



ANALYSIS OF GOVERNMENT-FUNDED RESEARCH IN INDONESIA FROM 2014-2018: IMPLICATIONS FOR RESEARCH TRENDS IN SCIENCE EDUCATION

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ABSTRACT

Government funding has the potential to increase research on particular topics that represent an integral focus of governmental policy. The reason is that researchers who seek funding from government sources need to target specific calls for research on topics that the government has identified as necessary for society. Analysis of funding trends can raise awareness about what topics are receiving adequate attention and can demonstrate how funding schemes may serve to limit (intentionally and unintentionally) researchers' authority to design and manage projects and disseminate findings that are not financially supported by government funding agencies. In this study, we used a content analysis approach to analyze all projects awarded to the top five public teacher education institutions (TEIs) in Indonesia from 2014-2018. From the research project list from the five TEIs, we identified 225 science education projects for the sample of analysis. We extracted all keywords (nouns and adjectives) from the research project titles and grouped all extracted keywords into four categories: research topic, research subject or context, research product and outcomes, and content target. From the analysis, we offer some educational context for why scientific literacy and character and values education have emerged as such prominent topics in Indonesia, and we highlight the importance of greater involvement of teachers in research projects, the significance of research outcomes for improving science teaching and learning in schools, and the need to promote research on pedagogical coursework.

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Keywords: Indonesian science education; governmental research funding; teacher education institutions

INTRODUCTION

Government funding has the potential to increase research on particular topics that represent an integral focus of governmental policy. The reason is that researchers who seek funding from government sources need to target specific calls for research on topics that the government has identified as necessary for society. For example, governments that have policies that champion climate change research tend to provide more funding for scientists working in that field, and

so those scientists can access support to research climate change, but governments that deny the science of climate change may significantly reduce funding which can restrict research in this area (Gomez-Echeverri, 2013). Thus, an analysis of funding trends can raise awareness about what topics are receiving adequate attention.

Besides, analysis can demonstrate how funding schemes may serve to limit (intentionally and unintentionally) researchers' authority to design and manage projects and disseminate findings that are not financially supported by government funding agencies (Nisbet, 2005). To date, there have been few research trend analyses

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in science focusing on research funded by government agencies. Such analysis could be helpful for researchers and policymakers in Indonesia where 18.433 funds were granted to researchers in higher education institutions in 2018. Previous studies targeted publications in scientific journals with various purposes and methodologies to identify trends in specific fields, like biodiversity (Kandel et al., 2016). This study is essential to inform the research community the critical areas related to the biodiversity that has been researched in a certain period and what areas received less attention and therefore need priority from researchers to bridge the gap of existing knowledge.

Previous studies of research trend analyses in the field of science education have shown that this analysis process is useful for various purposes. Zhao et al. (2008) conducted a comparative study to understand similarities and differences in educational research practices between China and the United States by analyzing all articles published in the top-ranked educational research journal in each country. This kind of analysis is useful to understand the nature of educational research across countries and major issues in education represented in the research. Erduran et al. (2015) also reviewed published papers in three key science education research journals from 1998 to 2014 to identify the research trends in argumentation and to compare the epistemic and linguistic aspects of argumentation represented in the publications during that period. Their study provides evidence of different conceptualizations of argumentation in science education research. Another study by Lin et al. (2019) employed a content analysis method to systematically analyze articles published in three different science education journals from 2013 to 2017. They also compared their recent findings with previous reviews to reveal the research trends in science education over the last two decades. The study found that in this period, the central countries contributing to this publication became more diverse over time, and the researchers' preferences in research topics have changed.

However, all of these studies reviewed published articles from journals as their data sources. While these studies could provide science education researchers with evidence of global trends for research topics being published in these specific dissemination channels, they fail to provide researchers in with any detailed analysis of what research topics are of importance in local contexts. Also, other research focusing on exploring the impact of English language hegemony on publication of science education research

by researchers representing institutes outside of native English speaking countries has found that less 2% of all studies published in these top-ranked journals represented researchers from the Asia-Pacific region (Martin & Siry, 2011; Martin & Chu, 2015). A close examination of all papers published in high impact science education journals (IF > 0.50) revealed a total of only four publications from scholars representing institutes in Indonesia. It means that previously published studies describing trends in science education research do not necessarily reflect research trends in Indonesia. This study seeks to fill this gap by analyzing government-funded research in Indonesia in the areas of science education.

As education researchers, we believe that analyzing government-funded research is relevant and interesting in the field of education. It is because it can inform the research community about the trends that can help to maintain the quality of overall research, provide an in-depth and comprehensive understanding of previously investigated topics, demonstrate changes in methodological approaches, and highlight what contributions current research has made to existing knowledge in the field (Haigh, 2012). We believe this type of analysis could be instructive for informing educational policy and for developing a more comprehensive understanding of what kinds of research is being done and what areas may need more attention to both improve educational outcomes.

In this study, we seek to apply techniques previously used in journal analysis to examine what educational research has been supported via government funds. Specifically, we seek to describe research trends in science education at a macro level in the country of Indonesia through our analysis of government-funded educational projects related to science education allotted to Indonesia's top research institutions in education. Our analysis will focus on examining what impact government funding of research projects may have on science teaching and learning, teacher preparation and professional development, and general science education research outcomes.

In this paper, the following lines of inquiry informed our research: What impact does government funding have on science education research with regards to affording or constraining research on specific topics and issues? What potential impact does government funding of research have on educational practices in the field? How might this type of analysis be instructive for informing educational policy and evaluating alignment between policy goals and funding initiatives?

Indonesia's K-12 education system is one of the largest in the world. Examining what kinds of educational research is being supported by government funding can provide science educators and policymakers in Indonesia with valuable information that can be used to reflect on funded projects may contribute to and support current curriculum and standards reforms initiatives and efforts to improve teacher education and student learning. The Indonesian government supports educational research by allocating budgets through competitive grants. Some of these grants are used to sponsor science education research projects. Most educational research in Indonesia is administered and conducted by teacher education institutions (TEIs) (Faisal & Martin, 2019). There are more than 400 TEIs around the country, both public and private. Research outcomes from this large number of institutions are expected to serve as resources to facilitate the improvement of teaching and learning practices. The dissemination of research outcomes from these studies through publications can be expected to significantly contribute to a growing body of literature about Indonesia's advances in education and educational research.

In this study, using journal publications as data sources is not appropriate because the studies in journal articles may have been self-funded or funded through private or non-governmental institutions. Besides, although the government requires researchers to publish their research outcome in scientific journals, the time necessary for preparing a manuscript for publication often exceeds the project period. In 2018, Indonesia's science and technology index or SINTA indicated that there were more than 2,700 journals listed from over 200 different institutions and professional associations. It would make selecting appropriate journals for analysis to be quite tricky. Therefore, for this study, we use official documents detailing the awarding of government-funded research projects to different higher education institutions in Indonesia. Compared to articles published in journals, the data provided in these government sources do not provide detailed information about the outcomes for each project. However, it provides discrete information about what funding was awarded, to which institutions, and for which topics – so it is possible to broadly examine various aspects of each science education research project being conducted at each of the top five TEIs in Indonesia.

In 2014, Indonesia began implementing a newly reformed national curriculum that included many changes to K-12 science education.

Since implementing the policy initiatives resulting in this new curriculum, many vital issues have emerged that impact on teachers, students, and educational research. For instance, how to support the massive number of schools, teachers, and students to achieve the curriculum standards and whether the educational standards and competencies in the curriculum have accommodated the diversity of students' social, economic, cultural, and religious backgrounds. In terms of curriculum reform policy, some studies have identified factors that may hinder or support the success of the reform. Analyzing what research projects were funded at different TEIs during the period of curriculum reform allows us to understand how researchers approached their study issues outlined by the underlying curriculum reform policy. It also lets us consider how effectively research projects funded at TEIs have attempted to support and address the issues that the government policies identified as pressing national challenges for science education research.

METHODS

In this section, we describe the research design, data collection and analysis phases of this study. This study was conceived and conducted by a team of researchers from Indonesia and Korea who have been collaborating on projects related to social network analysis and exploring the potential for big data to inform education research and policy. The researchers worked closely to identify, collect, and translate all data from Bahasa Indonesian to English and to then collectively code and analyze the data. The first author of the study is a researcher and science teacher educator from Indonesia who has broad knowledge about science education policy, curriculum reform, and funding initiatives in Indonesia (Faisal & Martin, 2019) and he was in charge of all initial data collection and sorting. The second and third authors of this study have previously conducted several analyses using social network analysis (SNA) methods to explore trends in journal publications related to equity in science education research in both international and Korean education contexts. Together, we used our expertise to design and conduct this research.

Research Design

This data took place in three distinct stages: data collection, data winnowing and preparation, and data analysis. In the first stage of the research, we identified detailed information about all projects funded by the Indonesian government.

Next, we set limits and treated the data using a series of winnowing techniques to exclude projects not related to science education and those projects not awarded to the top five public TEIs in Indonesia so that our analysis would focus on research likely to have the most significant impact on science teaching and learning. Finally, we selected and prepared the data for analysis using excel to code and sort data according to our analytical framework described below. In the following sections, we clearly explain each stage of the research. The procedural method for data collection and analysis was adapted from previous studies examining research trends in journal publications (Zhao et al., 2008; Lin et al., 2014; Erduran et al., 2015; and Lin et al., 2019). These studies informed our approach to data collection and analysis. However, as these studies dealt with journal publications rather than funded research projects, the method for data collection and winnowing was modified. While no research instruments were used for analysis, below is a detailed description of how data was collected (see Figure 1) and treated for content analysis (see Figure 2).

Data Collection

To identify and determine how to narrow the scope of analysis for examining all the research projects funded in this period, we first set the limits of our investigation to the five years (2014-2018) during which the most recent curriculum reform was first introduced and implemented. To prepare the data for analysis, we collected the official documents from a list of all government-funded research projects for all higher education institutions from 2014 to 2018. These documents were published annually on the Ministry of Research, Technology, and Higher Education (MRTHE) official website (<https://ristekdikti.go.id>). Data is released every year in January to announce what proposals have been funded for the year. The researchers downloaded all data files in October 2018. These files included a list of all government-funded proposals throughout 2014-18. The project list in each document contained five categories of information: university affiliation, research category, name of researcher, research title, and research status. For our analysis, we focused attention on four different aspects of research projects: research topic, target or context of the research, product and outcome, and content target.

Data Winnowing

In this section, we describe the process for how we determined which data was to be included or excluded from our data set. We began by identifying which funding data would be targeted. The Indonesian government is responsible for the preparation, certification, and professional development for over 50 million teachers. As mentioned earlier, there are more than 400 public and private TEIs that oversees teacher preparation. However, the Indonesian government has identified five public TEIs as the top leaders in science education research (MRTHE, 2015) because they have met or exceeded criteria in four different categories: human resources, management system, students' achievement, and research and scientific publication (2015). These five public TEIs include the State University of Malang (Universitas Negeri Malang), the State University of Yogyakarta (Universitas Negeri Yogyakarta), the State University of Semarang (Universitas Negeri Semarang), the Indonesia University of Education (Universitas Pendidikan Indonesia), and the State University of Surabaya (Universitas Negeri Surabaya). We narrowed our analysis to consider research projects awarded to only these top five public TEIs because these institutes have the most significant potential for impacting on teacher preparation, teacher professional development, curriculum, and classroom practice. There were 2,939 research projects awarded to these five TEIs from 2014 to 2018 (See Fig. 1).

Next, we began to winnow the data further by excluding all projects that were not funded in the field of education and within the scope of science education research. We included projects funded by the government that fall into all three of the primary research schemes: basic research, applied research, and development research. For each category of a funded project, we analyzed the full research title to determine whether the project could be categorized first as an education-related project and then through the second round of analysis as a science education project. Based on the title analysis, we excluded all projects that were not related to either education or science education. We then extracted and analyzed keywords that indicated research themes from the title of each science education research project. The details of data preparation and analysis are described below.

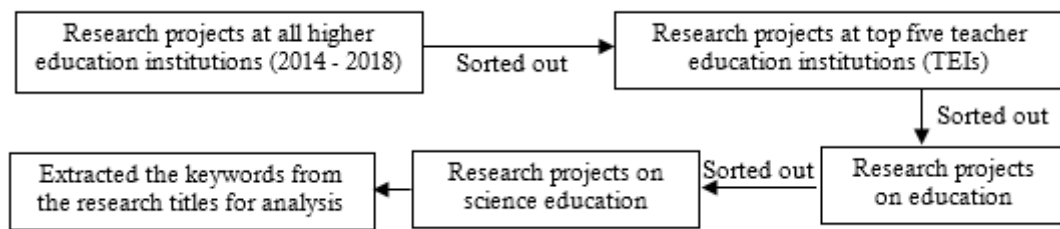


Figure 1. Process to Select Science Education Research Projects for Analysis

Data Selection and Preparation

After collecting all the government-funded research projects for each of the five years in the study for all science education-related projects, we sorted the data to list all funded projects by TEI. From the research project list from the five TEIs, we made a second list of education research projects through a manual search by careful-

ly reading the titles of each of the research projects. As criteria, we used these general education keywords “education,” “school,” “university,” “student,” “teacher,” “teaching,” “learning,” and “curriculum.” We categorized a project as education if the title had one or more of these keywords. The number of education research proposals identified was 1,424 projects (see Table 1).

Table 1. Number of Government-funded Research Projects at the Five Public TEIs

	2014	2015	2016	2017	2018	Total
All research projects	60	848	698	673	660	2,939
Education-related projects	24	452	363	271	314	1,424
Science education projects	5	60	60	46	54	225
Percentage of science education projects compared to all research projects	8.3%	7%	8.5%	6.8%	8.2%	7.6%

From this list of education research projects, we identified science education projects by using the science-related keywords “science,” “biology,” “physics,” and “chemistry.” The entire title of each project was examined to ensure the science education context of the research. Irrelevant research projects were eliminated. We discussed the identification results and made a third list, resulting in 225 projects being identified as our sample for detailed analysis. Researchers worked together and independently to code and compare coding decisions to identify agreements and disagreements in coding—consensus agreement for coding decisions allowed for 100% inter-rater reliability to be reached for all codes.

Data Analysis

In this study, we use a content analysis approach to gain a more detailed view of research development trends using data extracted from publically reported projects funded by the Indonesian government. A content analysis approach has been used by previous researchers to examine research trends appearing in science education journals (Chang et al., 2010; Lee et al., 2009). From our sample of 225 science education projects, we extracted all keywords (nouns and

adjectives) from the research project titles. We then translated all the extracted keywords from Bahasa Indonesia to English. The keywords were easily translated because the majority of the keywords were adapted from English terminology. We then made four different categories based on the characteristics of the extracted keywords (see Table 2).

The research topic category contains keywords that indicate the topic or the investigated variable of the research project. We did not divide this category into subcategories because the number of keywords was enormous and they had a wide variation. However, to identify the most frequently investigated topics, we ranked the extracted keywords from 1 to 10 based on their frequency.

The research subject or context category contains keywords that reflect the target or participants of the research or the context where the research was conducted. From all keywords included in this category, we identified three subcategories: student and school, pre-service teacher and university, and teacher and community. There were, however, few research projects whose titles do not include keywords related to the research subject or context.

The keywords chosen in the research product category indicate that the product of the research project involved teaching and learning activities. We divided this category into four sub-

categories: teaching and learning material, pedagogical model/strategy, instructional media, and assessment instrument.

Table 2. Categories of Extracted Keywords

Categories	Subcategories
Research topic	-
Research subject or context	Student and school Pre-service teacher and university Teacher and community
Research product and outcome	Teaching and learning material Pedagogical model/strategy Instructional media Assessment instrument
Content target	Science Biology Physics Chemistry Other

The majority of the research projects analyzed in the content target category had the keywords “science,” “biology,” “physics,” or “chemistry.” Projects that targeted different content areas such as biotechnology, inorganic chemistry, or environmental education were included in the other subcategory. We grouped all extracted keywords into these four categories and identified their subcategories. The majority of the subcategories were derived from extracted keywords. We then quantified the number of research projects for each subcategory (see Fig. 2 below).

is not easy for researchers, as they need to follow strict regulations. Besides, the combined budgets of the research proposals submitted often exceed the government’s research budget, which increases competition between researchers. To be more competitive, the purposes researchers choose to target for their studies may be local and national issues related to educational practices and policies. For example, one prominent policy in the Indonesia educational system was the reform of the national curriculum in 2013. Some issues that underlie the enactment of this policy were low student performance in science, promoting character education in schools, and the need to improve teachers’ competency (Permendikbud, 2016).

While the results of this analysis will allow us to describe some recent trends for funding of science education research in Indonesia, there are some limitations to this study. Receiving funding

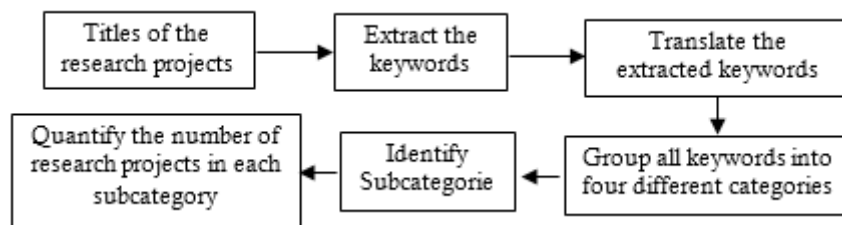


Figure 2. Process of the Data Analysis

Targeting these issues may increase the likelihood that a research proposal will be funded. For this reason, an examination of what research has been funded by the government can be useful to confirm alignment between the government’s concerns and educational research practices. However, our findings may not accurately reflect

all of the educational concerns that need to be addressed by researchers. Our analysis can only capture trends concerning what research needs have been identified by the government as a priority for funding; this is an explicit limitation of our study.

RESULTS AND DISCUSSION

In this study, we first identified the science education research projects from the list of government-funded research for higher education institutions. We selected all research projects for five public teacher education institutions (TEIs) from 2014 to 2018. We then analyzed the projects to reveal trends in science education research over the five years of the study. This analysis allowed us to highlight some significant findings in terms of research topic, subject or context, product and outcome, and content target.

Topics of Science Education Research

Research projects in science education covered a wide range of educational topics. As indicated in Table 3, from the first to 10th rank, there are 21 different topics. The frequency of occurrence of each topic varied from 30 to 7. Topics that occurred fewer than seven times are not covered in the rank system (e.g., “socioscientific issues,” “local wisdom,” and “scaffolding”). In addition, different topics may come from the same research project. For example, we found two research project titles from 2018 that contain both scientific literacy and problem-solving.

The results in Table 3 also show that science education researchers had the most significant interest in investigating topics involving scientific literacy, character, and cognitive. Topics such as higher-order thinking (14), conceptual understanding (13), pedagogical content knowledge (12), and nature of science (11) place in the middle. Research on metacognitive, problem solving, and critical thinking was less represented in the projects, with each topic appearing less than 10 times. Though these topics gain different amounts of attention from researchers, they reflect the main goals of science education research in Indonesia.

In addition, it is not surprising that the topic of scientific literacy and character values has attracted much attention from researchers in the last five years. Since Indonesian students have not performed well in science on both the national examination and international comparative assessments, such as PISA and TIMSS, scientific literacy became a significant issue on the national curriculum reform in 2013. Moreover, there has been a strong recommendation from the government to promote character education in schools.

Table 3. Key Topics in Science Education Research for Five Public TEIs from 2014 to 2018

Rank	f	Topic
1	30	Scientific literacy
2	24	Character values
3	17	Cognition
4	14	Higher-order thinking and Curriculum 2013
5	13	21st-century skills, conceptual understanding, inquiry, and scientific approach
6	12	Pedagogical content knowledge (PCK)
7	11	Competency and nature of science
8	9	Metacognition, misconception, process skills, STEM, technology
9	8	Problem-solving and conservation
10	7	Critical thinking and Indonesian national qualifications framework

In the curriculum, the main elements of scientific literacy are closely related to cognitive and psychomotor competencies. These two competencies emphasize students' conceptual understanding, science process skills, and higher-order thinking practice. Character values are represented in the spiritual and social competencies (Permendikbud, 2016). Spiritual competency relates to the students' beliefs, understanding, and practice religious values, while social competency is derived from social, moral, and cultural values such as being honest, self-discipline, responsible, social-awareness, cooperation, being tolerant, and others. The researchers may aim to resolve the significant issues related to students' low scientific literacy and the need to promote character education in schools by carefully examining the curriculum competencies from various contexts and perspectives.

Examining the complete titles of the research projects on scientific literacy helps us to understand the general context of the research on this issue. Some researchers investigated scientific literacy along with other variables: 21st-century skills, nature of science, socioscientific issues, STEM, problem-solving, and critical thinking.

It indicates the various perspectives and frameworks used by researchers related to the concept of scientific literacy. In science education research, researchers may have different conceptualizations of scientific literacy. For instance, Mun et al. (2015) included the dimension of habits of mind, character and values, science as a human endeavour, and metacognition as components of their global scientific literacy questionnaire.

The majority topics listed in Table 3 are components of the curriculum, indicating that in conducting their research, the researchers seem to consider the national education standards stipulated by the government firmly. In the curriculum, the standards of teaching and learning science emphasize inquiry-based instruction, scientific

approach, and process skills. The government also encourages teachers to integrate the element of information and communication technology into their teaching practice. Moreover, skills of problem-solving and critical thinking are integral parts of the curriculum competency (Permendikbud, 2016).

Further, in science education research practice, some of the project topics in Table 3 also correlate to each other and share standard features. For example, a study to measure teachers' confidence to teach 21st-century skills used a self-report scale that included the dimension of the utility of technology and problem solving (Jia et al., 2016).

Table 4. Subject and Context of Science Education Research

	2014	2015	2016	2017	2018	Total	Percent
Student and school	3	25	32	24	28	112	61
Pre-service teacher and university	1	18	16	11	17	63	35
Teacher and community	-	3	3	-	1	7	4
Total	4	46	51	35	46	182	100

In other research, an analysis of scientific inquiry-based tasks included a component of understanding scientific concepts, practising process skills, and development of higher-order thinking skills as evaluation criteria (Yang et al., 2019). Also, researchers use terms such as "critical thinking" and "problem-solving" to refer to the aspects of higher-order thinking (Sadler, 2009). This interrelated topic may affect how researchers select the relevant topics to be investigated in their research project.

Research Subject or Context in Science Education

In our analysis, we found that 182 (81%) of the science education research projects described their research subject or context. The research subject refers to the target or participants of the research, while research context refers to the educational institutions and communities where the research was conducted. In our analysis, we divided the research subject or context into three groups (see Table 4).

As shown in Table 4, in every year of the period of analysis, students and school were the main subjects and contexts of the research projects. The majority of the projects (61%) targeted students as research participants or were conducted in the school context. It indicates that researchers had the most significant interest in ex-

ploring the students' learning activities in school. Researchers may have realized that students are central to most educational programs from the government. Thus, targeting students as research participants seems likely the best alternative for the researchers to examine the effectiveness of pedagogical strategies or instructional materials on students' improvement in science. Also, the considerable number and very diverse of students' backgrounds (religion, economy, society, and culture) and the wide gap in the facilities and resources between schools in different areas in Indonesia provides significant and valuable research opportunities for researchers in TEIs. Investigating these aspects in the context of science education may contribute to the quality of teaching and learning practices. Moreover, the positive impact of high involvement of schools and students in the research will bridge the gap between research outcomes from the TEIs and educational practices in the schools.

In contrast, though all of the researchers in the projects are based at universities, the proportion of projects involving pre-service teachers or research contexts at universities was low, with only 63 (35%) projects in five years.

Promoting research at universities, however, is necessary in order for TEIs to build positive research cultures in their faculty and departments, particularly at TEIs that have a vision of

being leading research universities. Currently, few teacher education programs at TEIs have enough courses in their curricula to train pre-service science teachers in social science research methods. Thus, after completing their bachelor's degrees and receiving teaching certification, pre-service science teachers have had little experience in research methodology and often lack the necessary skills to conduct educational research. At higher education institutions, there are various ways to engage university students in research. For example, researchers and students may work collaboratively by adopting collaborative forms of participatory action research. In this way, students can have meaningful opportunities to learn the theoretical and practical elements of action research (Gibbs et al., 2017).

Another important finding from this analysis is that the science teachers and their professional communities were the least commonly researched subjects and contexts investigated during the 2014-2018 period, accounting for less than 5% of all projects. This result indicates shallow engagement and participation of teachers in TEIs' research projects. Factors such as differences in employment conditions and work patterns may limit research partnerships between school teachers and TEI researchers. In Indonesia, a certified secondary school teacher is required to work 37.5 hours/week, which includes teaching a minimum of 24 classes (Permendikbud, 2016).

To meet this requirement, a teacher needs to provide instruction for six different groups of students or about 200 students every week. In order to involve teachers in their research, TEI researchers need to consider these requirements. Studies conducted in contexts similar to Indonesia found that a top-down/bottom-up implementation strategy that represents the participation of the government and all stakeholders in reform is a crucial determinant of curriculum coherence for educational development (Pietarinen et al., 2017). It is also necessary to consider that researchers at TEIs are academics who are required to engage in teaching, community service, and administrative commitments. A better understanding of the occupational cultures of each professional group can help bring about a more fruitful research collaboration for both school teachers and university-based researchers (Ebbutt et al., 2000).

Although many challenges exist in building research partnerships between university-based researchers and teachers, as an essential partner

of the government in the education field, science education researchers at TEIs need to consider the improvement of teachers' pedagogical competency through research. Updating teachers' knowledge and competency are also necessary to respond to the new educational standards in the curriculum that require a specific type of teaching transformation in schools. Many studies in science education have shown the significance and contribution of research on teachers' professional development. For example, Lee & Yang (2017) implemented collaborative action research to help science teachers develop their knowledge and skills in teaching socioscientific issues. Saunders & Rennie (2013) developed a pedagogical model to support teachers exploring socioscientific issues through a series of instructional stages. Wongsopawiro et al. (2017) conducted a one-year professional development program to increase teachers' professionalism by encouraging them to design and implement action research in their science classrooms. The contexts of these studies are also closely related to the issue of scientific literacy that emerged as a prominent research topic in this analysis.

Another critical aspect of the relationship of research to school teaching is the increasing emphasis by the government on teachers having adequate skills in conducting research, particularly classroom action research. It has become one of the assessment components for the development of teachers' professional skills in Indonesia. To learn and improve research skills, teachers need support and a research-rich environment where they can connect abstract concepts and practical elements of the research (Deem & Lucas, 2006). With the growth of educational research programs at higher education institutions, we may hope a more comprehensive opportunity for research collaboration and partnership between TEI researchers and science teachers in schools.

Research Products and Outcomes in Science Education

Aside from scientific publications, products and outcomes of the research are an essential government requirement for receiving research funding. We identified 205 science education projects (91%) that explicitly mentioned research products and outcomes in their titles. Research products and outcomes are related to four categories of science teaching and learning practice (see Table 5).

Table 5. Products and Outcomes of Science Education Research

	2014	2015	2016	2017	2018	Total	Percent
Teaching and learning material	1	24	17	13	15	70	34
Pedagogical model/strategy	2	14	17	12	17	62	30
Assessment instrument	-	11	15	8	8	42	21
Instructional media	-	8	7	8	8	31	15
Total	3	57	56	41	48	205	100

The results in Table 5 show that from 2014 to 2018, science education researchers in the five public TEIs were interested in creating teaching and learning material and designing pedagogical models and strategies to support students' learning activities in schools (34% and 30%, respectively). Forty-two projects (21%) focused on developing assessment instruments, and 31 projects (15%) were aimed at creating instructional media for science content.

The majority of the science education projects describing research products and outcomes used keywords that were similar to the four-subcategories in Table 5. However, a few projects contained specific keywords that reflected general characteristics or functions of the four-subcategories related to educational practices. For example, research projects that used keywords such as "virtual laboratory," "multimedia," and "computer simulation" were grouped into the subcategory of instructional media. Besides, keywords such as "storybook," "textbook," "lecture program," and "e-module" were grouped into the subcategory of teaching and learning material.

Research products and outcomes from TEIs play a significant role in the successful implementation of the curriculum reform policy. As we explained above, the curriculum standards for science subjects were designed to focus on science literacy and character education. To achieve the curriculum standards, the government suggested some essential instructional strategies and classroom environments for teaching science, improving students' critical thinking, promoting inquiry-based learning, integrating local content, or utilizing instructional technology. However, in the implementation process, factors such as insufficient support and resources may limit teachers' capacity to translate all of the curriculum standards into their science classroom. Another challenge is the science content in the curriculum still covers an extensive range of science concepts, and this often makes transforming teaching to become more relevant to the curriculum competencies very challenging, particularly for teachers who are more familiar with lecture-

based instruction. Because of this, teaching and learning materials and pedagogical strategies from TEI research can provide useful resources to guide teachers and students to achieve the new educational standards in the curriculum.

In addition, some of the research products involving instructional media, such as computer simulation, virtual laboratory, multimedia, and mobile learning, show that researchers are making an effort to integrate information and communication technologies into the science classroom. The researcher is benefitting from the development in computer software and digital applications that allow them to create customizable learning environments by combining curriculum components and features of the technology. Customizable learning environments may contribute to students' participation in learning and provide a meaningful learning experience (Linn, 2003). For example, problem-solving activities embedded in educational video games provide interactive virtual learning environments for students to learn 21st-century skills (Annetta et al., 2010). A literature review conducted by Smetana & Bell (2012) also suggested that using computer simulation as a teaching and learning supplement is an effective strategy for promoting science content knowledge, developing process skills, and facilitating conceptual change.

The broader access of teachers and students to the internet, smartphones, and laptops, as well as the improvement of teaching facilities in schools, will support the effectiveness of this technology integration.

However, research products and outcomes from TEIs will not significantly affect science teaching practice in schools unless they are accessible to and applicable by teachers. Since our analysis also indicates the low involvement of teachers in research, it is crucial for science education researchers to ensure that all educational products from their research can be easily accessed and implemented by teachers. Also, as a supplement to curriculum materials, the educative features of a research product should be considered,

as different features provide different teaching and learning experiences for teachers and students. Researchers may include various educative features in their research product; however, the most crucial aspect is how the features are relevant to educational standards in the curriculum (Arias et al., 2016).

The Content Target of Science Education Research

The content target in our analysis refers to schools and university subjects. We identified 205 (91%) research projects that included the content targets in their titles. Based on our analysis, there are five different groups in this category (see Table 6). As shown in Table 6, science was the main content target of the research projects in the five TEIs (38%). It may be due to the structure of the schools' subjects in the curriculum. Science is a compulsory subject in elementary and junior secondary school. At these levels, students learn science as an integrated and thematic subject with no distinct separation between physics, chemistry, and biology content.

In elementary school, students learn science three times per week, while in junior secondary school, students take five science classes per week. As a subject taught in two different school levels, science has a higher chance to be investigated in TEI research projects. All five TEIs in

this study had programs for elementary school teacher education and science education (programs for preparing junior secondary school science teachers). Researchers who come from these two educational programs may target science content in their research projects.

Physics and chemistry content accounted for 44 (21%) and 33 (16%) projects, respectively, while biology was least represented in the projects (10%). This result indicates that research on biology education seems to attract less attention. Thus more interest and effort needs to be put into this research field both by biology education researchers and the government as a policymaker.

It is necessary because physics, chemistry, and biology all have equal proportions and significance in the curriculum (MOEC, 2013). Students who select the science track at the senior secondary level need to take classes in biology, physics, and chemistry with a time allocation of about 135 minutes per subject each week. The subjects' instructional standards and main competencies also were similar. In addition, physics, chemistry, and biology are included in the items of national examination and university entrance test. Promoting equal research on these subjects may help to improve science teaching and learning practice in senior secondary schools and resolve the issue of students' low performance in science.

Table 6. Content Target of Science Education Research

	2014	2015	2016	2017	2018	Total	Percent
Science	3	22	22	16	15	78	38
Physics	-	9	10	10	15	44	21
Chemistry	-	10	11	6	6	33	16
Biology	1	5	7	4	3	20	10
Other	-	10	8	5	7	30	15
Total	4	56	58	41	46	205	100

In the group of "other" content target, we included specific subjects at the university level such as biotechnology, inorganic chemistry, modern physics, and microbiology. This group accounted for 15% of the projects, which is still far below the percentage of the content targets for school subjects. The five public TEIs in this study offered two programs for undergraduate degrees: an education program and a non-education program. The education program focuses on pre-service teachers' preparation and for this program, and the coursework in the curriculum covers both subject matter and pedagogical content.

Interestingly, all of the content targets in this group are associated with the coursework for the subject matter, although science content and pedagogical competence are equally important and are interrelated components for preparing pre-service science teachers. In addition, many aspects of the pedagogical subjects in TEI curricula can be explored to facilitate the improvement of educational programs, particularly in dealing with the strict regulation of teachers' professional standards and current issues related to science teaching practice in school.

CONCLUSION

This study aimed to examine government-funded research projects from 2014 to 2018 at five public TEIs to reveal the current issues in science education research. The results suggest that the topics of science education research projects in TEIs are closely related to the components of the national curriculum. The top three research topics in the last five years were the main issues underlying the curriculum reform policy, while other topics were integral parts of the teaching standards in curriculum. It indicates a great effort of the researchers to support the curriculum reform policy through research. However, teachers' shallow engagement in research projects needs a great deal of attention from researchers because successful implementation of all the educational standards in the curriculum also depends mostly on teachers' knowledge and competency. Besides, since there have been no research projects targeting pedagogical coursework content in pre-service teacher education programs, it is crucial to promote research in this area.

Some limitations of this study should be addressed in further investigations of science education research. First, in this analysis, we depended mostly on research project titles as a data source, but these titles provided limited information to capture more details of the components of the research projects, such as the methodology and the research findings. Second, some of the project titles did not contain keywords that were related to the subcategories that we made. Thus we did not include them in the analysis. Third, this analysis focused on science education projects in the top five public TEIs in the country, so findings may differ if for analyses conducted in the different contexts of other institutions.

The overall findings from this study suggest that while government-funding initiatives are effectively supporting research that targets some of the government's curriculum reforms and educational policies seeking to improve teacher education, there is still some room for improvement. The analysis revealed that few studies focused on the needs of practising teachers, which could contribute to a growing gap between what government policy seeks to implement through reform measures and what research shows is to be done in real school and classroom contexts. While this research has implications specifically for Indonesia, our analysis also suggests that governments need to carefully consider the alignment of policy goals and funding supports in order to see better outcomes for reform.

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