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From discourse to action. How Engineering university teachers in Chile develop professionally and transfer their learning into practice

Abstract

Pedagogical training is widely regarded as an important tool in academic development and a fundamental element for improving teaching quality. Yet little evidence exists of the real impact that such training has in further developing teachers' teaching conceptions and practices, improving students' learning and in changing the institution's learning culture in Latin-American universities. The Faculties of Engineering of the Universidad Católica del Norte (UCN) in Chile have developed a new curricular model and, respectively, a training program aiming to support academics in its implementation. This article presents part of the outcomes of research aimed at examining teachers' motivation towards training, the training's impact on changed conceptions and practices and its transfer potential. Results show that teachers are highly motivated, but no fundamental changes in teachers' approaches to teaching take place after the program. Challenges to transfer are encountered in the teachers' individual capacity to transfer and in the institutional recognition.

Keywords

Engineering education, university teachers, transfer of training, impact, academic development, Chile

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1 Introduction

Academic development (AD) is regarded as a wide repertoire of formal and informal academic activities focused mainly on training academics to be teachers. Simply defined, its aim is to foster teaching practice in order to secure effective student learning. AD centers from universities world-wide are concerned with designing and implementing teachers' training programs, and evidencing, from a scientific point of view, the assessment of their efficacy; i.e. the extent to which their participants have acquired the necessary teaching competencies and transfer them into the classroom to improve students' learning. Assessment of the impact of training is seen as critically important, yet evaluation of training is typically limited to assessing trainees' satisfaction and often overlooks the process of transfer of teaching competencies into teaching practice.

Numerous studies, mainly from Anglo-Saxon and European universities, have dealt with the question of how to measure AD impact (FEIXAS et al., 2013; DE RIJDT, STES, VAN DER VLEUTEN & DOCHY, 2013; PARSONS, HILL, HOLLAND & WILLIS, 2012; STES et al., 2010; HANBURY, PROSSER & RICKINSON, 2008; POSTAREFF, LINDBLOM-YLÄNNE & NEVGI, 2007; GIBBS & COFFEY, 2004; GUSKEY, 2002; RUST, 2000). The majority have focused on assessing whether there has been conceptual development and change in: teachers' approaches to teaching (TRIGWELL & PROSSER, 1996), teaching intentions (NORTON et al., 2005), teaching practices (POSTAREFF et al., 2007), and students' learning outcomes (STES et al., 2010). In Latin-American universities, the development of such studies is still emerging (MARCHANT, cited in GONZÁLEZ, 2015). Therefore, what teachers transfer as a consequence of implementing new learning, or whether such changes have an impact on the organizational and teaching culture, still remains under-evidenced. More studies into the effects of teacher training are needed using well-designed studies with a pre-test, quasi-experimental characters or mixed-method approaches (STES et al. 2010).

To contribute to this field our research aims to evaluate the impact of AD activities developed by the Faculties of Engineering at the Universidad Católica del Norte (UCN) in the campuses located in the Region of Antofagasta and Coquimbo (Chile) by means of a mixed-method research approach with a qualitative and quantitative study. This article presents the quantitative study which focuses on changes in teachers' motivations and expectations towards training, changes in conceptions about teaching and learning experienced due to training as well as the training's transfer potential into teaching practice.

2 Impact and transfer of academic development

Literature concerning the impact and transfer of AD activities provides different models for AD evaluation (KREBER & BROOK, 2001; GUSKEY, 2002; STES, COERTJENS & VAN PETEGEM, 2010; CHALMERS, 2012; FEIXAS et al., 2013). They can be clustered within two approaches (PiNEDA-HERRERO, QUESADA-PALLARÈS, & CIRASO-CALÍ, 2014): (1) a direct evaluation approach based on the assessment of training effectiveness with a focus on results, mainly by means of KIRKPATRICK's (1998) four level, or GUSKEY's (2002) five level models; and (2) an indirect evaluation approach which covers the assessment of training effectiveness with a particular emphasis on revealing the factors involved in the training transfer process (BALDWIN & FORD, 1988; HOLTON, BATES, & RUONA, 2000).

Considering the direct evaluation approach, GUSKEY's (2002) five level model of teacher development largely reflects on methods used to review effects and identify where the impacts of development take place (CHALMERS & GARDINER, 2015). The first level considers teachers' reactions to the AD program; the second level identifies if there has been any conceptual change in teachers' thinking, their knowledge of teaching, and their attitudes and motivations. The third level examines changes in the organizational culture, practices and support (equivalent

to KIRKPATRICK's (1998) third level of transfer). The fourth level identifies behavioral changes in the way teachers use the newly acquired knowledge, skills and techniques in their teaching practices. Other models re-arrange level 3 and 4, so that the participant effects can be grouped together (STES et al., 2007). The fifth level explores changes in student learning. Other elaborations emphasize changes in student engagement, perception, study approaches and responses to teaching, rather than student learning, thus the difficulty of attributing changes in student learning outcomes as a result of teacher development programs (GIBBS & COFFEY, 2004; STES et al., 2013).

Under the indirect evaluation approach, HOLTON et al. (2000) proposed a comprehensive framework for diagnosing and understanding the causal influences of human resources' intervention outcomes. The model addresses one of the biggest risks of the previous level-based models, specifically, that any failure to achieve outcomes from an intervention could be attributed to the intervention itself when it could well be due to moderating variables. The model recognizes that individuals are expected to acquire learning during training, and that this learning is expected to improve performance at both individual and organizational levels. By means of the Learning Transfer System Inventory (LTSI), they identify potential transfer variables grouped into organizational, individual and pedagogical factors.

Several theoretical reviews have also shown factors influencing the effectiveness of training programs (BLUME, FORD, BALDWIN & HUANG, 2010; DE RIJDT et al., 2013). BURKE & HUTCHINS (2008), based on BALDWIN & FORD's work (1988), offer a comprehensive review of influential variables, including pedagogical factors such as the trainer's role or training timing. A study using an adaptation of HOLTON et al (2000)'s LTSI tool in the Spanish university context (FEIXAS et al., 2013) suggested that the strongest transfer factor was the training design of AD programs whereas the weakest factor was the organization of the teacher's personal workload. Environmental factors such as support from the study program manager, peer support, or the working culture of teachers' teamwork appeared as transfer facilitators.

Despite the wide range of AD assessment models, there is no consensus on the most optimal model; thus choice of model largely depends on the research objectives and the available resources (CHALMERS, 2012). Nevertheless, these reviews coincide in proposing frameworks that include the following levels of evaluation: trainees' satisfaction, teaching conceptions and competencies, students' learning, and institutions' teaching and learning culture, and highlight the need to produce new insights into the transfer process.

3 University teachers' professional development in Chile

Higher education in Chile has undergone wide-ranging transformations as a result of historical and socio-political developments. The teacher professionalization process has been slow and did not extend to all staff of the university system until the 1980s, partly thanks to public policies of investment in research, development and training of human capital. In the 1990s a new impulse was given with the establishment of the country-wide program called Strengthening Teacher's Initial Training. This intensification was seen in the increase to almost twice the total number of teachers including full-time teachers, and in the increase of teachers with doctorates and publications in refereed journals (BERNASCONI, 2015). Several initiatives have been implemented to strengthen teaching quality, one of the most important being the creation of AD centers between 2005 and 2010 from the Improvement of Quality and Equity in Higher Education funding program (MECESUP: Programa de Mejoramiento de la Calidad y la Equidad de la Educación Superior).

Despite advancements, a focus on students' learning quality is still emerging (BERNASCONI, 2007, 2015). Teachers do not need accredited teaching experience or professional development to work at Chilean universities. Most AD units offer counseling and coaching to novice teachers and non-mandatory

pedagogical training about teaching competencies which is centralized and non-disciplinary bounded.

Due to the relatively recent creation of AD centers, there had not been many possibilities for systematic evaluations. Some exceptions are the review at Universidad Católica de Temuco (CHALMERS, 2015), the doctoral dissertation by Marchant (cited in BERNASCONI, 2015) which examines the function and impact of the University of Santiago's AD center, and the doctoral study reported here.

3.1 Empirical settings: the training program at the Faculties of Engineering at Universidad Católica del Norte (UCN)

One of the fundamental political mandates of the Faculties of Engineering at UCN is to continuously improve engineers' professional development training. Despite notorious incremental improvements in indicators related to teacher professionalism and innovation of teaching methods, which have led to improvement in students' outcomes in terms of retention and employability, there is a significant gap between expected and achieved results. Within this framework an innovation project emerged involving a total of 3,669 students and 123 scholars with the purpose of reinventing the curriculum of UCN engineering teachers by means of establishing a new curricular structure based on CRAWLEY's (2015) CDIO (Conceive-Design-Implement-Operate) approach (UCN PMI Project, 1204).

The 36-month AD program organized in the Faculties of Engineering and Geological Sciences, Faculty of Engineering and Construction, Faculty of Science, and School of Risk Prevention and Environment located in the university campuses of Antofagasta and Coquimbo at UCN in 2013 is part of a wider institutional improvement plan (PMI) named "Reinventing the UCN Engineering", included within a Performance Agreement UCN 1204 in the area of curriculum harmonization.

The Teaching Unit for Innovation of Engineering (UIDIN) is responsible for implementing the program to strengthen the quality of the teaching and learning process for engineering students, by supporting the professionalization of teacher's

teaching competencies. The teachers' training program is designed based on the "Dictionary of teaching competences", a tool to diagnose participants' training needs. Content-wise, it addresses common core topics such as course planning, active methodologies, student assessment, and use of ICT to support teaching from a competence-based, reflective and practice-oriented perspective. Teachers enroll in single modules or training activities of 5 to 30 hours duration. Teaching modalities include workshops of a theoretical-practical nature, some of them with follow-up sessions and a strong focus on transfer.

4 Methodology

The objectives of the research are: (1) to analyze the motivations and expectations of university teachers participating in the training program of the Faculties of Engineering at UCN; (2) to analyze the changes in conceptions and teaching approaches experienced by teachers participating in teacher training; and (3) to identify the factors that determine their learning transfer into teaching practice, and their relationship with teaching approaches. Our theoretical model is based on the impact evaluation models of KIRKPATRICK (1998), GUSKEY (2002) and STES et al. (2010), and the model of AD transfer' factors of FEIXAS et al. (2013).

Research design follows a mixed-method approach including quantitative and qualitative tools. This article reports only the results of the quantitative phase, which follows a quasi-experimental approach with a pre and post-test evaluation. The quantitative phase incorporates demographic data, a questionnaire on Motivations and Expectations (FEIXAS & ZELLWEGGER, 2010), the Approaches to Teaching Inventory-Revised (ATI-R) (TRIGWELL, PROSSER & GINNS, 2005), and the Questionnaire of Factors Influencing Academic Development Transfer of FEIXAS et al. (2013) (Table 1). The population consists of all the participants of the training program (N=97 university teachers); considering those who voluntarily answered all the instruments, the sample is 66, with a response rate of 68%.

More concretely, with the aim of analyzing the motives, interest and expectations of academics towards the AD program, a questionnaire about Motivation and Expectations (FEIXAS & ZELLWEGER, 2010) was administered before training. Items refer to teachers' expectations towards gaining self-confidence and improving specific teaching knowledge, skills and attitudes; and teachers' motivation to apply new methods in the classroom, to gain a more solid theoretical understanding of teaching and learning processes, and to enroll to meet with like-minded people to further develop their teaching.

To explore changes in teachers' conceptions and approaches to teaching and learning, the Spanish version of the ATI-R is used before and after the training. Developed by TRIGWELL & PROSSER (1996), they suggested that the ways teachers approach teaching have important implications for students' approaches to learning and indicated that an Information Transmission/Teacher-Focused approach to teaching (ITTF) is associated with surface approaches to learning (learning for reproduction), and a Conceptual Change/Student-Focused (CCSF) approach to teaching with a deep approach to learning (learning for meaning).

After training, the Questionnaire of Factors Influencing Academic Development Transfer of FEIXAS et al. (2013) was administered. It consists of eight factors related to training design, individual factors and organizational factors.

Table 1. Description of the questionnaires used in the quantitative phase of research

Questionnaire	# Items	Cronbach's alpha	Scale
Motivations and Expectations towards AD (from FEIXAS & ZELLWEGER, 2010b). One scale: Motivation and Expectations.	5	.790	1-5 (from low to high importance)
ATI-R (from TRIGWELL, PROSSER & GINNS, 2005). Two scales: (1) Information transmission/teacher-focused approach to teaching; (2) Conceptual change/student-focused approach to teaching.	22	(1)Pre-test = .743 (2)Pre-test = .888 (1)Post-test = .836 (2)Post-test = .877	1-5 (from low to high frequency)
Questionnaire of Factors Influencing Academic Development Transfer (from FEIXAS et al. 2013). Eight scales: (1) Training design and acquired learning; (2) Study program coordinator support; (3) Willingness to change; (4) Environmental resources; (5) Student feedback; (6) Institutional recognition; (7) Team teaching culture; (8) Personal organization and transfer capacity.	50	.841	1-5 (from low to high agreement)

Data was analyzed using SPSS v.22, Inc. through various types of statistical analyses such as reliability, descriptive statistics, inferential analysis, correlations and multiple regression models following a step by step method.

5 Results

Upon examining the sample based on the profile variables, there are 66 teachers who fully completed all the instruments. Most of them are men (71.2%); their average age is 52 years old with 11 years of deviation – i.e. the largest number of teachers were between 41 and 63 years. With regard to disciplines, 80.3% are from Engineering, 16.7% from Sciences and 3% are from Psychology. Only 36.4% of teachers have had prior teacher training. Regarding level of studies, 9.2% have a 4-year degree Bachelor, 6.2% are Master candidates, 40% have a Master's degree, 4.6% are PhD candidates and 40% are Doctors.

Results presented focus on teachers' motivations, changes in teaching approaches, and the factors that influence their transfer.

5.1 Motivations and expectations of teachers before training

The Faculties of Engineering have placed a lot of resources and emphasis in supporting the implementation of the new curriculum by, among others, offering AD activities. Before training, most teachers regard the AD program with high expectations. Results show that most teachers expect to gain self-confidence in their work with students (4.86) and improve specific teaching knowledge, skills and attitudes (4.60). They are highly motivated to apply the new training in their teaching (4.67), to gain a more solid theoretical understanding of teaching and learning processes (4.63). To a lesser degree, they enroll to meet with like-minded people to further develop their teaching (4.67).

5.2 Changes in approaches to teaching and learning

ATI-R findings indicate that the AD program has not contributed to changing trainees' teaching conceptions. Before training, the Information Transmission/Teacher-Focused (ITTF) approach ranked 3.65 and the Conceptual Change/Student-Focused (CCSF) approach to teaching ranked 3.87. They both slightly increased after training (ITTF=3.69 and CCSF=3.90). These results reveal

that teachers already have a deep approach to teaching before training and training further develops their conceptions to only a limited extent.

Teachers who already approached their teaching from the students' learning perspective show some changes after training; nonetheless, inferential tests inform that these changes are non-statistically significant.

Correlation tests were run between both variables and their application time. Both, the IITF approach and the CCSF approach have a medium correlation between their pre-test and post-test form ($r=.628$ and $r=.689$, respectively). These results indicate that pre-test and post-test variables are positively and significantly related.

5.3 Factors influencing transfer of training to teaching practice

The results of the Questionnaire on Transfer Potential of Academic Development (QTFAD) are shown in Table 2. Data is interpreted according to the intensity of transfer potential. Within a 5 point-Likert scale, and following previous studies (Feixas et al. 2013), it's been considered that a mean value of 3 implies facilitation of transfer. Below 3, the factor means ranging from 2 to 3 are considered a 'risk to transfer'; factor means between 3 and 4 are considered a 'weak facilitator'; and factor means above 4 are considered a 'strong facilitator'.

Table 2. Descriptive statistics and transfer factor role (ordered by mean value)

Factors	Mean	Role of transfer factor facilitation
Training design and acquired learning	4.00	Strong facilitator
Team teaching culture	3.62	Weak facilitator
Student feedback	3.37	Weak facilitator
Institutional recognition	3.37	Weak facilitator
Study programme coordinator support	3.36	Weak facilitator
Environmental resources	3.00	Weak facilitator
Willingness to change	2.85	Risk to transfer
Personal organization and transfer capacity	2.80	Risk to transfer

Only one factor is a strong facilitator for transfer: *Training design and acquired learning* (4.0). The factor includes items related to training design and its high mean value indicates that the AD programs and activities have proven to be well-designed and implemented. Participants' self-efficacy is, in this regard, perceived as high.

Team teaching culture (3.62) factor has a value above average but it is considered a weak facilitator. It refers to cultural aspects that need to be understood in the specific environments of the participating teachers, which can be very different among disciplines or campus. Specifically, it analyzes the need of colleagues who teach the same subject matter to collaborate with each other, the climate of support and feedback, and the opportunities for exchanging educational experiences.

Student feedback (3.37) factor is also a weak facilitator. This result can be understood in the sense that the importance of student opinion is relative to the implementation of new teaching practices. Noting students' impressions and

observations of the teaching-learning process can be a stimulus for making changes and pursuing improvement.

The *Institutional recognition* factor has the same mean (3.37) as the previous one therefore considered a weak facilitator. Participants believe that their efforts to improve student learning will be sufficiently recognized and valued. The items relating to this factor are defined in terms of expectations, i.e. participants expect the institution to recognize and value the efforts they make to transfer what they have learnt, and that in turn should have an impact on academic promotion.

The *Study program coordinator support* (3.36) is also a weak facilitator. People who are responsible for overseeing teaching, such as study program coordinators, heads of department and others, do not usually attend teacher training or accommodate transfer.

Environmental resources is also seen as a weak facilitator (3.0). It embraces organizational aspects, such as material, human and financial resources. With the exception of training initiatives requiring the use of technology, the impediments to transfer are not of a material nature.

Personal organization and transfer capacity (2.98) is a factor that acts as a risk to transfer although close to being a weak facilitator. In this case, the impediments to transfer are found in the teachers' organization of work and individual capacity. It is likely that academics are under work pressure as well as setting other priorities before planning the transfer of what has been learnt; therefore, the acquired knowledge and skills have a limited application in and impact on pedagogical practice.

Willingness to change is a factor that measures the perceived resistance to change in the teachers' environment (study programs, departments or centers). With a mean value of 2.85 is also a risk to transfer.

5.4 Factors influencing transfer of training in relation to teachers' approaches to teaching

Multiple regression models were performed among factors influencing transfer of training as independent variables and teachers' teaching approaches as dependent variables. Table 3 shows the factor model using the Information Transmission/Teacher-Focused (ITTF) approach, before training as a dependent variable. It is composed of three factors that explain 25.1% of the variance of this variable. In particular, the factor, personal organization and transfer capacity, has a greater weight in the model; i.e. for teachers with an ITTF approach before training, aspects such as organizing their time and resources to apply learning play an important role in its development. Similarly, institutional recognition and willingness to change factors contribute to the ITTF approach to a lesser degree; that is, for teachers with an ITTF approach before training, it is important that the institution recognizes their effort. However, it is important to consider that the factor, willingness to change, in this model has a negative value which means that teachers with an ITTF approach before training are less willing to change.

Table 3. Information Transmission/Teacher-Focused (ITTF) approach and Transfer factors, before training

	<i>B</i>	<i>SE B</i>	$\hat{\alpha}$
Step 1			
Constant	2.671	.391	
Personal organization and transfer capacity	.334	.127	.364*
Step 2			
Constant	2.043	.457	
Personal organization and transfer capacity	.294	.122	.322*
Institutional recognition	.230	.097	.317*
Step 3			
Constant	2.305	.459	
Personal organization and transfer capacity	.389	.127	.425*
Institutional recognition	.265	.094	.352*
Willingness to change	-.218	.106	-.286*

*Note: $R^2 = .113$ for Step 1, $\Delta R^2 = .196$ for Step 2, $\Delta R^2 = .251$ for Step 3, * $p < .05$*

When a multiple regression model was applied considering ITTF approach after training, inconclusive results were obtained. In this sense, it was not possible to obtain a model with significant factors with the variables considered.

Table 4 shows the regression model using CCSF approach before training as a dependent variable. It is formed with the factor, student feedback, explaining 9.8% of the dependent variable's variance. This result implies that before training, teachers with a CCSF approach regard students' comments and assessments about

innovative practice as potentially impacting on their development in a positive way.

Table 4. Conceptual Change/Student-Focused (CCSF) approach and Transfer factors, before training

	<i>B</i>	<i>SE B</i>	<i>â</i>
Step 1			
Constant	2.510	.584	
Student feedback	.440	.179	.343*

Note: $R^2 = .098$, * $p < .05$

Finally, the model using CCSF approach after training as a dependent variable, is composed of two factors that explain 27.8% of its variance (Table 5). In fact, the factor training design and acquired learning has a greater weight in the model which means that teachers that tend to perceive the training design positively, show a high level of self-efficacy and perceive that they learnt a lot, will have a CCSF approach. Similarly, their *willingness to change* has an impact on their teaching approach even though to a lesser degree. This implies that if a CCSF approach is to be encouraged, it is necessary to improve their willingness to change before and during the training activity.

Table 5. Teaching approach Conceptual Change/Student-Focused (CCSF) and Transfer factors, after training

	<i>B</i>	<i>SE B</i>	<i>â</i>
Step 1			
Constant	2.541	.366	
Training design and acquired learning	.337	.088	.487*
Step 2			
Constant	1.939	.447	
Training design and acquired learning	.347	.085	.500*
Willingness to change	.201	.092	.267*

Note: $R^2 = .221$ for Step 1, $\Delta R^2 = .278$ for Step 2, * $p < .05$

6 Discussion and conclusions

While highly effective teachers can make a big difference to students academically (BAIN, 2004), they can only accept a partial share of responsibility for how well their students do. Similarly, highly effective academic development (AD) programmes can only be partly responsible for the quality of university teachers' teaching and student learning. Thus, the discourse of academic developers does not always see active application into practice. There are numerous factors that play an important role in the transfer of pedagogical knowledge acquired by university teachers who have been enrolled in AD activities.

The overall research goal was to evaluate the impact of the AD program developed by the Faculties of Engineering at UCN on the teaching culture and students' learning. This article reports on the achievement of three main objectives related to the quantitative study, namely: examining teachers' motivations towards training,

the changes in conceptions about teaching and learning experienced due to the training, as well as the training's transfer potential into teaching practice.

At the beginning of the training process, a high percentage of teachers had great expectations and declared feeling motivated to apply the pedagogical skills developed in the teacher training program in their own classrooms. These expectations were even greater when there was a desire to offer better student learning opportunities.

Regarding teachers' teaching approaches, it is possible to conclude that there are no significant changes conceptions after training, partly because participants already report knowledge and practice of a student-centered teaching approach, and partly because they only attend short workshops. Although there are no changes at the group level, there might be individual changes which cancel each other out at the group level. From a methodological point of view, gathering more data from individual teachers is needed to report on changes. This information is being carefully addressed in the qualitative study (not reported here) by means of in-depth interviews and two classroom observations on a sample of ten academics.

In relation to facilitating or hindering factors of training transfer, the study highlights the absence of barriers. This is a positive aspect since teachers show a good disposition to transfer the learning acquired in the training process. The obstacle to transfer lies in the *Personal organization and transfer capacity* and in the *Institutional recognition* factors. A highly facilitating factor is *Training design and acquired learning* and less facilitating factors are *Study program coordinator support*, *Environmental resources*, *Student feedback*, and *Team teacher culture*. Such results support those obtained by Feixas et al. (2013): teachers have difficulties with transfer because of the personal organization of work (lack of time, energy, agenda priorities) which limit their own transfer capacity. This study adds the particular difficulty of those teachers with an ITTF approach to teaching, who report, before training, that they are less willing to change. They also expect the institution to somehow recognize the effort implied in attending training and transferring the learning achieved.

Teachers with a CCTF approach to teaching already consider the role of students' feedback in implementing innovative practices. Towards the end of training, this group is more willing to change and recognizes the importance of the training design and the acquired learning. This result is particularly important since the purpose of AD is to develop teachers' conceptions towards student-centered approaches to teaching.

In order to improve the transfer of pedagogical training at the Faculties of Engineering, it is necessary to focus on the improvement of two factors: the personal organization of academics' work, and the perceived unwillingness to change. Recommendations would include measures supporting teachers individually in their struggle to improve teaching and transfer learning in a research-intensive environment, and to identify contextual resistance to change.

The targeted group in this study corresponds to the overall population participating in the AD program (N=97), and the obtained sample formed from a 68% response rate. Although this is regarded a very good response rate considering the length and complexity of the study, data can only be generalized within the context of the Faculties of Engineering at UCN. Complementary studies are foreseen to continue examining the transfer process of AD activities into practice.

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