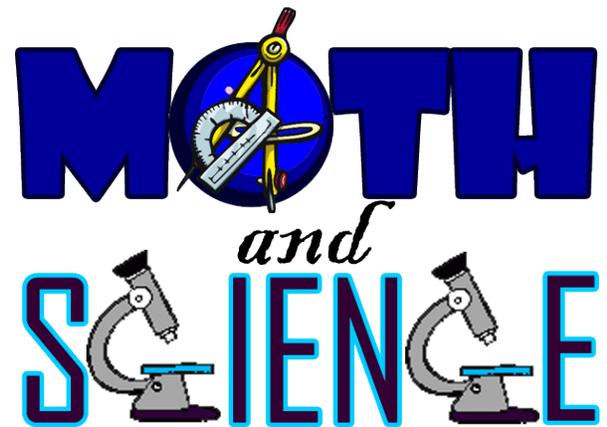


Needs Assessment Result to Launch MED in Educational Science: Teaching of Mathematics & MED in Educational Science: Teaching of Science Subjects



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Education and
Behavioral Sciences**

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ABBREVIATIONS

BDU	Bahir Dar University
CEBS	College of Education and Behavioral Sciences
CPD	Continuous Professional Development
CTE	College of Teacher Education
ESDP	Education Sector Development Program
FGD	Focus Group Discussion
GEQIP	General Education Quality Improvement Program
GTP	Growth and Transformation Plan
HDP	Higher Diploma Program
MED	Master of Education
MLC	Minimum Learning Competence
MoE	Ministry of Education
NLA	National Learning Assessment
NTNU	Norwegian University of Science and Technology
PCK	Pedagogical Content Knowledge
STEM	Science, Technology, Engineering and Mathematics
TPCK	Technological Pedagogical Content Knowledge
UJ	University of Juba

1. INTRODUCTION

In collaboration with the NTNU and UJ, BDU has won a project titled “advancing quality in the primary and lower secondary schools of Ethiopia and south Sudan.” The project has a five year (2016 – 2021) life span and constitutes three components – education, research, and institutional capacity building. It mainly aims to develop the capacity of the two southern partner institutions (BDU and UJ) to improve quality and relevance of science and mathematics education in primary and secondary schools.

As part of the education component, there is a plan to launch MED programs in Science Education and in Teaching and Learning Mathematics. These programs are presumed to contributor to the development agenda of Ethiopia. In its growth and transformation plans, GTP I (MoFED, 2010) and GTP II (NPC, 2016), the government of Ethiopia has emphasized on science and technology as driving forces for development and hence to become a middle income country by 2025. However, attaining this national vision entails expanding the primary and secondary education and ensuring its quality for quality education is a hallmark to prepare skilled human resource by equipping students with the competencies (knowledge, attitude and skills) needed by various sectors of the economy. This necessitates improving classroom practices pertaining to science and mathematics teaching and learning.

It is with the above rationale that a needs assessment is undertaken to launch MED programs in Science Education and Teaching and Learning Mathematics. In this report, the objectives of conducting the needs assessment, the methodology employed, the major findings and ways forward are presented.

2. OBJECTIVES OF THE NEEDS ASSESSMENT

- To understand the current status of science and mathematics education
- To identify the existing gaps in the preparation of particularly primary school teachers in science and mathematics
- To identify the existing gaps in the preparation of teacher educators for CTEs, and
- To develop relevant MED curriculum in Science Education and Teaching and learning Mathematics

3. METHODOLOGY

The study was qualitative in its design. Primary and secondary data sources were used for the study. The primary sources include deans from colleges of teacher education, science and mathematics department heads in CTEs, graduates of previous MED in Science and Mathematics, policy makers and experts at the Ministry of Education, teacher educators at a University. Secondary data sources used were NLA results (MoE, 2000 – 2016), ESDPs (2010 – 2015), GTP I (MoFED, 2010) and GTP II (NPC, 2016), curricular documents, other national and international reports, as well as existing research outputs.

A total of 37 participants (10 deans and vice-deans, 10 department heads, 6 teacher educators, 2 experts, 2 policy makers, 7 previous graduates) were purposely selected from five Colleges of Teacher Education (Debre Markos, Dessie, Finote Selam, Gonder, and Woldiya), two universities (Bahir Dar and Wollo Universities) and from the Science and Mathematics Subjects Improvement Center at the MoE. Data were collected from documents and using semi-structured interview and focus group discussion (see appendix for interview and FGD guides). The interview and FGD guides were prepared by the project team members and validated during the project launching workshop together with the partners in the North. Moreover, two experts from the CEBS, BDU, validated the instruments. Based on the feedback, the instruments were improved and common understanding was reached among data collectors as to what and how to collect the data. Before interviews and focus group discussions, consents were obtained from the participants. Six data collectors were involved in collecting the data. The average time an interview took was about 1 hour and 20 minutes and that of the FGD was on average 2 hours.

4. MAJOR FINDINGS

4.1 Document analysis

To assess the prevailing conditions of science and mathematics education in Ethiopia, curricular materials, policy documents, and learning assessment reports were examined. The results of the review are presented below.

4.1.1 The status of science and mathematics learning in Ethiopian schools

The assessment result generally shows that primary and secondary education in Ethiopia is low in its quality. For example, students' achievement in five subsequent NLAs at grade 4, 8 and 10 was generally below 50% indicating that most students are not reaching to the minimum required standard of achievement set by the MoE. For instance, the extent of underachievement in the NLAs, particularly in science subjects, conducted at grade 8 from 2000 to 2016 is indicated in Table 1. The results show that the mean scores of the students in the subjects is below 50%.

Table 1

Academic performances of grade 8 students in various subjects and trends across years

Subjects	Mean scores for two years				
	2000	2004	2008	2012	2016
Biology	47.16	41.34	38.3	42.10	46.26
Chemistry	40.27	40.10	34.7	36.44	41.29
Mathematics	38.23	40.93	34.1	25.53	35.20
Physics	-	35.32	32.2	34.45	42.58
Composite	31.42	39.42	34.83	34.63	41.33

Source: National Educational Assessment and Examinations Agency (NEAEA, 2000, 2016)

One major reason for the poor performance of the students in the various subjects is the presence of low quality primary teachers. Teachers were poorly prepared and lack subject matter mastery and pedagogical content knowledge to ensure teaching effectiveness at the levels they are teaching (MoE, 2003; Joshi & Verspoor, 2013). Due to the teachers' lack of adequate preparation and relevant background, classroom environment are found to be primarily teacher-centered, limited active student learning and engagement in inquiry processes which contributed for lesser metacognitive skills development and creativity (Joshi & Verspoor, 2013). The low impact of school-based continuous professional development on teachers' classroom practices is also an additional reason for low quality education (Haftu & Yalew, 2013).

4.1.2 *Quality of textbooks*

Another possible reason for the low performance of students in the national learning assessments is the difficulty and the bulkiness of contents of the textbooks used in schools. For instance, according to the World Bank report (Joshi & Verspoor, 2013), the secondary education curriculum in Ethiopia is academically demanding. The report further indicated that the Ethiopian secondary curriculum is “difficult and highly academic compared to most other countries, even those where teaching is in students’ mother tongue” (Joshi & Verspoor, 2013, p. 62). When the length of the undergraduate studies was made to be three years rather than four in 2002, curriculum contents which were part of first year undergraduate studies are moved down to be taught at preparatory school level. The moving down of contents is also done to subsequent lower grades which resulted in increased overall difficulty of contents at lower grade levels.

In response to the challenges faced with regard to teacher professional development, school leadership and management, and textbook quality, the MoE introduced the GEQIP in 2007, under which existing teacher education curricula were revised, new textbooks were developed, and teachers and school leaders were trained. The revision of teacher education curricula considered the promotion of active learning and student-centered approaches. Special emphasis was also given to promote pedagogical content knowledge with a focus on producing reflective teachers that can adapt their approaches based on content and context. This comprehensive reform requires not only better qualified teachers but also teacher educators that can effectively translate the initiative into quality teacher preparation programs. However, the documents (previous MED curricula and curricula for the training of in-service teachers at Master’s level in the summer program) reviewed showed that, such existing efforts are not in line with the desired reform in the teacher education system. For instance, in the curricula for MED in Mathematics and Physics programs, there were problems of (a) provision of subject area and pedagogy courses in a separate fashion that left their integration for the trainees; (b) the pedagogy course were very much limited in terms of number and credit points allocated; (c) the teacher educators themselves have no sufficient and relevant background as they did not pass through relevant training. The table below shows the course number, credits, and organization for an MED program in Mathematics Education at a sample public university.

Table 2

Courses and credit hours allocated to the MED in Mathematics program

No.	Major area courses		
	Course title	Course code	Credit hours/week
1	Algebra I	Math 641	3
2	Algebra II	Math 642	3
3	Real Analysis I	Math 631	3
4	Real Analysis II	Math 632	3
5	Introduction to topology	Math 652	3
6	Functional Analysis	Math 731	4
	TOTAL		19
	Professional courses		
1	Methods of teaching mathematics	Math 601	2
2	Seminar on teaching mathematics	Math 702	1
3	Advanced educational research methods and applications	EPsy 627	3
4	Curriculum design, implementation, and evaluation	Educ 631	3
5	Thesis	M. Ed 700	3
	TOTAL		12

4.2 Results of field study

4.2.1 Achievements gained in the CTE programs

The participants were asked about the successes of their respective colleges in their effort to produce competent science and mathematics primary school teachers for the region. One of the successes mentioned is the colleges' capacity in producing large number of graduates. A dean from a college of teacher education and a department head of a science section from a college noted that

...we have been producing many primary school teachers since the establishment of this College, and thus contributed to the achievement of the Region's major vision with respect to promoting "Primary Education for all." At least we have been successful in terms of producing large number of graduates (you may call it "mass graduation") who can teach in primary schools of the Region (Dean)

The college's success may be explained in terms of helping to expand educational access by way of training more teachers to the growing primary education (Science department head)

Despite the belief that there is better access to education for those who want to be primary school teachers, the participants mentioned that the expansion is not yet sufficient to the extent of fulfilling the demand of teachers. This implies that more work needs to be done. A science section head and a college dean noted that

Despite all these challenges, the college is striving to fill the existing demand of science and math teachers (Science department head)

Despite we are training many students every year in all modalities, there is huge teacher demand particularly in science and math (Dean)

In line with expanding access to education, the presence of dedication on the part of the colleges to support the government's emphasis on science and mathematics as key for development was also mentioned as a success. This is noted from the remark by a dean of a college during an FGD.

The college is working towards achieving the government's priority to improve science and mathematics education because these areas are believed to have key role in speeding up development of the country.

Another issue the participants remarked as strength in the CTE is the continuous improvement of curricula. This has been perceived as a means to make the curricula responsive to the priorities of the country. An excerpt of a remark made by a dean during an FGD supports the idea

Over the past 10 years, there have been several curricula reforms – improvements one after the other in line with the country’s priorities and the advancements of science and technology. I would say the fact that we have been improving the primary school teacher training curricula over the past 6 years is one of the strengths (at a broader level). Overall, I can say that one of the major successes of the College is that we have been trying to optimize the curricula based on the needs of various stakeholders.

4.2.2 Teacher educators’ profiles vs their roles in CTEs

During the focus group discussions, participants were asked whether the profiles of the science and mathematics teacher educators in their respective colleges matches with their roles and responsibilities and about the challenges faced by science and mathematics teacher educators in their colleges in terms of training competent primary school teachers (in terms of their training background and their pedagogical skills). There was almost a unanimous agreement that subject matter knowledge of the teacher educators is unquestionable. This has been reflected in the remarks of deans as well as department heads.

I believe that there is no subject matter knowledge gap on the part of teacher educators to teach their respective subjects (Dean)

I agree that teacher educators have sufficient subject matter knowledge to train teacher candidates (Math department head)

An evidence for the fact that most of them do not have problem in subject matter mastery is that many of them have Masters degrees in their respective disciplines. But, the Masters degrees they hold are in pure disciplines that the degrees are not very much relevant for someone who pursues a career as a teacher educator. A science department head from one of the colleges explained the situation very well as follows:

Overall, I can say that the way our teacher educators are trained in their masters programs is absolutely irrelevant to the College’s purpose. When we give the opportunity to our

staff to go and attend further education (master's degree), the assumption is that he/she would get sufficient training and experience to become effective teacher educator for math or physics or other disciplines. However, there are no relevant masters programs in Ethiopia that would equip teacher educators to become effective to train primary school science and mathematics teachers (the same is true with other domains). For example, the training of those teacher educators who completed their master's degree is MSc in Space Physics or MSc in Spatial Mathematics or MSc in Inorganic Chemistry. Of course these are good master's degrees, but they are not relevant for someone who is going to be a teacher educator at primary school level.when we look at the training background of that teacher educator, it is not relevant to the work he/she is expected to do at the College. I can generally say that our teacher educators in the College don't have the required training to become effective teacher educators for math and science and other disciplines.

In the sample colleges, some teacher educators who attended MED in mathematics and MED in physics programs that existed some years ago (by now the programs are interrupted) in some universities in the country were found and interviewed. These teacher educators confessed that it is difficult to say that the programs they attended for the MED degrees adequately emphasized integration of subject matter and pedagogy.

In the earlier program, we took two kinds of courses. The first is subject matter courses, and the second is education courses. Unfortunately, we took only two education courses. These are curriculum and advanced educational research. Although the nomenclature of the degree says 'masters of education in mathematics', the education courses were inadequate in helping me to effectively teach mathematics. Even these courses were not delivered in organized and no attempt was made by instructors to integrate with the subject matter. For example, the curriculum course focused on general issues than making it related to designing, implementing and evaluating mathematics.

The lack of appropriate training background on the part of teacher educators has in general created a mismatch between what the teacher educators are competent in and what they are expected to do in the colleges as remarked by the vice dean of one of the colleges

I believe there is mismatch between teacher educators' competence and what they are required to do in training student-teachers. The teacher training program is highly influenced by teaching traditions (teaching in the same way they were trained) than innovative pedagogies. As a result, we teacher educators are not effective to make student teachers skillful, and developed professional identity (student-teachers do not consider themselves as teacher trainees)

There is a huge gap between the MSc trainings and the job we are expected to accomplish here (Science department head)

As the teachers are responsible for training future primary school teachers, they are expected to have the necessary pedagogical skills so that teacher trainees, as would be teachers, can benefit to learn from them through modeling. However, it was echoed from the participants that most of the teacher educators lack the necessary pedagogical skills

The problem is on the pedagogical aspect where most teacher educators lack how to represent subject matter concept in a way that can help students understand the content best. For example, teacher educators lack skills to design lesson plans in an innovative way, and hence there are wide disparities amongst us (Math department head)

Moreover, teachers lack pedagogical skills. Teachers lack to implement various active learning and assessment strategies pertinent to the content. And hence, teachers fail to create a learning environment that motivates students to learn effectively (Dean)

The teacher educators' lack of pedagogical skills may be taken as a reason for the improper handling of courses which are meant to equip pedagogical skills to the colleges' trainees themselves as indicated on the remarks from a dean and a vice dean from the sample colleges

There are some PCK courses included (subject area method courses), but the major problem is that our teacher educators don't have the required training to teach those courses as per the design. Our teacher educators were not trained in line with the current curriculum (Dean)

Although there are some subject methodology courses, I assume that those courses are not well-designed and very much theoretical, and I personally don't think that those courses are being taught in the proper way with the right teacher educators (V/Dean)

Furthermore, a vice-dean from a college stated that "teacher educators are not doing enough in developing positive attitude in students towards teaching in general, and do not prepare them to deal with the challenges they will face in the school environment." This shows that the teacher educators lack of adequate pedagogical skills might have caused them to instill a sense of professionalism among the trainees.

In the colleges, there are efforts in order to fill the gap of pedagogical content knowledge through short-term training programs. But, the participants noted that besides the inadequacy of the trainings, the teacher educators themselves are not very much interested on the trainings

Teacher educators have substantial gaps particularly in teaching specific content area. What makes things worse is that professional development opportunities to update our previous trainings are not sufficiently available. The existing HDP is inadequate in the sense that it only focuses on general pedagogy rather than being tailored to specific subject matter teaching (Math department head)

There have been attempts in the College to organize short-term trainings to fill the PCK gap. There is also the Higher Diploma Program, which I think has introduced many of the teacher educators with some of the basic instructional strategies. But, I think I should mention here that our teacher educators may not be fully aware of what they are expected to do as a teacher educator, and they think they are doing the right thing at the moment, and not very much ready to participate in trainings. Even when they know that they lack the proper training to become effective teacher educators, some of them don't have the disposition to reflect on their challenges and seek support form colleagues (V/Dean)

In general during the FGDs, it was reflected from the participants that teacher educators' lesson plans do not meet the standard that science and mathematics learning needs to be. We identified

three critical problems of teachers: content mastery, pedagogy, and assessment. The delivery of contents is traditional in the sense that the curriculum contains too much content and teachers also fail to use innovative pedagogies (such as funs and games) in teaching math and sciences. This made students to feel pressured and get frustrated which leads students to develop negative attitude towards math and sciences. This requires teachers to have skills of inquiry learning to relive students' anxiety and promote positive attitude.

Assessment is often used for grading purposes rather than for promoting students' learning and understanding. Assessment for learning is not frequently practiced and hence teachers couldn't make their assessment practices in relation to the Minimum Learning Competence (MLC) designated for the level.

4.2.3 Quality of teacher trainees

The primary objective of the teacher education program is producing quality teacher trainees who can effectively facilitate the learning of students. A number of factors however influence the quality of teacher training including factors related to candidates themselves (e.g. minimum competence to enter the program), the training process (e.g. the quality of instruction), policy and organization related factors (e.g. organization and relevance of the curriculum).

Regarding the quality of candidates joining the teacher education program, participants have mentioned several reasons why the teacher education program is unable to satisfactorily achieve its primary goal. The candidates lack the basic knowledge, skills and dispositions that are necessary to be trained as science and mathematics subject teachers in schools where most of them were reported to lack knowledge of even basic mathematical operations and chemical elements and symbols. The candidates recruited for the teacher education program are grade 10 completers who couldn't pass to higher education preparatory schools, and they often have low scores particularly in science and mathematics. Hence, it is becoming extremely difficult to teach science and mathematics subjects in the teacher education program. When asked about the quality of candidates joining the teacher education program in general and science and mathematics in particular, a science department head disappointedly responded that:

Students joining the teacher education program are ‘*leftovers*’ from health, TVET and agriculture training programs and have no other options. Even those who joined the program see it as a ‘waiting station’ (‘*batakoyegne*’) and are half-heartedly attending the training, and are ready to leave anytime when they get other opportunities (Science department head)

Moreover, a mathematics teacher educator explains the process of assigning candidates into different departments and how that influences quality of candidates. According to him candidates are assigned into various streams based on their grade 10 achievement results. While those with better achievement prefer to join the social sciences and languages, the low achieving ones are often left for science and mathematics. Candidates who are joining the science and mathematics stream are those with low achievement records and low motivation. They feel frustrated and have negative attitude towards learning science and mathematics.

Participants were also asked to describe the instructional process in CTEs and characterize it using the dimensions of instructional quality (e.g. student engagement, feedback, etc). The respondents acknowledge students their role in the instructional process, however, most of their responses focus on the role of teacher educators in creating a powerful learning environment that can motivate students to learn and achieve better. Asked about the competence of teacher educators, one of the deans of CTEs reflected that:

There is lack of pedagogical content knowledge among teacher educators for they fail to practically demonstrate to teacher trainees how a specific content can be taught better. As a consequence, primary school teachers who passed through the current training program are also unable to effectively teach and contextualize math and science topics in a way that children understand best (Dean)

According to the respondents, a ‘real teacher educator’ is someone who has the competence about how to integrate content and pedagogy effectively. Frequent feedback from schools and exit exam results of prospective teachers affirm that this problem is critical and needs immediate action from concerned bodies.

The organization and relevance of the current teacher education curriculum is another theme highlighted by the respondents to have substantial influence on the quality of teacher graduates. The response of a science department head illustrates how much the organization of the teacher education curriculum influences student learning and also teachers' effectiveness in teaching. According to him, the current training modality merges the science courses (physics, chemistry and biology) together to prepare teachers to teach integrated science subject in primary schools. It becomes very difficult to address all the major content areas given the limited amount of time allocated for the course. This has contributed to candidates' low content mastery and teachers' inefficiency in integrating the different science topics together. This is also partly due to the fact that teacher educators were not prepared to deal with courses of such nature which are given much emphasis in the current teacher education program.

The subject area and professional course mix still remains a sticking point in the teacher education system of the country where some argue the current teacher training curriculum does not give sufficient emphasis to content while others argue for pedagogy. Participants therefore emphasized the need to continuously revise the curricula in order to keep balance between content and pedagogy. For example, one of the deans of CTEs explains

One of the main issues that we couldn't resolve during the curricula reforms has been the balance between subject area and methodology courses that trainees need to go through during the training. There have been complaints among the large majority of the College community that not enough attention is given to subject area courses. At the same time, others complain that not enough methodology courses are included in the curricula.

This response shows widespread conceptualization of separating pedagogy and content knowledge among teacher educators themselves. This in turn indicates the need to move towards integrating content and pedagogy rather than looking for a balance that still keeps them separately conceptualizing pedagogy and content.

5. CONCLUDING REMARKS AND DIRECTIONS

Based on the results obtained from the document analysis and field reports, the following concluding remarks and directions for developing the MED curricula for Science Education and Teaching and Learning Mathematics are forwarded.

- *Launching masters programs in teaching and learning mathematics and science education is timely and relevant*

The country's vision of becoming a middle income country by 2025 is mainly based on science and technology as these fields are seen as key drivers of development. The Ethiopian government has declared a 70:30 program mix for higher education institutions, where 70% of students joining universities shall be assigned to science and technology fields and the remaining 30% to social sciences. To achieve this vision and fulfill the program mix policy, it is important to prepare and make in place the required human resource. This, in turn, requires supporting primary and secondary schools through supplying competent teachers and support inputs, following up and supporting the teaching and learning process, so that students learning could be improved. It is also important to develop dispositions of students towards science, mathematics and technology starting from primary schools. At the heart of these activities are teachers who are equipped with the relevant knowledge, skills and attitudes.

In this regard, as indicated in the report, all the participants unequivocally agreed that the proposed masters programs are timely and highly relevant to improve the existing problems in the teacher training and development of teacher education in Ethiopia particularly in training mathematics and science teacher educators. As voiced by all the participants such masters programs are extremely crucial if we have to do something with regard to the quality of primary and lower secondary education in Ethiopia. In this regard, BDU needs to be exemplary in designing relevant masters programs. Participants appreciated BDU's initiative to open such programs as there are no other similar master's programs in Ethiopia that are designed to train teacher educators integrating pedagogy, content and technology. Moreover, the importance of launching the programs is not only for school teachers and teacher educators, but also for institutions like the Ministry of Education; specifically, the national center for mathematics and science education improvement, where they are expected to provide short term capacity

development for teacher educators who in turn are supposed to train key teachers from school clusters throughout the country.

- ***Integrate pedagogy, content and technology (tPCK)***

All participants and the documents reviewed are consistent in indicating for the need to move from the current separate provision of content, pedagogy and technology to integrating them. The training of teacher educators thus needs to be reconsidered in a way that can provide opportunity to integrate technology, content and pedagogy. Participants and reviewed documents indicated that the current separate provision of tPCK is producing unqualified teachers who are unable to teach effectively and meaningfully by bringing the contents down to the level of the students. That is, the teacher educators have limited capacity to equip the teacher trainees pedagogical skills that could help them teach basic primary school science and math contents. The teacher educators don't have the necessary training background on how to support the teacher trainees to become effective primary school teachers. They were also consistent in indicating the need for making the proposed programs practice oriented. Almost all participants contended that the current practice lack integrating theory with practice and the student-teachers are left to do this by themselves after joining the schools. One of the teacher educators remarked that "listing the available active learning strategies and telling trainees to implement in their future classrooms does not suffice to produce competent teacher educators. This has direct impact on the training of competent primary school teachers." When it comes to the content, participants reiterated that teacher educators don't need advanced training, and they suggested the planned MED programs to give proper attention to pedagogical issues. When designing the master's curricula, participants indicated that they need to show how to teach the contents at each grade level. Overall, the MED programs need to take into consideration the challenges that teacher educators are currently facing particularly in terms of equipping them with tPCK. The framework preferred for integrating technology, pedagogy, and content knowledge in the newly developing curricula is indicated in the figure below,

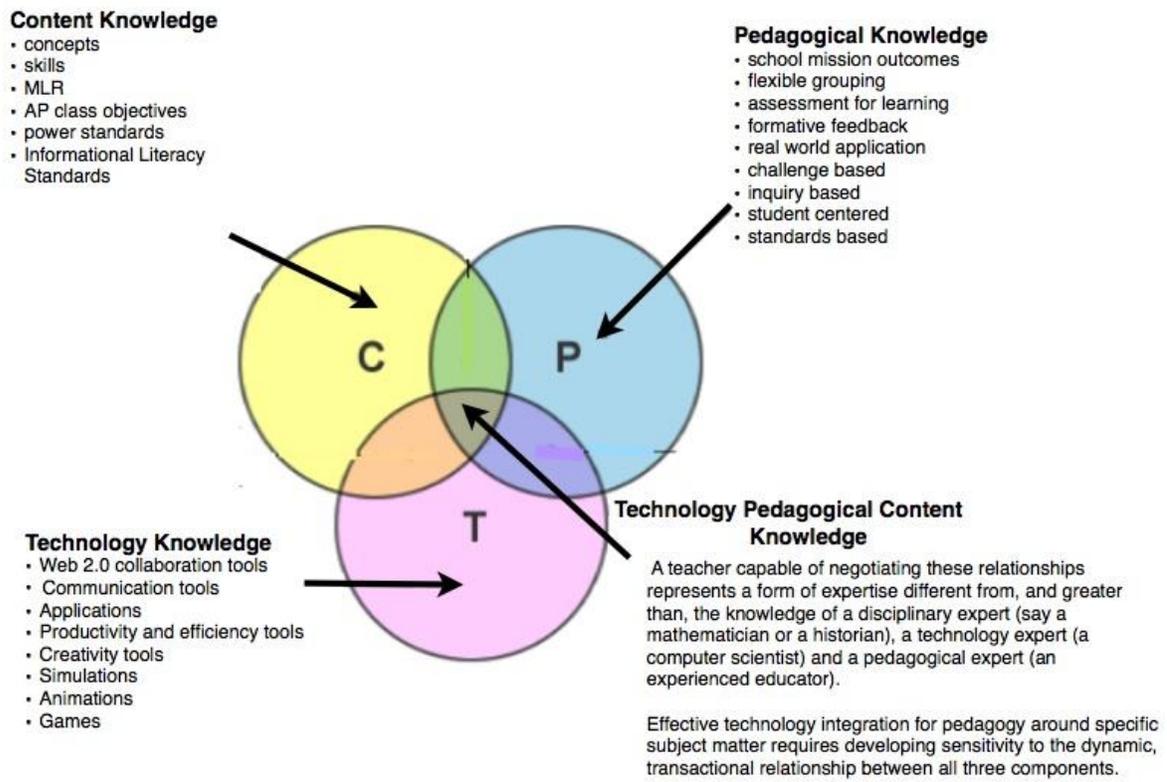


Figure 2: Framework selected for the newly developing MED curricula

- ***Align the responsibilities of teacher educators in CTEs with the competencies acquired at University***

It is also mentioned that the proposed masters programs need to consider the limitations of the previous ones in that serious attention need to be given to aligning the competencies in the curricula at university and the roles and responsibilities they have at CTEs. In the current system of training teacher educators for CTEs, they are trained to specialize in their respective disciplines though the student-teachers curricula or contents do not require sophisticated content mastery as such. For instance, a person with a bachelor degree in mathematics or other science fields is specializing in one of the streams in the disciplines such as MSC in quantum physics, MSC in inorganic chemistry or zoology. In other words, in the participants' words, such system of training is producing graduates to become science experts, not to be real teacher educators. It is advised that the current programs need to fill in such gaps in the training. In other words, we need to make sure that teaching primary school students is a science by itself. The fact that

someone who finished an MSc in Math and has an advanced understanding of a certain content of mathematics, for example, doesn't necessarily suggest that the person will be an effective mathematics teacher educator. Properly training teacher trainees who will teach in lower grades and acquainting them with necessary requisites to design effective lessons requires teacher educators to possess these skills themselves. This is not only for teacher educators in CTEs but the professors in the university who are supposed to train the teacher educators for CTEs also need to demonstrate the skill of integrating content and pedagogy. Mere rhetoric, without demonstrating to students that it is working, may not guarantee the potential primary school teachers or teacher educators at CTEs practice it.

- ***Design a relevant curriculum***

Many of the participants mentioned that the curriculum design needs to include relevant courses to address the current problems in the training of teacher educators. They cautioned that the constructive alignment among objectives, contents and assessment mechanisms need be crafted carefully so that the curriculum could meet its objectives. They also underscored the need for seamless integration of pedagogy, content and technology. Some of the participants also mentioned the need to include courses that focus on motivating teacher educators to be committed for their work and thereby enable them to instill the disposition into their teacher candidates. Moreover, to make the programs relevant and meet the desired objectives, they should be designed based on the primary and secondary school curriculum contents. That is, the graduates of such a program need to have knowledge and skills of pedagogy that help them design, deliver and assess specific contents in their respective subjects and grade levels or cycles. With this regard, one the teacher educator noted that “teacher educators should pass through a training program that focuses on primary and secondary school curricular contents and that creates opportunities to integrate content and pedagogy. Teacher candidates should be trained on what they will do in primary schools, and how.”

- ***Promote the MEd programs to all relevant stakeholders and strengthen/establish collaboration***

The need for promoting the MEd programs to all relevant stakeholders was underscored by participants. They mentioned that it needs to be fully recognized by the Ministry of Education,

regional education bureaus and most importantly by employers. Some of the participants suggested the need for a framework with regard to those teacher educators who have already an MSc degree in one of (?) the suggested disciplines. Otherwise, it will be a matter of willingness for this people to join such programs. Most importantly, there should be a clear regulation that for someone to teach in teacher training colleges, he/she should have an MEd in Science or Math education or have an education-oriented degree. They also mentioned for the need to work towards modifying the civil service procedures which simply allow everyone with master's degree to get hired as a teacher educator. Moreover, collaborative work among stakeholders including schools, CTEs, policy makers, etc. is needed. Teacher educators' training programs should be aligned with how and what to teach in primary and secondary schools (relevance of courses need to be revisited). Hence, it requires understanding current limitations of teacher educators' training programs. Emphasis should be given to practice oriented training of teacher educators. Tailoring the existing CPD for teacher educators into their domain areas (e.g., HDP) is also suggested.

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7. APPENDIX

Questions for needs assessment study to launch MED program in science and mathematics education

1. Questions for Focus Group Discussion at College of Education and Behavioral Sciences, Bahir Dar University (Participants: dean of the college, vice-dean of the college, head of the department of psychology, head of the department of curriculum and instruction)

- a) Higher education in Ethiopia has been reformed over the past decade in response to the need for improved skills development, particularly in STEM education. The recently adopted policy of 70/30 enrolment ratio in favor of STEM is a case in point. What have been the contributions of the College so far in supporting the successful implementation of this policy (e.g., preparing students and teachers in STEM fields?)
- b) What do you think are the major successes and challenges concerning STEM education in the Ethiopian education system?
- c) What is the college's plan to expand academic programs particularly in science and mathematics education, or subject area teaching in general?
 - Recruitment of subject area methodology staff
 - Establishment of academic units
 - Number of teachers who have subject area teaching specializations
 - Collaboration with other colleges and academic units
- d) How do you see the need of launching MED in science and mathematics education?
 - Relevance to country priorities
 - The capacity (e.g., staff, resources, etc.) the college has
 - If launched, commitment of the college to sustain the programs after the project (what exit strategies can you suggest?)
- e) What do you suggest the program to include in terms of professional and subject area course mix?

2. Questions for Focus Group Discussion at Amhara Regional State Education Bureau. There will be two FGDs here:

FGD 1 participants: head of the bureau, vice-head of the bureau, coordinator of the Colleges of Teacher Education

FGD 2 participants: science and mathematics teaching experts

- a) Higher education in Ethiopia has been reformed over the past decade in response to the need for improved skills development, particularly in STEM education. The recently adopted policy of 70/30 enrolment ratio in favor of STEM is a case in point. What have been the contributions of the office so far in supporting the successful implementation of this policy at the school level? (e.g., preparing students and teachers in STEM fields?)
- b) What are the major successes and challenges concerning STEM education in the region's education system?
- c) How do you evaluate science and mathematics teachers' competence, in primary and secondary schools?
- d) How do you see the current professional upgrading of preparatory school teachers' through summer programs to Masters Degree in science disciplines? What do you think about the effectiveness of the program in preparing the teachers to be good science teachers (subject area mastery + pedagogical knowledge)?
- e) If your assessment of primary and secondary school teachers' competence (in effectively implementing the current 70/30 higher education) is not so positive,
 - What kind of competence would you suggest teachers to possess?
 - What kind of competence would you suggest teacher educators working in CTEs to possess
- f) What roles do you think you will have if BDU launches MED in science and mathematics education?
 - Commitment to select, and give study leave for candidates from CTE, primary, and secondary schools?
 - Commitment to collaborate with BDU in conducting researches that involve designing and implementing instructional interventions in regular sessions?

- g) How do you evaluate the science and mathematics expertise of your staff? For instance, to what extent the profile of science and mathematics experts in the bureau matches with the roles and responsibilities of the job?
- I was wondering if there are continuous opportunities for your experts to attend (short-term/long-term) trainings that may bridge some of their knowledge gaps?
 - Would you say the Bureau has the commitment and plan to train science and mathematics experts if they don't meet the required standard?
- h) How do you see the need of launching MED in science and mathematics education at BDU?
- Relevance to the country's and the region's priorities
- i) What do you suggest the program to include in terms of professional and subject area course mix?

3. *Questions for Focus Group Discussion at Amhara Regional State Colleges of Teacher Education (Participants: college dean, college vice-dean, science education section head, mathematics education section head)*
- a) What do you think are the major successes of your college in its effort to produce competent science and mathematics primary school teachers for the region?
 - b) How do you describe the challenges faced by science and mathematics teacher educators in your college in terms of training competent primary school teachers?
 - In terms of their training background
 - In terms of their pedagogical skills
 - c) How much the profile of science and mathematics teacher educators in your college matches with their roles and responsibilities?
 - Commitment to train science and mathematics teacher educators within the college if they don't meet the required standard
 - d) I assume you may have some information about the competence of your students when they graduate in the various disciplines.
 - How do you evaluate, for example, the subject matter knowledge of those would be primary school science and mathematics teachers when they graduate?
 - How do you evaluate their pedagogical knowledge?
 - How do you evaluate their pedagogical content knowledge?
 - e) How do you evaluate the teacher educators' competence in helping the teacher trainees integrate mathematics and science subjects with other subjects and school activities?
 - f) What is the College's plan to train teacher educators particularly in science and mathematics education, or subject area teaching?
 - g) How do you see the need of launching MED in science and mathematics education at BDU?
 - Relevance to country priorities
 - h) What roles do you think you will have if BDU launches MED in science and mathematics education?
 - Commitment to select, and give study leave for candidates from CTE, primary, and secondary schools
 - Research collaboration (action research)?

- i) What do you suggest the program to include in terms of professional and subject area course mix?

4. Interview items for staff at Colleges of Teacher Education who hold MED in science or mathematics teaching from earlier programs at different universities

- a) How do you describe the challenges faced by science and mathematics teacher educators in your college in terms of training competent primary school teachers?
 - In terms of their training background
 - In terms of their pedagogical skills
- b) What limitations did you see as part of your MED training?
- c) How do you see the need of launching MED in science and mathematics education at BDU?
 - Relevance to country priorities
- d) What improvements do you suggest to be made in MED programs in science/mathematics teaching? What do you suggest the program to include in terms of professional and subject area course mix?