions of critical incidents present significant individual differences. So, what are the key factors that affect academics' perception of critical incidents? The results of our exploratory interviews show that for dedicated teachers, critical incidents occur from time to time, and these incidents trigger strong emotional fluctuations and then produce their significant changes in cognition and behavior, especially critical incidents of negative results, are more likely to lead to transformative learning.

Therefore, it can be inferred that engineering academics' work engagement determines their perception of and self-reflection on critical incidents, and the impact of critical incidents on engineering academics professional development in the education and teaching process (hypothesis H4, H5, H6). For highly engaged teachers, they are sensitive to various details in the education and teaching process, and critical incidents will push them to critically reflect on teaching practice and thus change their belief system. In contrast, academics with low levels of work engagement may be accustomed to all kinds of incidents and take it for granted. Even if an unexpected incident in the classroom might instantly trigger their intense positive or negative emotions, they often fail to probe into the reasons behind the incidents and thus miss the opportunities to have critical self-reflections of and to make dialogues on critical incidents with others to promote their own professional development.

The established 17-item Utrecht Work Engagement Scales (UWES) has been widely used to measure employees' work engagement from 3 dimensions of vigour, dedication and absorption[28]. This scale has also been proved to have desirable validity with academics. Academics' work engagement denotes the effort that academics have devoted to their teaching career and the enjoyment gained from it. Some researchers have found that the level of teacher engagement can predict positive commitment and other beneficial outcomes[29-33]. These research findings on academics' work engagement provide a convincing empirical basis for this study to regard engineering academics' work engagement as a determinant of the role of critical incidents in their professional development. (hypotheses H1, H2, H3).

In view of the above, it can be inferred that the level of work engagement of academics is the internal motivation for deep learning. Critical incidents serve as the booster that prompts engineering academics to start transformative learning and also a prism that reflects their professional development landscape. The perception of and the reflection on critical incidents are the precursor of transformative learning, and the professional development of engineering academics is the result of transformative learning. To recap, this study assumes that engineering academics' work engagement directly affects their CI perception, CI reflection and CI impact on professional development; engineering academics engagement also indirectly affects CI impact on professional development through a chain of mediation between CI perception and CI reflection. The specific hypotheses are as follows:

Hypothesis 1 (H1): Engineering academics' work engagement has a positive impact on their perception of critical incidents;
Hypothesis 2 (H2): Engineering academics' work engagement has a positive impact on their reflection of critical incidents;
Hypothesis 3 (H3): Engineering academics' work engagement positively affects the effect of critical incidents on their professional development;
Hypothesis 4 (H4): Engineering academics' perception of critical incidents positively affects their reflection on critical incidents;
Hypothesis 5 (H5): Engineering academics' reflection on critical incidents positively affects the impact of critical incidents on their professional development;
Hypothesis 6 (H6): Engineering academics' perception of critical incidents positively affects the impact of critical incidents on their professional development.

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Based on the above-mentioned hypothetical relationship, a model of the interaction relationship between the variables was established as shown in Fig 1. The critical incident in the figure is abbreviated to its initials CI. In Fig 1, H1 indicates that the level of work engagement of engineering academics can predict their awareness and perception of critical incidents; H2 suggests that the level of engineering academics' work engagement also affects the depth, manner and frequency of their reflection on critical incidents; H3 is the assumption that engineering academics' work engagement can predict whether critical incidents exert the function on their professional development. H4 and H5 are chain mediation hypotheses: the level of engineering academics' work engagement affects the impact of critical incidents on their professional development through CI perception and CI reflection; H6 is the hypothesis that engineering academics CI perception will affect their CI impact on their professional development.

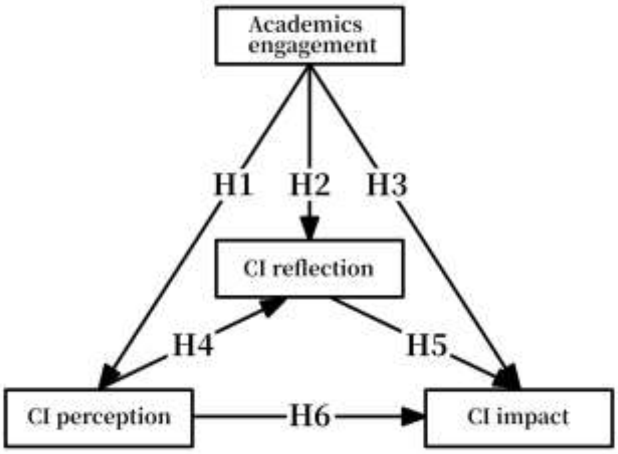

Fig 1: Conceptual model of engineering academics' work engagement on CI triggered professional development

III. MATERIALS AND METHODS

3.1 Materials

In this study, 4 latent variables are included, each of which are measured by more than 3 observable variables. According to the conceptual model of the mechanism as shown in Fig 1, the four latent variables in the figure are measured by the relevant scale of previous studies(UWES for engineering academics' work engagement)[28] and the previous interviews of this study(self-developed 3 scales: CI reflection scale, CI perception scale and CI impact scale). As a result, 5 to 9 observable variables were constructed to measure the corresponding latent variables, using Likert's 5-point scale, from "totally disagree" to " totally agree" ranging from 1 to 5 points. The questionnaire composed of four scales has a total of 25 items, including 2 inverse questions, which are the 7th and 14th items of the questionnaire. According to the pilot test result, the questionnaire was revised meticulously to improve the clarity and comprehensibility of language expression, and finally a formal questionnaire was formulated. The questionnaire was developed into an online questionnaire through the widely-recognized questionnaire star platform, and the

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questionnaire star distribution settings were utilized to set the questionnaire distribution as non-public, demanding the identity verification of the respondents to ensure that the questionnaire items were responded by the target population of this study. The questionnaire was distributed by sending a link to the questionnaire to engineering academics of public universities of science and technology across China through emails, QQ groups and Wechat groups. After a month, 582 responses were received one after another. After all the electronic questionnaires were retrieved, first, based on the detailed personal information of the respondents, the 19 responses from teachers of higher vocational colleges and independent undergraduate colleges that did not belong to the scope of this study were deleted; 13 responses including obvious contradictions or many omissions were removed. After deleting the invalid copies, finally 550 valid ones were counted, and the effective rate of recovery was 94.50%. Finally, the 550 serially numbered questionnaires were randomly split into two 275 copies according to odd or even numbers, and exploratory factor analysis and confirmatory factor analysis were conducted in turn.

3.2 Methods

3.2.1 Item Analysis

The purpose of item analysis in the questionnaire is to remove the question items that do not have a significant degree of discrimination so as to improve the discrimination of the questionnaire items. Using SPSS24 statistical software, we first calculate the sum of the scores of all questions in each valid questionnaire and then arrange these scores in descending order and ascending order respectively. After calculating the critical point at 27%, 2 scores were got. According to these 2 scores, the data above the critical scores were taken respectively and accordingly the high and low groups were obtained, then the independent sample t test was used to see whether there is a significant difference between the high and low groups. The independent sample T test results show that all the 25 questionnaire items in this study passed the test, indicating that the questionnaire has an ideal degree of discrimination.

3.2.2 Reliability Test

The purpose of the reliability test is to examine the consistency and stability of the questionnaire items, generally by using the Cronbach's alpha coefficient test. In the field of social sciences, it is generally believed that if the reliability coefficient of the whole scale is greater than 0.80, then it is regarded as good, and the range between 0.70 and 0.80 is acceptable. After the reliability test of the questionnaire, the reliability of the questionnaire increased after the deletion of questions 1 and 14, so these 2 items were deleted, and the questionnaire items were reduced to 23 items. It consists of four sub-scales: perception of critical incidents, reflection on critical incidents, impact of critical incidents on engineering academics professional development and engineering academics engagement. By running SPSS24, first the total reliability coefficient of the questionnaire was calculated, and then the reliability coefficients of the 4 sub-scales respectively. The results can be seen in Table I. The reliability coefficients of the four sub-scales (perception of critical incidents, reflection of critical incidents, the effect of critical incidents on professional development and engineering academics engagement) are 0.708, 0.730, 0.836, 0.895 respectively and each of them are bigger than 0.70 with the reliability coefficient of the total scale being 0.893, which is far bigger than 0.8, which is acceptable minimum value. The reliability test results show that the reliability of the sub-scale is relatively ideal, and the reliability of the total scale is very ideal.

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TABLE I: The total reliability of the questionnaire and the reliability of the sub-scales

Variable types	*Variable names*	**Reliability coefficient**	*Number of items*
	CI perception	0.708	4
exogenous latent variable	CI reflection	0.730	5
	CI impact	0.836	5
Endogenous latent variable	Academics engagement	0.895	9
Overall reliability		0.893	23

3.2.3 Exploratory Factor Analysis

SPSS24 software was used to perform KMO measurement and Bartlett's sphere test on 23 questionnaire items. The running results show that the KMO coefficient is 0.87, and the Bartlett's sphere test significance P value is less than 0.001, indicating that the sample data is suitable for factor analysis. After the maximum variance was rotated, a total of 4 common factors with eigenvalues bigger than 1 were extracted, the factor cross load is less than 0.4, and the load of each factor is higher than 0.5, but the cumulative explanatory rate of the four common factors is 56.19%, which is not ideal. Therefore, according to the factor loading of the item, it is necessary to delete the lowest factor load items step by step. After deleting 7 questionnaire items step by step, SPSS24 software was run again, after the maximum variance method was rotated, the KMO value is 0.86, and the Bartlett sphere test significance P value is 0.000, less than 0.001, just like the one in the first time, 4 common factors with feature values bigger than 1 were extracted, named academics engagement, CI perception, CI Reflection, and CI impact, which are completely consistent with the concepts in the conceptual model. The interpretation rate increased to 62.88%, the minimum load was 0.50, and the factor structure was clearer and more reasonable after the items were deleted. All data converged after 6 iterations, indicating that the questionnaire has good convergence validity.

IV. RESULTS

4.1 Model fit

LISREL 8.8 was used to perform confirmatory factor analysis and structural equation modelling on the data to obtain the regression path coefficients of the structure model as shown in Fig 2. From the path coefficients of the structural equation model, it can be seen that: (1) engineering academics' work engagement has a very significant direct predictive effect on CI perception (0.34***) and CI reflection (0.34***) with a significant direct predictive effect on CI impact on professional development (0.14*). At the same time, engineering academics' perception of CI (0.34***) and reflection on CI (0.55***) have a very significant predictive effect on CI impact on professional development; (2) CI perception, CI reflection of engineering academics respectively plays a partial mediating role between engineering academics' work engagement and CI impact on professional development. The mediating effect of CI perception and CI reflection respectively is 0.34×0.34=0.12 and 0.34×0.18×0.55+0.34×0.55=0.22; (3) The total effect of engineering academics' work engagement on CI impact on professional development is 0.48, of which, the direct effect is 0.14, accounting for 29% of the total effect, and the mediation effect is 0.12+0.22=0.34, accounting for 71% of the total effect. It can be seen that engineering academics' work

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engagement has a direct positive effect on CI impact on professional development, but more significantly, it acts on it through the chain mediation of CI perception and CI reflection.

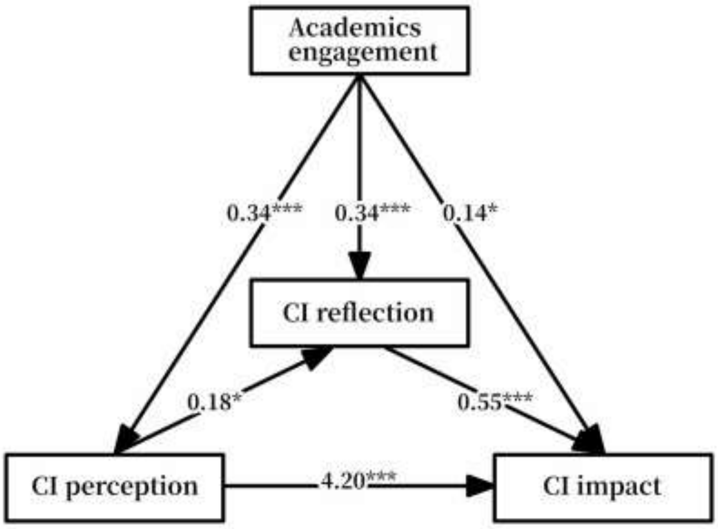

Fig 2: Structure model of engineering academics' work engagement on CI triggered professional development

4.2 Model Evaluation

According to the output results of goodness of fit, the results of evaluating the goodness of fit of the conceptual model of this study are shown in Table II:

TABLE II: Fit results of SEM for the role of engineering academics' work engagement on CI triggered professional development

Fit indicators	Ideal fit criteria	Degree of fit	Test result
X^2/df	<3	1.78	Excellent
GFI	>0.9	0.93	Excellent
AGFI	>0.9	0.90	Good
NFI	>0.9	0.95	Excellent
NNFI	>0.9	0.97	Excellent
CFI	>0.9	0.97	Excellent
RMR	<0.05	0.04	Excellent
RMSEA	<0.05	0.05	Good

It can be seen from Table II that the ratio of chi-square to degrees of freedom (X2/df) of the structural model constructed in this study is 1.78, which meets the ideal standard (less than 3); the goodness of fit index GFI is 0.93, and the adjusted goodness of fit index AGFI is 0.90, respectively being greater than and reaching the ideal standard of 0.90. The comparative fit index CFI and the non-normal fit index NNFI are both 0.97, which meet the ideal standard of being higher than 0.90. The root mean square residual RMR is 0.04, which meets the ideal standard(less than 0.05) ; the root mean square error RMSEA is 0.05, which

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meets the ideal standard of 0.05. The fit indexes comprehensively show that the conceptual model has a good fit effect because it fits well with the empirical data, which indicates that the conceptual model is well-grounded.

4.3 Confirmatory Factor Analysis

By running the structural equation software LISREL8.8, the path coefficient and T value of the structural equation model are obtained (See Table III for details). According to the significance of the T value, it can be judged whether the six research hypotheses are valid or not. The test results in Table 3 show that the T values of the action paths of the six research hypotheses are all greater than 1.96, which means that the six hypotheses pass the test and all are valid. There are two hypothetical paths with a significance level of 0.05 and a T value greater than 1.96, namely H3 and H4 in Table 3. The significance level of the other four hypothesis paths is 0.001, and the T value is greater than 3.29, indicating that the action paths of these four hypotheses (HI, H2, H5, H6) are very significant.

TABLE III: The Structural Equation Path Coefficients and Research Hypothesis Test Result (N=275)

Research hypothesis	Action path	Standardized path coefficient	T Value	Statistical test results
H1	engagement→CI perception	0.34***	4.22	Very Significant
H2	engagement→CI reflection	0.34***	4.07	Very Significant
H3	engagement →CI impact	0.14*	2.09	Significant
H4	CI perception→CI reflection	0.18*	2.03	Significant
H5	CI reflection→CI impact	0.55***	5.96	Very Significant
H6	CI perception→CI impact	0.34***	4.20	Very Significant

Note: *p<0.05, **p<0.01, ***p<0.001

V. DISCUSSION

This study mainly examined the interaction between engineering academics' work engagement and impact of critical incidents on their professional development from the perspective of transformative learning. Though critical incidents have been universally recognized to be a useful tool for teacher education, little research has been done to reveal how critical incidents act on engineering academics' professional development. There is a gap of knowledge about the relationship between critical incidents and transformative learning, both of which are closely linked to professional development. To bridge the gap, the present study went a step further beyond the relevant literature by making an attempt to investigate the driver and the difference maker of the role of critical incidents in the course of engineering academics' professional development. Based on the exploratory interview with 80 Chinese engineering academics from different engineering disciplines and with diversified personal and academic background, it was found that work engagement was the determinant of the extent to which critical incidents make

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difference to engineering academics' professional development through the mediation of perception of and reflection on critical incidents. Perception represents academics cognition state of critical incidents, which is subjected to the influence of internal (engagement and commitment，motivation and goal orientation) and external factors (academic atmosphere, community of practice, institutional policy and regulations). In the meantime, perception change affects academics behaviour and decision making, readiness of reflection and future action course.

Part of the reason why engineering academics' work engagement can predict how critical incidents influence their professional development is that their work engagement directly affects their dedication and commitment. Engaged academics are sensitive to every single incident which happens in the course of their teaching and engineering practice and tend to take these incidents, whether positive or negative, as an opportunity to reflect on and try every means to search for satisfactory solutions to all problems they encounter. Engineering academics' work engagement has a very significant direct positive effect on the perception of and reflection on critical incidents. Our research results show that the level of engineering academics engagement directly affects their active cognition and understanding of critical incidents and directly determines whether they will actively reflect on critical incidents, and engineering academics perception of critical incidents has a significant positive predictive effect on the reflection of critical incidents. At the same time, the two have a direct positive effect on the role of critical incidents in the process of professional development. Notably, the reflection on critical incidents has a direct effect on the impact of critical incidents on professional development, the effect of which is the most significant. This is because reflection will enable academics reexamine what they do, how they do and why they do. Consequently, they might challenge their beliefs and ways of thinking towards more reasonable, more tolerable and more open-minded perspective and view of points, undergoing the four processes of transformative learning, basically the three levels of reflection: content reflection, process reflection and premise reflection[25].

VI. CONCLUSION AND IMPLICATIONS

6.1 Conclusion

This study is informed by transformative learning theory and employed Structural Equation Modelling approach to reveal the mechanism how critical incidents function as a trigger to drive engineering academics to critically reflect on their practice towards the transformation of their habits of mind and underlying beliefs. It is engineering academics' work engagement that determines their attitudes towards and perception of critical incidents. If they share their experiences, particularly "disorienting dilemmas" within their community of practice, they are more likely to expose themselves to competing perspectives to embark on the journey of transformative learning, which is characterized by critical reflection and will sustain their ongoing professional development.

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6.2 Managerial Implications

6.2.1 Enhancing engineering academics engagement

The cultivation of first-class engineering talents must rely on the dedication and work engagement of highly dedicated college and university academics. As this study indicates, engineering academics' work engagement determines whether critical incidents can play a key role in the transformation of their professional development. Therefore, development programs for engineering academics shall not only take the antecedents of work engagement seriously but also integrate with diverse engineering practice to formulate more transformative strategies to ensure the quality of higher education.

6.2.2 Utilizing critical incidents to transform professional development

The realistic way to achieve transformative professional development goal is to take a variety of critical incidents in the engineering education and industry production as training materials to awaken engineering academics' sensitivity towards them, to extensively make dialogues and exchanges between engineering academics and staff of different career stages to stimulate in-depth critical reflection on individual practice because reflection is a universally recognized effective technique to prompt professional growth and maturation.

6.3 Research Limitations

This study is of quantitative nature, though the self-developed scales are based on semi-structured exploratory interviews with 80 engineering academics all over China, so future study should incorporate qualitative method to deepen this line of empirical survey given the intricate characteristics of critical incidents. Future studies could use mixed methods to reveal the complex mechanism of critical incidents acting on academics professional development through transformative learning. Another limitation lies in the convenient sampling and limited number of population in this study. Random sampling of larger population would be recommended for further study. Longitudinal studies could be encouraged to depict how critical incidents induced transformative learning could transform the professional development of engineering academics and engineering staff at various career stages with their particular academic concerns and predicaments.

REFERENCES

[1] Lannes, W. J. (2001). What is Engineering Management? IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT, 48(1), 107-110. doi:10.1109/17.913170
[2] Omurtag, Y. B. (2009). What is Engineering Management? A New Look at an Old Question. Engineering management journal, 21(4), 3-6. doi: 10.1080/10429247.2009.11431839
[3] Daughton, W. (2017). Trends in Engineering Management Education From 2011-2015. Engineering management journal, 29(1), 55-58. doi: 10.1080/10429247.2017.1280747
[4] Winston, A. W. (2004). Engineering Management: A Personal Perspective. IEEE Transactions on Engineering Management, 51(4), 412-413. doi: 10.1109/TEM.2004.836586

[5] Collins, T. R., Berivudes, M. G., Youngblood, A. D., & Pazos, P. (2004). Professional Development Training for Engineering Managers. Engineering management journal, 16(3), 3-9. doi: 10.1080/10429247.2004.11415251

[6] Elia, G., Margherita, A., & Passiante, G. (2021). Management Engineering: A New Perspective on the Integration of Engineering and Management Knowledge. IEEE Transactions on Engineering Management, 68(3), 881-893. doi: 10.1109/TEM.2020.2992911

[7] Gardner, A., & Willey, K. (2016). Academic identity reconstruction: the transition of engineering academics to engineering education researchers. Studies in Higher Education, 43(2), 234-250. doi: 10.1080/03075079.2016.1162779

[8] Kennedy, A. (2014). Understanding continuing professional development: the need for theory to impact on policy and practice. Professional Development in Education, 40(5), 688-697. doi:10.1080/19415257.2014.955122

[9] Lloyd, M., & Davis, J. P. (2018). Beyond performativity: a pragmatic model of teacher professional learning. Professional Development in Education, 44(1), 92-106. doi:10.1080/19415257.2017.1398181

[10] ZOU, T. X. P. (2019). Community-based professional development for academics: a phenomenographic study. Studies in Higher Education, 44(11), 1975-1989.doi:10.1080/03075079.2018.1477129

[11] Appova, A., & Arbaugh, F. (2018). Teachers motivation to learn: implications for supporting professional growth. Professional Development in Education, 44(1), 10.

[12] Buechner, B., Dirkx, J., & Konvisser, Z. D., et al. (2020). From Liminality to communitas: the collective dimensions of transformative learning. Journal of Transformative Education, 18(2), 87-113.doi:10.1177/1541344619900881

[13] Caffarella, R. S., & Zinn L. F. (1999). Professional development for faculty: a conceptual framework of barriers and supports. Innovative Higher Education, 23(4), 241-254. doi:10.1023/A:1022978806131

[14] Chalmers, D., & Gardiner, D. (2015). An evaluation framework for identifying the effectiveness and impact of academic teacher development programmes. Studies in Educational Evaluation, 46, 81-91. doi:10.1016/j.stueduc.2015.02.002

[15] Cranton, P., & King, K. P. (2003). Transformative Learning as a Professional development Goal. New directions for adult and continuing education, 98: 31-38.doi:10.1002/ace.97

[16] Atai, M. R., & Nejadghanbar, H. (2016). Unpacking in-service EFL teachers' critical incidents (CIs): The case of Iran. RELC Journal, 47(1), 97–110. doi:10.1177/0033688216631177

[17] Atai, M. R., & Nejadghanbar, H. (2017). Exploring Iranian ESP teachers' subject-related critical incidents. Journal of English for Academic Purposes, 29:43–54. doi.org/10.1016/j.jeap.2017.08.0015-21.doi:10.1080/19415257.2017.1280524

[18] Farrell, T. S. C. (2008). Critical incidents in ELT initial teacher training. ELT Journal, 62(1): 3–10. doi. org/10.1093/elt/ccm072

[19] Farrell, T. S. C., & Baecher, L. (2017). Reflecting on Critical Incidents in Language Education: 40 Dilemmas for Novice TESOL Professionals, London and New York: Bloomsbury.

[20] Hall, J. M., & Townsend, S. D. C. (2017). Using critical incidents and E-portfolios to understand the emergent practice of Japanese student-teachers of English. Teaching and Teacher Education, 62:1–9. doi.org/10.1016/j. tate.2016.10.017

[21] Harrison, J. K., & Lee, R. (2011). Exploring the use of critical incident analysis and the professional learning conversation in an initial teacher education programme. Journal of education for teaching: JET, 37(2): 199-217.doi:10.1080/02607476.2011.558285

[22] Nejadghanbar, H. (2021). Using critical incidents for professional development with Iranian novice English teachers. TESOL Journal, 12(1). doi:10.1002/tesj.521

[23] Mezirow, J. (2000). Learning as transformation: critical perspectives on a theory in progress. San Francisco: Jossey-Bass.

[24] Nohl, A. (2014). Typical phases of transformative learning: A Practice-Based Model. Adult Education Quarterly, 65(1), 35-49.doi:10.1177/0741713614558582

[25] Mezirow, J. (1991). Transformative dimensions of adult learning. San Francisco: Jossey-Bass.

[26] Cranton, P. (2016). Understanding and promoting transformative learning: a guide to theory and practice. 3rd ed. Sterling, Virginia: Stylus Publishing, LLC.

[27] Mezirow, J., & Associates. (2002). Learning as transformation. San Francisco, CA: JosseyBass.

[28] Schaufeli, W. B., Salanova, M., González-Romá, V., & Bakker, A. B. (2002). The measurement of engagement and burnout: a two sample confirmatory factor analytic approach. Journal of Happiness Studies, 3(1), 71-92.doi:10.1023/A:1015630930326

[29] Bakker, A. B., & Bal, M. P. (2010). Weekly Work Engagement and Performance: A Study among Starting Teachers. Journal of Occupational and Organizational Psychology, 83 (1): 189-206. doi:10.1348/096317909X402596

[30] Bermejo-Toro, L., Prieto-Ursúa, M., & Hernández, V. (2015). Towards a Model of Teacher Well Being: Personal and Job Resources Involved in Teacher Burnout and Engagement. Educational Psychology, 36 (3), 481–501.doi:10.1080/01443410.2015.1005006

[31] Fiorilli, C., Buonomo, I., & Romano, L., et al. (2020). Teacher Confidence in Professional Training: The Predictive Roles of Engagement and Burnout. Sustainability, 12(16), 6345. doi:10.3390/su12166345

[32] Yin, H., Wang, W., & Han, J. (2016). Chinese Undergraduates' Perceptions of Teaching Quality, Approaches to Studying and Course Satisfaction. Higher Education, 71(1), 1-19. doi: 10.1007/s10734-015-9887-5.

[33] Han, J., Yin, H., Wang, W. (2016). The effect of tertiary teachers' goal orientations for teaching on their commitment: the mediating role of teacher engagement. Educational psychology, 36(3), 526-547. doi:10.1080/01443410.2015.1044943