Creating and sustaining effective professional development for mathematics teachers in Korea

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Introduction

The paradigm of teachers' professional development (PD) methods, which affect expansion of teachers' professionalism must be changed in order to seek qualitative improvement in education and to create a new wind in schools. Many studies show that a simple delivery of knowledge is not effective in changing teachers' belief, attitude or teaching (Greenberg & Barson, 2000).

Measures for increasing teachers' professionalism are not derived from in-depth understanding of contents nor acquired from direct lectures of outside professionals; they should be based on authentic contexts which reflect teachers' first-hand participation in defining and creating difficulties of execution (Cobb & Browers, 1999). Consequently, recent teacher PD is executed in relation to the actual contexts in which class assignments or activities are developed based on research results (Shulman & Shulman, 2004) claiming that teachers' professional development is closely related to their class practice.

Recent teacher PD tends to be completed in teacher communities, which include colleagues, senior and junior teachers, as well as teacher educators at colleges of education (Cochran-Smith & Lytle, 1993). Researchers have reported that teacher communities, which share similar school atmospheres, educational environment, interpersonal closeness and mutually agreed-upon objectives for teaching activities may foster mutually beneficial relationships among teachers (Kim et al., 2010; Lee et al., 2013). Considering such points, mathematics teacher PD program needs to be executed based on teacher communities within the same school, and teacher communities may even stimulate development of other teachers after the PD. This means that one may see teachers as a practice researcher rather than a mere executer of developed educational process. A new form of PD, which enables acquisition and development of practical knowledge combining theory and practice by creating teacher communities needs to be suggested in order to stimulate teachers' active learning and research activities and to support their professional development.

This study describes a sustainable PD program centered on mathematics teacher communities and the analysis of its effects. The teacher PD program suggested in the present study not only encourages teachers to simply participate in already-prepared PD program, but also enables them to be active as a member of the program and to become reflective researcher themselves.

Theoretical background

Kwon et al. (2014) have developed a teacher PD program, which aims at active participation, applicability and sustainable development of professionalism at a community-based level in order to develop Korean mathematics teachers' professionalism. Theories for mathematical teacher education on which the community-based PD is based are "situated cognition and learning" theory, community of practice, and reflective practice.

The main idea of "situated cognition and learning" theory is to acknowledge knowledge, thinking and learning as 'contextual perspective' in education (Greeno, Collins, & Resnick, 1996); it may be the cause for important features of teacher PD, which aims at teacher participation and practice. The central premise of the "situated cognition and learning" theory is social interaction, which means learning is completed when a learner participates in a practice community including certain beliefs and behaviors.

Wenger, McDermott, & Snyder (2002) aimed to theorize the concepts for community of practice more in detail and suggested subject area, community and practice as three structural elements to construct community of practice. If analyzed from the perspective of teacher community, subject area, community and practice may be set as each of class development, mathematics teacher community within school, and class plans and open classes, respectively.

The last theoretical background for the PD is reflective practice. Meanings of reflective practice vary; however, it is normally understood as a learning process through experience and from experiences for acquiring new insights on practice (Finlay, 2008). Schön's (1983, 1987) study represents researches emphasizing on the importance of reflection in teacher PD. He stated that reflection on one's own process of practice is much needed in order to decrease the disparity between knowledge and practice and to develop professionalism of practitioners.

Based on these theories, a community-based PD was established and operated the conceptual models with the following overall PD management principles (Kwon et al., 2014).

First, a community-based participation should be derived from the same school basis. Such is the basic condition in which the teacher community co-develops and applies class materials and realistic effects take place in school-based class developments. There is continuous help from mentors supporting teacher community, as well as the close relationship with the PD committee, enabling everyone to constantly reflect on the needs of the teacher community.

Second, the objective is implementation from theory to practice. PD topics that are current issues in mathematics education were selected, allowing for practical applications in actual classes. In turn, opportunities to directly experience and practice setting assignments related to each topic, discourse methods for class and reflection leading the class change with theories were provided.

Third, an active participation structure of teachers is intended. It not only means change from lecture-centered PD to experience-centered PD, but also includes pursuit for change in actual classes by school-based class application and development. Teacher communities, which participated in the PD may experience class analysis and reflection, as well as class development, and are able to autonomously and continuously develop their potentials.

Contrary to the previous PD, which centered on knowledge acquisition and did not reflect changes in class, the new conceptual model attempts to ultimately increase teachers' class practicability and to improve teaching by changing to a community-based participation in PD, execution from theory to practice, and active participation.

Development principles for the community-based mathematics teacher PD program are based on the contents of the recent teacher PD program, "situated cognition and learning" theory, which initiated changes in management methods, community of practice and reflective practice.

Conceptual and procedural model for professional development

The teacher PD program which the present study developed was designed considering the following three major points to foster teachers who are practitioners combining theory and practice and researchers aiming for continuous professionalism.

First, the meaning for trainers or teacher educators is re-established. In the existing teacher PD program, each teacher individually applies for PD, individually receives PD, and separate roles existed for trainers and trainees. For the new program, however, three or more mathematics teachers who work at the same school must apply together for PD, participate together, and contemplate about their classes together. Teachers who work at the same school teach students from the same school, meaning that they are able to discuss the level of class structure which best suits the learners and that they may possibly share the class objectives, since they are in similar work environments.

Second, the contents of the PD were constructed grounded on the trainees' contexts and "situated cognition and learning" theory. The contents of the existing teacher PD program are focused on teaching advanced knowledge related to class curriculum. The new program, on the other hand, aims to increase teachers' professionalism. Thus, the topics for the new program were selected from the current issues of mathematical education, and include practical contents, which may help the selected topics to be applied for actual classes. In other words, the contents were constructed in a way that prepare and help each trainee to apply the PD topics in their own situations, as practice and development of class are fundamental interests for all teachers, even though the "current" issues may change from time to time. In turn, trainees were provided multiple opportunities where they can experience and practice setting assignments according to topics, discourse methods for class, and reflection, which stimulates class change, along with the theoretical foundations.

Third, PD methods were diversified within one program. In the new program: (i) trainees were grouped from the application stage after individual meetings in order to facilitate the trainees' participation to the maximum; (ii) trainees were provided as many opportunities to participate during the program as possible through various teaching methods, including lectures, discussion sessions, workshops, and councils; (iii) reflection activities were mandated. Moreover, 'Site Visit PD', which is a field- type PD, was arranged in order to provide opportunities for teachers or trainees, to plan and practice classes and for communities to enact councils. This may be regarded as one of the research-type PD, which enables trainees to autonomously hold a class and to cultivate their capability as field researchers.

The conceptual change of trainees, PD contents and PD methods in the mathematical teacher PD program ultimately attempts to practice and develop new teaching in class. In order for such changes to continue meaningfully, a PD program that fulfills all three aforementioned requisites must be developed. The conceptual model is visualized and represented in Figure 1, as follows.
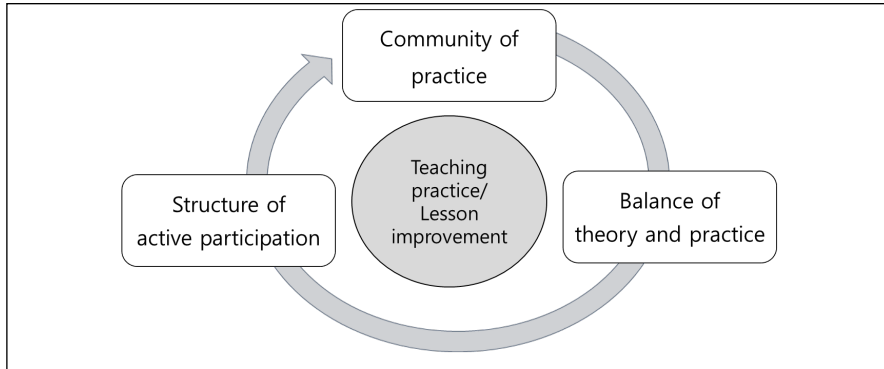
Figure 1. Conceptual model for PD program

The PD program in the present study constructs PD contents to enable communities to combine theory and practice as trainees, encourages trainees' active participation through various PD methods, and ultimately attempts to achieve class practice and development, which is one of the PD objectives. This model overcomes the limitations of previous PD models that mainly focused on lecture or delivery of pedagogical knowledge to individuals and had little effect on actual class development, even though it may seem to concentrate on class in the lectures or deliveries. The teacher PD program that the present study developed is based on class situations where teachers and students mutually interact and is centered on teachers' understanding and practice, considering environments outside of class.

Our PD program was implemented in three stages. The design and procedures for PD program are shown in Figure 2 below.
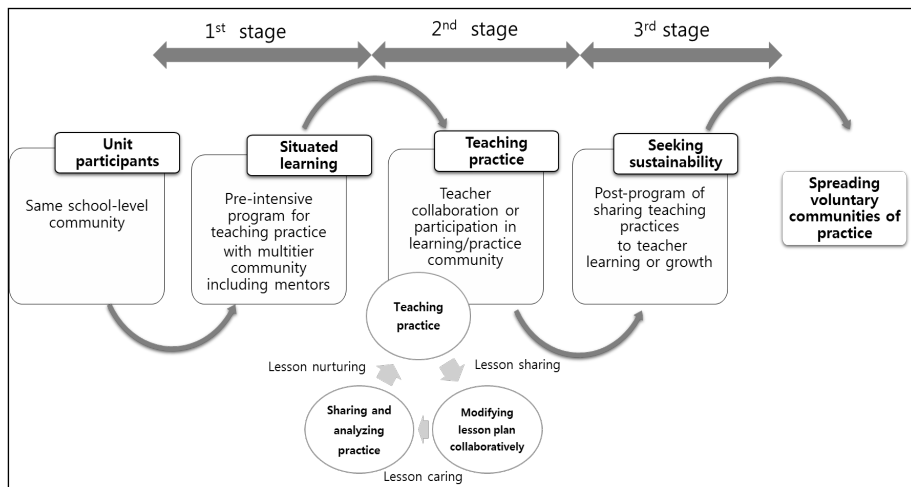

Figure 2. Design and procedural model for PD program

The first stage provides various types of PD program and the programs are aimed to stimulate teachers' practical knowledge structure and reflective practice experience. The program was run every Saturday for three weeks from September 28, 2013, for 18 hours in total.

The second stage provides time to plan and practice actual classes, and was run for 15 hours total, in two months period. During the two months period, trainees managed their teacher communities at school and wrote applicable class plans in relation to PD topics, based on the PD contents. Online mentoring was executed, where mentors and mentees participate in the process of class plan mapping by emailing each other or chatting online. After the trainees complete class planning according to the schedule, they open classes with the plans directly applied, while mentors and some management staff observe, record and provide class analysis and feedback by participating in community councils.

In the present study, two open classes were run consecutively to gradually improve class plans and class practices and to ultimately execute the second stage according to cyclical procedures.

The third stage took place after the second stage has finished, for 12 hours over two consecutive days, totaling in 45 hours of PD. During the third stage, trainees reflected on their own PD process, presented their community management results and shared diverse examples with all the other trainees. They also planned continuous management and development of teacher communities even after the PD program has ended, and presented about those plans.

PD management staff extracted implications from analyzing participation examples of community PD and provided guidelines for substantial management and development of teacher communities.

The community-based mathematical teacher PD program
The first stage: Preparatory intensive course
The first stage is characterized as a preparatory intensive course for field application at school. Although different schools had distinct PD topics, trainees worked together for topics that need whole-group discussions, such as class reflection, community management, and/or teachers as researchers. The program was run every Saturday for three weeks from September 28, 2013, for 18 hours in total.

Eighteen hours of management could have been completed without hiatus in the form of intensive PDs. However, the PD program had a week of intervals from each session for teachers to develop classes based on the PD contents and to have time for planning.

The program was also executed during the weekends to minimize the interference with the trainees' actual classes at school.

In 'teacher PD for storytelling class' for elementary school teachers, lectures such as meaning of storytelling, comparison between storytelling textbooks and regular textbooks, storytelling assignment development, writing lesson plans for storytelling mathematics class, elementary school class video analysis, and preparing lesson plans after predicting student responses, were prepared.

In 'Mathematics-based integrated class' for high school teachers, programs included lectures such as meaning and types of mathematics-based integrated class, ideas for mathematics-based integrated class, examples and experiences, activities with 3D printers,

assignment planning and class management, teacher discourse analysis, and preparing lesson plans after predicting student responses.

One of the main characteristics for the first stage is that the program is rather activity-centered than lecture-centered so teachers can actually participate, and that the programs provide lectures to organize the activities and offer the teachers opportunities to concretize their lesson plans. The management staff encouraged the trainees to reflect on each day's PD, required them to analyze the PD program, and adjusted and complemented the PD contents and assignments according to the teachers' needs.

During the PD period, mentors participated in the PD with the teachers from the same community in order to spend time together, built affinity to prepare for School Visit PD, and supported tailor-made application methods for the PD contents.

For the teacher community to share their visions, set a detailed goal, and establish plans in field and in School Visit PD, the program supported teacher community management, and the trainees prepared lesson plans and community management for which they can apply the PD contents.

The second stage: Teaching practice and collaboration

The second stage is characterized as teacher practice and collaboration. The program required all teams to consist of teachers from the same school to enable collaboration in class development and concretization, and mentors were required to support them online and offline in the process.

The second stage had three steps: "lesson sharing," "lesson caring," and "lesson nurturing," involving community of practice meetings, online discussions with mentors, open classes, and site visits by mentors.

In lesson sharing, ideas were freely exchanged to develop teaching and learning plans through regular teachers' community meetings and online discussions with mentors. Next, in lesson caring, mentors visited school classrooms, where they watched the participants' classes together with members of the community. Based on the results of the visit, the process in which they improve the teaching and learning plans and reapply to their classes was repeated, again with the reflection and discussion with mentors.

Last, in lesson nurturing, teaching and learning plans were finalized by incorporating the discussion that took place during the teachers' community meetings and the site visits.

In some cases, after a teacher taught a class, the teachers' community improved the teaching plan and the teacher conducted again in a second class. In another case, after the first teaching and meeting of the teachers' community, another teacher practiced the lesson with another class using a modified teaching plan. In the other case, the teaching method was improved and then all members of the community taught a class together (team-teaching). All these exercises were done in different ways depending on school situations and characteristics of the community.

During the PD period for the second stage, teachers of each community write teaching and learning plans for classes developed within their school. Through the process of applying and analyzing the plans for class, they readjust and complement the previous teaching and learning plans in the teacher community. At least two sessions of online mentoring and visit mentoring were mandated during the second stage. If not available for visit mentoring, videotaping was allowed in place of one or the two sessions. Online discussions were also scheduled before and after the site visits for flexible management.

The third stage: Post-program for sharing participation experiences

The third stage consists of two PD sessions, and can be considered "harvest PD." Each teacher community has opportunities to share and discuss their experiences during the PD process with each other. The third stage was run simultaneously on January 3rd and 4th in 2014. The trainees presented class examples that they applied during the second stage and underwent the process of analyzing and discussing the related topics, according to schools levels. Mentors and sub-mentors, who participated in the site application process, prepared the discussion contents for school-based presentations. At the end of the stage, the trainees were given time to search for the future directions and management measures of teacher communities after the completion of PD.

The procedural characteristic of the present study, consisted of preparatory PD, site visit PD, and harvest PD. The PD program developed by the present study is exclusive in two major points: (i) the preparatory PD does not consist of theoretical lectures, but rather contains concretized contents which trainees are able to apply on actual classes by combining theory and practice; (ii) while previous programs put a burden on each individual for field application and only confirmed the outcomes, this program operates on a community-level when planning, practicing and reflecting on classes, as well as experiencing the process of sharing classes with mentors or professional supporters.

Cultural change of professional development

The important reasons for which the trainees could have built confidence in understanding teaching methods related to new topics and applying them for actual classes are twofold: (i) the program's management system, which enabled the trainees to directly construct classes on site based on theories they learned and; (ii) the support of mentors who assisted the trainees with planning, managing and reflecting of classes.

The mentors, who have prior knowledge and previous experience in the practice of storytelling or mathematics-based integrated education, helped the trainees from constructing assignments to teaching methods, for a smooth execution of their classes and development of higher confidence within themselves.

Awareness of the needs of community not only affected the teachers who participated in the PD, but also other teachers at the same school. One of the elementary school teachers who received the PD responded that "fellow teachers gave positive feedback on community activities," and they showed interest in the PD activities by observing the classes that the teachers from their school taught, etc. For one of the elementary schools and one of the high schools, some teachers mentioned that they plan on constructing a

community together with the trainees and decided to join as a member of the PD community after program ended.

Three or more teachers from the same school form a team in this PD program making it fairly easier for them to gather in terms of time and space. This is better than a community with individual teachers from different schools. For cases in which a community consists of teachers teaching the same grade, the school activities and learning contents for each teacher are almost identical enabling them to collaborate easily and effectively.

A small-size teacher community also allows teachers to easily share their directions and goals in the process of adjustment and agreement of opinions, which is an appropriate choice for teachers who are beginning to participate in community activities.

Mock classes or open classes from the previous PD program do allow trainees to share practical knowledge; however, teachers make improvements by videotaping their classes and sharing them directly or indirectly in this program. Teachers may find something they perform well in classes, but they also have a vague fear of being criticized of their shortcomings. In a classroom culture where teachers do not interfere with classes of one another, most teachers find open classes a public exam on their professionalism and an attack on their classes. One elementary school teacher who has confessed to the pressure of open classes has overcome her fear of opening her classes little by little throughout the program.

In collaboration, the teachers shared the process in which they reached an agreement, planned together, and examined teaching practices together. During the process, the teachers feel that they share a class they planned together, rather than having a one-way open class of one teacher. The conversion of thought has become a foundation for trusting their colleagues with the community activities and having a collective responsibility on the classes. In the harvest PD program, the elementary school teacher talked about her experience of 'lesson sharing' on her 'open class', and shared her experience of 'lesson sharing' with other teachers. Therefore, the open class in this program was not for demonstrating to other teachers but for sharing with other teachers; not a responsibility of an individual from planning to practicing but a common responsibility of the community; not an evaluation on capability of an individual but an activity to improve capability of a community; in short, resulting in a change in perception.

As the trainees learn the same topics, contemplate together, and solve problems together in a setting other than the school, they obtained a sense of belonging "together," not "only me." During the time in which they deliberated together without considering their career history or other conditions, colleagues built trust on each other and appreciated the value of each other. This enabled a true collaboration among teachers. In collaborating for a class together, teachers feel a shared responsibility of the class. The teachers are more confident in open classes, for open classes are not to evaluate them but to gain new perspectives and improve measures. This can be seen as a change in perspectives from opening classes to sharing classes.

In other words, open classes have changed from something to avoid to an opportunity for a continuous discussion with other teachers in order to improve classes. They have changed into a useful tool for a sustainable teacher community in which an individual's problems become the community's assignment and are solved together. In the classroom culture where teachers do not interfere with classes of one another, open classes expand teacher community culture throughout the whole school, by being the gateway to collaborative teaching that changes the classroom culture.

Conclusion

The ultimate objective of the PD program is to assume the professionalism of mathematics teachers as the catalyst for developing classes and helping students' learning, and to support the continuous increase in teachers' professionalism. Also, an individual teacher does not hold sole responsibility; rather, a teacher community assists in improving individual professionalism through collaboration and reflection in the community.

As one can learn from the name of the program, *A community-based mathematics teacher PD program*, the most prominent difference from any previous PD program is that the new program is planned and managed with teacher communities. The teacher community basically refers to a group of trainees who work for the same school, and may even include mentors and sub-mentors who support the particular school community. Mentors and sub-mentors have constant discussions on class improvements with the trainees and on managing the program with the PD management staff. Furthermore, mentors and sub-mentors also request for support and provide assistance when needed. Therefore, teacher communities should include the PD management staff and lecturers as well.

Figure 3 (next page) shows a multi-tiered teacher community in the PD program. The first picture refers to a school-based community, and the second picture refers to the expanded version of the first picture, in which each community shares their experiences.

With the help of the teacher communities, the participants in this PD program were able to develop and strengthen their practical capabilities that can be applied on actual classes. The PD provided opportunities for teachers to apply their theoretical knowledge on actual classes and allowed them to grow into reflective practitioners for their classes after consecutive feedback.

The development of practical elements of teacher communities is expected to strengthen class improvements, the common area of concern of teacher communities, as well as play a crucial role in implementing concrete changes in actual classes.
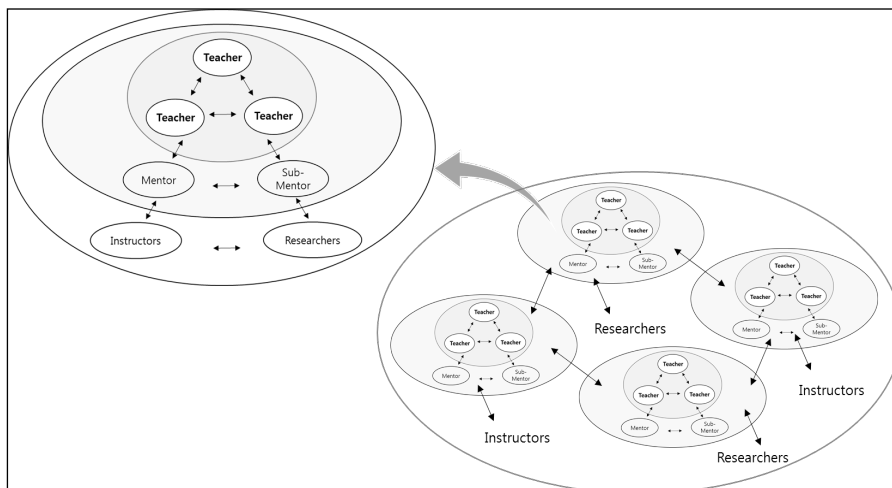
Figure 3. Multi-tiered teacher community

References

Cobb, P. & Bowers, J. (1999). Cognitive and situated learning perspectives in theory and practice. *Educational Researcher*, *28*(2), 4-15.

Cochran-Smith, M. & Lytle, S. L. (1993). *Inside outside: Teacher research and knowledge*. NY: Teachers College Press.

Finlay, L. (2008). *Reflecting on 'reflective practice'*. Practice-Based Professional Learning Centre. Retrieved December, 27, 2012, from http://www.open.ac.uk/cetl-workspace/cetlcontent/documents/4bf2b48887459.pdf

Greenberg, J., & Baron, R.A. (2000). *Behavior in organizations, 7th ed*. Upper Saddle River, NJ: Prentice-Hall.

Greeno, J. G., Collins, A., & Resnick, L. B. (1996). *Cognition and learning. In D.* Berliner & R. Calfee (Eds.), Handbook of educational psychology (pp. 15-46). New York: Macmillan.

Kim, J. H., Choi, W. J., & Shim, J. S. (2010). Narrative inquiry in class criticism: case of community of teacher learning practice. *Secondary Institute of Education, 58*(3), 333-355.

Lee, J. K., Lee. T. K., & Ha, M. (2013). Exploring the evolution patterns if trading zones appearing in the convergence of teachers' ideas: The case study of a learning community of teaching volunteers 'STEAM teacher community'. *Journal of the Korean Association for Research in Science Education*, *33*(3), 1055-1086.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.

Schön, D. A. (1987). *Educating the reflective practitioner*. San Francisco: Jossey-Bass Publishers.

Shulman, L. S., & Shulman, J. H. (2004). How and what teachers learn: A shifting perspective. *Journal of Curriculum Studies*, *36*(2), 257-271.

Wenger, McDermott, & Snyder. (2002). BOOK EXCERPT It Takes a Community. *CIO-FRAMINGHAM MA-*, *15*(15), 111-114.

Kwon, O. N., Ju, M. K., Park, J. S., Park, J. H., Oh, H. M., & Cho, H. M. (2013) .The study on the development principles for the mathematics textbook based on storytelling and the possibility of implementation. *Journal of the Korean Society of Mathematical Education Series A*: The Mathematical Education, *27*(3) 249-266.

Kwon, O. N., Park, J. S., Park, J. H., & Cho, H. M. (2014). Designing and implementing professional development program of multitier teacher community: Focus on "Together making mathematics teacher PD program". *Journal of the Korean Society of Mathematical Education Series A*: The Mathematics Education, *53*(2) 201-217.

Kwon, O. N., Park, J. H., Oh, K. H., & Bae, Y. G. (2014). A case study on the development and practice of lessons for mathematics-oriented convergence through the professional development of multi-tiered teacher community. *Journal of the Korean Society of Mathematical Education Series A*: The Mathematical Education, *53*(3) 357-381.

Kwon, O. N. et al. (2014). A model of professional development program for mathematics teachers (Rep. No. AD-1406-0004). Seoul: The Korea Foundation for the Advancement of Science and Creativity.

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