Kidney Medicine

Faculty Use of Active Learning in Postgraduate Nephrology Education: A Mixed-Methods Study

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Background: Active learning is an effective instructional tool in medical education. However, its integration by nephrology faculty remains limited despite residents' declining interest in nephrology.

Study Design: A sequential explanatory mixed-methods study design was used to explore nephrology faculty understanding of difficult teaching topics and active learning integration using the theory of planned behavior as theoretical framework.

Setting & Participants: Nephrology faculty at 6 residency sites in Singapore were recruited.

Methodology: A 28-item questionnaire was administered to conveniently sampled faculty followed by 1-to-1 semi-structured interviews of a purposively sampled subset.

Analytical Approach: Quantitative data were analyzed using descriptive and regression statistics. Qualitative data were analyzed using thematic analysis in line with the theory of planned behavior constructs (attitude, subjective norm, perceived behavioral control, intention, and behavior).

Results: 49 of 82 invited faculty responded, with 49% and 42% perceiving self-directed learning and interactive lectures, respectively, as active learning formats. Fluid, electrolyte, and acid-base disturbances; transplantation immunology; glomerulonephritis; and hemodialysis adequacy were cited as difficult topics by 75%, 63%, 45%, and 31% of responders, respectively. Only 55% reported integrating active learning formats when teaching difficult topics. Faculty in leadership roles and teaching difficult topics more regularly were more likely to adopt active learning formats. Multivariable logistic regression analysis showed that faculty attitude strongly and significantly predicted active learning intention. Thematic analysis identified 4 themes: active learning competence, barriers and challenges, environmental influence, and self-identity. Self-identity, defined as values developed from past behavior and experience, emerged as an important contributor to active learning adoption outside the theory of planned behavior framework.

Limitations: Sampling, context, and measurement biases may affect study reliability and generalizability.

Conclusions: Nephrology faculty lack active learning competence and face cognitive challenges when teaching difficult topics. Faculty teaching experience significantly influenced active learning adoption. Our findings build on the theoretical understanding of faculty instructional innovation adoption and can inform nephrology faculty development initiatives.

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Postgraduate medicine learners face learning challenges with poorly understood nephrology topics.[1,2] In a competency- and outcome-based learning environment, cognitive, procedural, and attitudinal skills mastery is essential for learners to effectively solve real-world and high-order complex tasks, as well as pursue life-long learning.[3]

Editorial, p. 83

A number of studies indicate nephrology faculty preference for teacher-centered rather than learner-centered learning models when teaching these topics despite a large body of evidence suggesting an increasing sense of nephrophobia (ie, low renal residency elective uptake, declining interest in nephrology fellowship, and lower fellow progress test scores).[2,4,5] This is particularly so in Singapore, where despite adoption of Accreditation Council for Graduate Medical Education International (ACGME-I) in residency medical education in 2010, entrenched teacher-centered learning styles leave learners unprepared for learner-centered learning.[6,7]

During the past decade, there has been a rising clarion call from postgraduate nephrology education circles, including the American Society of Nephrology, for adoption of remediating instructional innovations based on active learning formats.[2,8-14] Active learning can be defined as an andragogical construct encompassing behavioral, cognitive, and social dimensions geared toward life-long, self-directed, reflective, and collaborative learning and real-life problem solving.[15,16] It is exemplified by techniques such as team-based and problem-based learning and interactive case-based lectures. It is well grounded in modern constructivist adult learning theories.[17] At least 2 previous studies from Infectious Disease and Emergency Medicine specialties suggest that implementation of an active learning andragogy correlates well with successful recruitment and retention of learners and improvement in their learning.[18,19]

However, there is a paucity of data from nephrology education research on factors that hinder or facilitate faculty adoption of active learning. We therefore sought to explore nephrology faculty understanding of active learning and difficult nephrology teaching topics and active learning

adoption using the theory of planned behavior as a theoretical framework.[20] This theory postulates that an individual's intention is the most proximal determinant of behavior and mediates the effect of 3 sets of belief-based constructs: attitude, subjective norm, and perceived behavioral control. Attitude relates to faculty belief in active learning ease of use, compatibility, and effectiveness. Subjective norm denotes faculty social and professional network influence and values. Perceived behavioral control describes faculty willingness to adopt active learning based on self-efficacy, available resources, and facilitating conditions. A major strength of this theory is that it is a well-validated framework for exploring instructional innovation adoption in a number of educational contexts.[21-24]

METHODS

Study Design

This mixed-methods study used a sequential explanatory design consisting of a quantitative phase followed by a qualitative phase.[25] Figure 1 illustrates the study design, recruitment, and data analysis process. Theory of planned behavior constructs were used to inform the formulation of 4 research questions: (1) What are nephrology faculty perceptions of active learning? (2) What are nephrology faculty perceptions of difficult nephrology topics? (3) How do theory of planned behavior constructs relate to the degree of faculty use of active learning to teach residents difficult nephrology topics? (4) What are the barriers and enablers to active learning adoption?

We first sought to gain a general understanding of the range of nephrology faculty beliefs, attitudes, and intention toward active learning through a survey. This was followed by 1-to-1 semi-structured interviews of selected faculty to obtain a deeper, richer, and more meaningful understanding of the survey findings. The study was approved by our Institutional Review Board (approval number 2017/00733).

Participants

The target study participants were nephrologists (senior consultants, consultants, and associate consultants) involved in nephrology curriculum design, teaching, and assessment at a postgraduate level as either program directors, associate program directors, core faculty members, or faculty members at Singapore's 6 teaching government hospitals affiliated with the 3 ACGME-I renal residency programs. Faculty are generally involved in teaching at the bedside and during ambulatory longitudinal clinics as part of their generic day-to-day clinical and supervisory duties, but not necessarily in teaching difficult topics based on ACGME-I core curriculum using innovative active learning methods. A Singapore Society of Nephrology registry had indicated 82 active and eligible faculty at these sites.

Data Collection and Analysis

Quantitative

Participants were targeted through a convenient sampling approach. Anonymous paper survey forms with a presumed consent clause were sent to departmental secretaries for distribution. The survey instrument was composed of 3 sections (Item S1): (1) demographic items, (2) open-ended questions on faculty understanding of active learning and difficult nephrology topics and involvement in teaching these topics, and (3) 28 Likert-like items scaled from 1 to 5 (ie, 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly disagree). The instrument was adapted with permission from a validated theory of planned behavior instrument.[24] It was pilot tested for clarity and comprehensibility. The revised items'

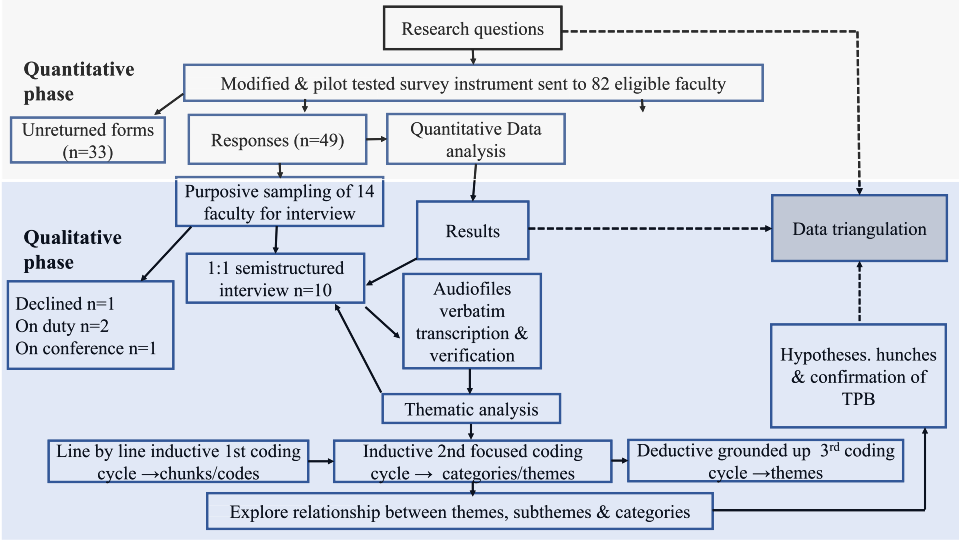

Figure 1. Depiction of study design, sampling, quantitative, and qualitative hybrid inductive-deductive thematic analysis process.

internal consistency was also assessed. Cronbach α ranged from 0.86 to 0.96, implying acceptable reliability.[26] Attitude was quantified as an aggregation of 3 subconstructs: active learning ease of use, compatibility, and usefulness.

Collected data were categorized and analyzed using descriptive statistics from SPSS, version 24 (SPSS Inc). The 4 research questions guided the direction of data analysis. Results were expressed as percentage for categorical demographic variables and open-ended questions and median and interquartile range (IQR) for continuous variables. Survey scores were reported as either aggregated percentage of "agree" and "strongly agree" scores or median and IQR of summed up scores for a given set of items in a particular theory of planned behavior construct.[27] The former approach allowed univariate analysis to be performed to identify demographic factors associated with active learning adoption. The latter approach permitted conduction of linear regression modeling to examine how multiple predictors or explanatory variables relate to and interact with the theoretical constructs' dependent variables.

Qualitative

The qualitative phase involved use of a multiple case study paradigm to help explain the significant findings from the quantitative phase. An open-ended interview guide was developed based on review of survey data (Item S2). This was pilot tested to allow revision and clarification of language and improvement in content capture. The interview guide was further modified as more interviews were conducted and new information that needed clarification emerged. Interviewees were recruited using a purposive sampling approach. We studied the survey data and chose faculty with differing viewpoints, perceptions, and experiences in an effort to ensure an adequate spectrum of representation for thematic analysis. Informed consent was signed at the time of interview.

Interviews lasting 30 to 45 minutes were conducted at the designated faculty workplace by C.R., who has domain-specific knowledge in both nephrology and qualitative research. Field notes were also collected. All audiofiles were transcribed by an independent third-party transcriber. Transcripts were checked for accuracy and clarity and had field notes and clarification questions added when deemed appropriate. Transcripts were e-mailed to participants for respondent validation of authenticity. Participants were compensated $36 for their time.

Qualitative data were coded manually by 2 independent coders trained in qualitative research (C.R. and S.S.) using an iterative 3-cycle hybrid inductive-deductive thematic analysis approach (Fig 1).[28] Half the transcripts were read line by line in a primary inductive open coding cycle to identify the chunks, phrases, and patterns. This was followed by a more detailed secondary inductive axial coding cycle to categorize them into subthemes. The scripts were then subjected to a third and final cycle of deductive coding using emerged subthemes to identify major themes. The remaining 50% of transcripts were coded by a deductive approach using subthemes and themes established from the initial 50%. The 2 coders met on 3 occasions to review coded scripts. Differences in interpretation, analysis, and choice of themes and subthemes were negotiated verbally by consensus to improve interrater reliability. Thematic saturation was defined as no further identification of new themes or subthemes in an interview, allowing for discontinuation of further data collection and analysis.[29] This was achieved on the 10th interview. Themes and subthemes were reported in the text along with corresponding theory of planned behavior constructs, research questions, and supporting quotes. Analyzed and coded data were also sent to interviewees for member checking of our interpretative claims.

Table 1. Participants' Demographic Characteristics

Variable	Value
Age, y	39 (10)
Age category	
>50 y	7 (14%)
41-50 y	15 (31%)
31-40 y	27 (55%)
Men	28 (57%)
Ethnicity	
Chinese	37 (76%)
Indian	9 (18%)
Non-Asian	3 (6%)
Teaching experience > 5 y	26 (53%)
Clinical role	
Senior consultant	15 (31%)
Consultant	22 (45%)
Associate consultant	12 (24%)
Academic role	
Program director	3 (6%)
Associate program director	3 (6%)
Core faculty	11 (22%)
Faculty member	32 (66%)
Practice location	
Sponsoring institution	30 (61%)
Other restructured hospitals	19 (39%)

Note: n = 49. Values for categorical variables are given as actual numbers (percentages); values for continuous variables, as median (interquartile range).

RESULTS

Of the 82 faculty, 49 (60%) returned completed survey forms. Table 1 summarizes the sample demographic characteristics.

Regarding the first research question, "What are nephrology faculty perceptions of active learning?," self-directed learning and interactive lectures were the 2 most commonly cited active learning formats (Table 2). Two responders had never heard of active learning, whereas none offered reflective learning as an example (see Item S3 for definitions of these active learning formats).

Table 2. Faculty Description and Understanding of Active Learning and Difficult Topics

Format or Topic	Response
Active learning formats	
Self-directed learning	24 (49%)
Interactive lectures	21 (42%)
Learner's active participation	8 (16%)
Case-based learning	3 (6%)
Problem-based learning	3 (6%)
Engaging learners	5 (10%)
Flipped classroom	3 (6%)
Apprenticeship	2 (4%)
Group discussion	5 (10%)
Authentic learning	1 (2%)
Reflective learning	0 (0%)
Do not know	2 (4%)
Difficult nephrology topics	
Transplantation immunology	31 (63%)
Fluid, electrolyte, and acid-base disorders	37 (75%)
Glomerulonephritis	23 (47%)
Hemodialysis adequacy	15 (31%)
Genetic disease	7 (14%)
Onconephrology	1 (2%)
Obstetric nephrology	2 (4%)
Ethics in nephrology	2 (4%)
Kidney stones	2 (4%)
Research	1 (2%)
Critical care nephrology	5 (10%)

Note: n = 49.

Table 3. Faculty-Aggregated Theory of Planned Behavior Construct Survey Scores

Theory of Planned Behavior Construct	Likert Scale Score
Attitude	3.75 (3.31-4.00)
Subjective norm	3.29 (3.00-3.64)
Perceived behavioral control	3.44 (2.91-3.78)
Intention	4.00 (3.67-4.00)
Behavior	4.00 (3.00-4.00)

Note: n = 49 and a score of 4-5 denotes agreement with item question in survey. Values expressed as median (interquartile range [25th-75th percentiles]).

On the second research question, "What are nephrology faculty perceptions of difficult nephrology topics?," 75% of responders cited fluid, electrolyte, and acid-base disturbances; 63%, transplantation immunology; 47%, glomerulonephritis; and 31%, hemodialysis adequacy as difficult topics (Table 2). Fifty-one percent taught any one of these difficult topics to residents as part of the core curriculum more than once a year. Only 55% said they used some form of active learning formats for that purpose.

For the third research question, "How do theory of planned behavior constructs relate to the degree of faculty use of active learning to teach residents difficult nephrology topics?," median aggregated construct scores are shown in Table 3, with higher scores indicating higher levels of support. Responders tended to agree more with item questions associated with attitude, intention, and active learning behavior constructs. They were more neutral about subjective norm and perceived behavioral control.

With regard to the fourth research question, "What are the barriers and enablers to active learning adoption?," univariate analysis showed that faculty in leadership roles and those who taught more than 1 difficult topic per year were more likely to adopt active learning: odds ratios (ORs) of 2.44 (95% confidence interval [CI], 0.93-6.41), $P = 0.04$, and 2.36 (95% CI, 1.25-4.45), $P = 0.02$, respectively (Table 4). Faculty with more than 5 years of teaching experience at the postgraduate level were also more likely to be active learning adopters, although this only trended toward significance (OR, 1.69 [95% CI, 0.92-3.11]; $P = 0.06$).

Linear regression analysis (Table 5) also demonstrated that faculty beliefs about active learning usefulness had the strongest influence on attitude (standardized $\beta = 0.56$; $P < 0.001$) and could explain 55% of the variance in attitude (adjusted $R^2 = 0.55$). Attitude also strongly and significantly influenced intention (standardized $\beta = 0.70$; $P < 0.001$; $R^2 = 0.69$), but not subjective norm or perceived behavioral control. Attitude accounted for 60% of the variance in intention. Learners' influence had a significant effect on subjective norm and could explain 54% of the variance in the model (standardized $\beta = 0.33$; $P = 0.02$; $R^2 = 0.54$). However, subjective norm was not significantly influenced by either peer or supervisor influence. Facilitating conditions but not self-efficacy had only moderate effect on perceived behavioral control (standardized $\beta = 0.42$; $P = 0.002$; $R^2 = 0.69$). Similarly, intention had moderate influence on actual active learning adoption (standardized $\beta = 0.41$; $P = 0.005$; $R^2 = 0.41$) and could explain only 27% of the variance in active learning adoption.

Ten of 14 approached survey respondents agreed to participate in the qualitative interview. Four themes emerged: active learning competence, barriers and challenges, environmental influence, and self-identity (Tables 6 and 7). Each had distinct subthemes. The 12 subthemes mirrored the theoretical belief constructs of attitude, subjective norm, and perceived behavioral control. Table 6 also shows how the themes and subthemes relate to the theoretical framework and research questions. Representative exemplar quotes are provided for illustration in Table 7.

DISCUSSION

In our study, a sequential explanatory mixed-methods design was used to answer 4 research questions that arose from gaps identified in the existing literature with regard to nephrology faculty understanding of active learning and difficult nephrology topics and how the

Table 4. Univariate Analysis of Active Learning Behavior and Demographic Factors

Demographic factor	Odds Ratio (95% CI)	*P*
Male sex	1.16 (0.70-1.92)	0.4
Chinese ethnicity	0.82 (0.65-1.21)	0.3
Senior consultant	2.06 (0.76-5.58)	0.1
>5 y teaching experience	1.69 (0.92-3.11)	0.06
Faculty working at sponsoring institution	1.29 (0.80-2.10)	0.2
PD/APD/CFM	2.44 (0.93-6.41)	0.04
Teaching difficult nephrology topics >1×/y	2.36 (1.25-4.45)	0.02

Note: n = 49.
Abbreviations: APD, associate program director; CFM, core faculty member; CI, confidence interval; PD, program director.

theory of planned behavior clarifies the extent of faculty active learning adoption in teaching these topics. We identified that nephrology faculty had a narrow and very basic understanding of active learning as an andragogical tool. This centered mostly on active learning behavioral and social dimensions as seen in self-directed learning, interactive lectures, and learners' active participation in their own learning. Faculty understanding ignored elements of active learning related to learners making meaning of their own learning experience through reflection or metacognition.[15,16] Metacognition has been cited as a key component of effective learning in nephrology education.[5]

However, our findings are in keeping with those from Calderon et al,[8] who in a survey of 220 students, residents, and nephrologists identified that 45% of faculty were unaware of innovative teaching tools that could help strengthen effective instruction of difficult topics. Furthermore, Hoenig et al,[2] in a survey of 69 kidney physiology and pathophysiology course directors across US medical schools, found that 68% relied on audience response device–mediated interactive lectures as the sole active learning format. Case-based learning, in our study, was surprisingly mentioned by only a small proportion of faculty as an active learning tool despite evidence that it promotes in a very interactive way understanding and retention of difficult learning materials both within and outside nephrology education.[9,30]

Our findings also agree with previous findings that a lack of active learning competence often translates into a low level of integration of modern theories of adult education in nephrology teaching despite a strong desire by faculty to educate learners and create interest in nephrology training for clinical and research career promotion.[14] Furthermore, they agree with the previous assertion that nephrology education lags behind the research and innovations prevalent in other specialities.[31] Interestingly, in our study, faculty reflected on these gaps and showed intention to innovate. They attributed their active learning incompetence to a lack of concrete models and real cases with which to apply these learning formats, as well as time constraints.

Faculty perception of poorly understood nephrology topics was in keeping with the published literature, which describes difficult areas as fluid, electrolyte, and acid-base disturbances; transplantation immunology; dialysis; and glomerulonephritis.[1,2,10,11] Our findings also agree with those from a survey of 100 internal medicine elective renal residents, in which ~50% believed renal topics are more difficult to comprehend than topics in other specialties due to the dense pathophysiologic concepts and learners' inability to apply these concepts in real-world situations.[32] An interesting and novel insight was that for faculty, their

Table 5. Linear Regression Models With Individual Theory of Planned Behavior Constructs as Dependent Variables

Equation	R^2 (adjusted R^2)	β (95% CI)	*t* Score	*P*
Attitude	0.65 (0.55)			
Compatibility		0.19 (−0.11 to 0.48)	1.23	0.2
Perceived usefulness		0.56 (0.28 to 0.85)	3.85	<0.001
Ease of use		0.10 (−0.17 to 0.37)	0.71	0.5
Subjective norm	0.55 (0.54)			
Student influence		0.33 (−0.078 to 0.72)	2.44	0.02
Peer influence		0.22 (−0.10 to 0.53)	1.34	0.2
Supervisor influence		0.20 (−0.19 to 0.59)	1.01	0.3
Perceived behavioral control	0.58 (0.46)			
Self-efficacy		0.22 (−0.053 to 0.49)	1.58	0.1
Facilitating conditions		0.42 (0.17 to 0.67)	3.26	0.002
Intention	0.69 (0.59)			
Attitude		0.70 (0.41 to 0.96)	4.86	<0.001
Subjective norm		0.24 (−0.02 to 0.49)	1.80	0.08
Perceived behavioral control		−0.03 (−0.32 to 0.26)	−0.22	0.8
Behavior	0.41 (0.27)			
Intention		0.41 (0.14 to 0.69)	2.97	0.005

Note: n = 49. The 95% CIs for standardized β coefficient and adjusted R^2 are shown in parentheses. Demographic factors are not shown.
Abbreviation: CI, confidence interval.

Table 6. Summary of Themes and Subthemes as They Relate to Theoretical Constructs and Research Questions

Subtheme	Theory of Planned Behavior Construct	Research Question
Active learning competence		
Understanding of active learning	Perceived behavioral control	RQ1
Understanding of difficult topics	Perceived behavioral control	RQ2
Ease of use and complexity	Attitude	RQ1/RQ4
Faculty development	Perceived behavioral control	RQ3
Barriers and challenges		
Time	Perceived behavioral control	RQ4
Key performance index	Perceived behavioral control	RQ4
Collaboration	Perceived behavioral control	RQ4
Resources	Perceived behavioral control	RQ4
Compatibility	Attitude	RQ4
Environmental influences		
Resident expectations/feedback	Subjective norm	RQ4
Peer influence	Subjective norm	RQ4
Supervisor influence/institutional culture	Subjective norm	RQ4
Self-identity		
Perceived usefulness	Attitude	RQ3
Relative advantage	Attitude	RQ3
Learning tradition	Intention	RQ3
Personal experience	Subjective norm	RQ3

Note: RQ1: What are nephrology faculty perceptions of active learning? RQ2: What are nephrology faculty perceptions of difficult nephrology topics? RQ3: How do theory of planned behavior constructs relate to the degree of faculty use of active learning to teach residents difficult nephrology topics? RQ4: What are the barriers and enablers to active learning adoption?
Abbreviation: RQ, research question.

own personal learning experience and journey in nephrology help shape their understanding and their teaching style for these difficult topics.

With regard to faculty active learning adoption, we showed that despite 59% of faculty teaching difficult topics on a regular basis as core curriculum, only 55% actually use active learning as a teaching format. This rate is surprising given the high scores given for intention and attitude for active learning and the larger influence of attitude on intention in the survey. A likely explanation for

Table 7. Representative Quotations for Each Theme

Theme	Quotations
Active learning competence	"Actually, the first time I heard of active learning was during the survey. I interpret it learning from the learner rather than just delivering a lecture." -Interviewee #0006 "Faculty who practice active learning methods tend to teach more. They are innately more passionate about teaching, take an active interest in critically assessing the effectiveness of their teaching and proactively attend faculty development programs to better their skills. Such behavior may then very well drive a positive cycle in whom the best teachers get better." -Interviewee # 0005
Barriers and challenges	"I don't find myself practicing reflective learning that often. I don't think we really have the luxury to allow someone to sit down there, recollect, think about their own learning, come back with more questions again." -Interviewee #0009 "It cannot just be case-based scenarios and residents' basics are shaky and the content is not there for learners to apply. I personally would probably find it difficult to do active learning as the only learning method even if mandated by my boss." -Interview #0010
Environmental influences	"There will be people who would approve of active learning but whether they buy into the concept and then do it themselves might be questionable. In our own undergraduate program, we are very much team-based learning focused and therefore I am very kind of for active learning." -Interviewee #0003 "I deal with learners with different backgrounds, so actually not all respond to active leaning techniques and methods. Some are more traditional and prefer the traditional way of teaching." -Interviewee #0002
Self-identity	"Renal medicine was very poorly taught during my undergraduate and subsequently during my internal medicine training. Most of the teaching was in the form of didactic teaching by physicians and there was no active learning. Most of us found anything to do with renal medicine rather traumatic." -Interviewee # 0004 "So when we try to teach certain topic, a concept, I make it quite clear that I myself understand the flow of the thought process and if I am not able to explain certain things myself to myself then you will expect that the learner will be equally confused as well." -Interviewer #0009

this is that although faculty may have the right attitude and the intention for active learning, a lack of immersion and competency jeopardizes adoption.

Our findings are fairly novel because there is no existing comparative literature on nephrology faculty active learning adoption. They reflect the paucity of data for nephrology educational research on active learning practices. Nonetheless, educational research outside nephrology offers a mixed perspective. Ajjan and Hartshorne[24] asserted that faculty in general have little intention of adopting instructional innovation. Contrastingly, the quantitative study by Demir[21] on primary school teacher intention to use the internet for professional development and the mixed-methods study by Sadaf and Johnson[22] on enrolled teachers' integration of digital literacy into classroom practice showed that the majority of faculty are receptive to instructional innovation.

Last, our findings identified significant enablers and barriers to active learning adoption. We found that faculty teaching experience, leadership role, exposure to teaching difficult topics, and attitude toward active learning affect its adoption. It is possible that faculty who teach more, are more senior, and are in the leadership are more likely to understand difficult topics, have undergone active learning faculty development, and have a larger pool of cases and therefore more confidence in integrating active learning formats such as case-based learning. Another key enabler was faculty attitude, which was found to be mainly driven by faculty-perceived usefulness of active learning. This is again surprising because most faculty in the qualitative component of the study thought that active learning is a useful tool for teaching problem solving but not for covering content and the basics. In addition, interview data suggest that learners' expectations, time, and faculty previous learning experience and behavior also enable active learning adoption despite failure of regression data to show subjective norm and perceived behavioral control as significant predictors of intention. Supporting data can be found outside of nephrology. Theory of planned behavior–based education research demonstrates that faculty attitude, but not subjective norm, predicts intention.[21-24,33]

Identification of self-identity as an influencing factor in active learning adoption was surprising given that it is not one of the theoretical constructs.[20] However, it merges with a growing body of evidence that self-identity predicts and influences intention independent of attitude, subjective norm, and perceived behavioral control.[34,35] Self-identify can be described as an enduring aspect of one's own perspective of and the meaning and values one develops toward fulfilling a behavior based on socially defined influences and past experience.[34] It is possible that faculty who identify with teacher-centered learning methods find it more difficult to change their style and thus may lack the motivation or time to develop new active learning teaching materials.

Our findings have implications for nephrology instructional practice. They can inform faculty development initiatives on wider active learning skills integration. The focus of such initiatives can be on developing faculty self-efficacy in the materials they teach and instructional formats they use. Faculty also need to know their subjects well because those who are less able to comprehend topics they teach are more likely to shun active learning formats, thus undermining the quality of the teaching and generating more nephrophobia.

Our findings also emphasize the need for facilitating conditions such as adequate time to prepare and teach the materials when using active learning formats. They also reinforce the pivotal role of engaging learners with the right aptitude, cognitive construct, and willingness to learn in an active learning format as partners in its adoption. However, addressing these factors alone may not be sufficient to significantly affect faculty active learning intention and behavior. Faculty need to develop the right attitude themselves, which, as we found, is the most significant influencer of intention.

Our study has strengths and limitations. The strengths are that steps were taken to minimize threats to study reliability. Credibility was encouraged through member checking and having accurate data collection based on a validated survey instrument and sound theoretical framework. Transferability was maintained by contextualizing our study to one on postgraduate learners in an outcome-based learning setting. Thick description of the methods was provided so that the study can be replicated in other contexts. Consistency was maintained through transcription verification and having 2 independent coders.

Limitations relate to sampling, instrument item wording, measurement, and researcher biases. Forty percent of eligible faculty did not participate in the study. Faculty older than 50 years were underrepresented, hence limiting the valuable perspectives of more seasoned members. We also limited ourselves to studying nephrologists in Singapore, rendering our conclusions less generalizable. We did not specifically ascertain whether participants had received formal training in active learning, which could have confounded some of our findings. Our survey instrument was adapted from an instrument designed for a tertiary nonmedical education setting with all its cultural and contextual limitations.[24]

A sample size of 49 seems to fall short of the power required to ensure a reasonable chance of preventing bias in predictive multiple regression statistics. However, based on the rules of thumb that can be used as a surrogate to power analysis, this number falls close to the required 50-plus number of independent variables for multiple correlation to exert minimal bias.[36,37]

In sum, nephrology faculty in an outcome-based setting harbor attitudinal and cognitive insecurities about active learning and poorly understood nephrology topics and thus have less intention in adopting active learning formats when teaching residents despite ample evidence on its efficacy and

increasing nephrophobia. These findings make significant contributions to our theoretical understanding of faculty instructional innovation adoption through the lens of the theory of planned behavior. They also build on our theoretical understanding of self-identity as an important contributor to instructional innovation adoption. They can therefore inform future faculty development recommendations, instructional transformation, and design-based research in postgraduate nephrology education.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

Item S1: Survey form.

Item S2: Open-ended interview guide for qualitative phase of study.

Item S3: Definitions of active learning and medical education theory terms.

ARTICLE INFORMATION

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