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The 70-30 Dilemma and Physics Teachers' Preparedness

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Abstract

The new direction of education chosen for Ethiopia promises the country's development and poverty eradication to be ascertained by the development of large army of trained citizens in science and technology fields. Some three years have passed since the implementation of the 70:30 policy comes into effect. This paper tries to assess how realistically this direction is being pursued in general and what the preparedness of physics teachers for the best attainment of the goal looks like. Using government documents, a general overview of the reality of Ethiopian schools in relation to science education has been presented and the existing dilemma has been established. The dilemma is larger proportions of students are directed towards the natural science direction while their achievement in science is very low. Therefore, the majority of the students, as high as 90% of them, are below the policy minimum in one of the central subjects in science and technology. Then, by way of resolving the dilemma and assuring progress in the 70:30 direction; well qualified physics teachers have been suggested. These qualified teachers needed are those which are more than ordinary to work in the grim conditions of students' achievement and reverse the declining trend. However, the existing professional readiness of physics teachers as demonstrated with selected case study[5] researches is alarming in both their subject matter as well as professional knowledge. Finally, the paper concludes with suggestion of revisiting, diversifying and deepening physics teachers' training which focuses on both the basic physics subject matter knowledge (SMK) and the pedagogical content knowledge (PCK).

Introduction

Historical Evolution

Ethiopia has traveled a long way since the beginning of modern schooling around the end of 1890s to date. Though science education is believed to exist in Ethiopian school system from the very beginning, little attention has been given to it at least in the first half of the 20th century (Kebede, 2006). Of course, the recognition of the role of

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[5] The case study on graduating trainee teachers was conducted by another researcher, but used in this investigation for a purpose other than its initial one.

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education in science and technology for the country's development was even demonstrated in the Zemen Mesafint by the strongest desire of Emperor Tewodros II (Rassam, 1868). However, the "First Curriculum", as Solomon Areaya (2008) refers to, which served up to about the end of the 1940s and exclusively to the primary schools did not contain science education as such. It is the secondary school curricula of the years to follow that have included science as an independent subject (MoE, 1955). The expansion and progress of science and technology education in modern Ethiopia seem to be marked as late as 1950's with the opening of science and technology related faculties and colleges (Zewde, 2002).

Ever since the beginning of modern education in Ethiopia, it (and in particular science and technology education) seem to have revolved around the same axis supporting the country's development towards civilization. As emphasized by many researchers (Kebede, 2006; Areaya, 2008; Semela, 2009; Asgedom, 2010), though it was far from being realized, Emperor Tewodros (Rassam,1868) expressed in his letters to the British Queen and in words to her messengers that he wishes to educate Ethiopian in artisanship and lead them to civilization, prosperity, and power. Similarly, Emperor Menelik II also shared the same vision for education expressing his desire of having "educated people" to ensure peace, to reconstruct the country, and to become great nation in front of the European powers (Areaya, 2008, p. 38). Partly as inheritance from the Emperors, and due to shame of defeat at the hand of Italians, Emperor Haile Selassie I had also worked a lot in expanding and disseminating education throughout Ethiopia with the same agenda of development and civilization (Zewde, 2002).

During the Derg regime, in addition to the role of assisting the development of the country into a modern and prosperous socialist country, science education was part of the development of all-rounder socialist citizen (Zewde, 2002). The 1994 New Education and Training Policy of Ethiopia (TGE, 1994) redirected Ethiopian education in general and science and technology education in particular. Nowadays, the developmental mission of science and technology education is to "strengthen the individuals and society's problem-solving capacity, ability and culture starting from basic education and at all levels." (TGE, 1994, p. 1) Being this the agenda of education in Ethiopia, remarkable expansion and development activities have generally taken place since the new Education and Training Policy was proclaimed in 1994.

The 70:30 Policy for Ethiopian Public Higher Education

One of the relevant activities to our issue is the policy direction putting science and technology education at the top of the educational agenda. High ranking officials in the education system of Ethiopia describe this new direction, which is commonly known as the 70:30 policy, as motivated by the rapid economic growth witnessed in various sectors of the country (Otore, Ayele and Gebremariam, 2009). The same officials, Otore and his associates argue that the present condition of the country has demanded highly qualified and competent professionals in the field of science and technology. The Policy document, the MoE (2008) as well conforms to the above claim by beginning its introduction with such a statement:

> *The Federal Democratic Republic of Ethiopia continues to marshal all of its resources to eradicate poverty and achieve the status of a democratic lower-middle-income country with good governance and where social justice prevails by the Ethiopian 2020.*

In this struggle of eradication of poverty and sustaining the current economic and social growth, the Government of Ethiopia has placed a great emphasis on the importance of science education as an essential component for development needs of the society (Otore, et al., 2009). Though it is now focused on science and technology, taking education as instrumental for development by Ethiopian rulers and leaders is still maintained here.

The central idea of the Ethiopian Education and Training Policy is to reserve 70% of Higher Education Institutions (HEIs) annual intake for science and technology education, whereas 30% to be left to social studies. The proportion of science and technology education as prescribed in the 70:30 Policy document has not been arrived at independently from the long standing slogan of Ethiopian education. The United Nations Education, Social and Cultural Organization (UNESCO), as early as the mid-20th century, developed an international guideline for enrollment ratio in higher education, recommending a 60:40 distribution between science/technology and art/humanities (World Bank, 2003). According to a study of the World Bank, only 33% of the students in Ethiopian HEIs were pursuing science and technology disciplines. Thus, the 2008 Policy of 70:30 percent seems to conform to international standards and may be to make up for the backlog by exceeding the UNESCO's recommendation for some time.

Context of the 70:30 Policy

To the effect of developing the country with knowledge based progress, so far a lot has taken place that has direct impact on the status of science and technology education in the country. Therefore, one can see that the implementation of the 70:30 percent Policy is in the arena of very fast progress in education sector as well as in other sectors (MoE, 2010b). In the past three years, the number of primary schools just increased from 20,660 to over 26,950 and secondary schools from 952 to 1,335. During the same period, the number of students enrolled in the Ethiopian primary and secondary schools grew from about 15.4 million to 17.5million (MoE, 2010a). With simple arithmetic calculations, one can witness that the infrastructure development (school building) exceeded the student population's increment which is an indicator of commitment to improve the schools' conditions for science and technology education to play the development role.

Secondary schools are responsible for preparing the army of students to the policy direction. As reported in the Education Statistics Annual Abstract of 2009/10, the conditions of the secondary schools have also dramatically changed. This implies that conducive environment for science and technology education has been established (MoE, 2010a). Student teacher ratio (PTR), student-section ratio (SSR), and proportion of qualified teachers are some of the indicative variables of quality. In the years 2004/05 to 2009/10, all these variables showed rapid improvements. The PTR in secondary schools in these five years has been reduced from 51 to 36 and the SSR reduced from 82 to 64 even with some of the regions to go below the national standard of 40 per section. With multifaceted approaches, the population of qualified teachers in the secondary schools has also increased from 41% to 77.4% in the same time span.

Laboratories are always taken for granted to be an integral part of science education. In this direction, the existing picture of the Ethiopian secondary schools is quite encouraging, for example, the majority of the secondary schools have two or more laboratories. In general, only 122 schools (9%) out of the total schools in the country have reported that they have had no laboratory at all. If classrooms are not congested and the teachers are qualified, the availability of laboratory is likely to lead to improved teaching. Thus, it is legitimate to claim that the implementation of 70:30 has been on fertile grounds.

Furthermore, momentous increase is observed in higher education during the past few years. The number of governmental Higher Education Institutions (HEI) has increased from few to 26, while the student population increased from 143,753 in 2004/05 to 357,519 in 2009/10 only in public universities and colleges. This means that using the World Bank (2003) estimate of the science and technology proportion of student population (33%) to 2004/05 and the 70:30 policy proportion for the year 2009/10; there is more than four fold increase in student population in favor of science and technology in Ethiopia.

Statement of the Problem

The rapid socio-economic development of the country necessitated highly qualified citizens in the areas of science and technology. This demand resulted in maneuvering the direction of development of Ethiopian Higher Education Institutions and, consequently, also the secondary schools. There is no assurance of sustainability of growth and winning a country’s share from the global knowledge based competition without large size and good quality science and technology education. Thus, the Policy of 70:30 percent is arguably a necessity. This policy is not just anticipating domestic job opportunities for the science and technology graduates but it also recognizes the expanding skilled manpower need of at least the nearby countries demonstrated now in brain drain in some fields (MoE, 2008). Though it is not openly expressed in the Policy document, the high level skill and competency vision of the Policy can also be inferred from these two demands. Commitment to the realization of the vision and objectives of the 70:30 policy are demonstrated by large size investment and observed remarkably fast developments in Ethiopian schools and HEIs. Several new schools have been established, existing secondary schools expanded since the student-section ratio drops below the national standard, to some extent, in some regions. Teachers have also been trained to increase the proportion of qualified teachers by 36.4%. More than 90% of schools were organized with laboratories that could support the activity of teaching science in these schools.

This is being the context of the 70:30 policy in the country; it is reasonable to think that the policy is on the right track and baring its fruits. Obviously, the success of such a policy among other things depends on its inputs (including students) and how the implementation process goes on. Thus, it is reasonable to ask at this point whether the country is at the point to receive the promised highly qualified graduates from its HEIs or not. Even though the answer to this question is yes from the quantitative perspective, the quality aspects and impacts are still issues which require proper scrutiny and evaluation.

Therefore, this study tried to establish an existing gap between the anticipated quality output and the undesirable quality shortfall in the input. Furthermore, as one of the contributing factors to the existence of the gap, the physics teachers' preparedness to work on the input side of the policy will be assessed using two mini case studies. Hence, the two questions this research tried to answer are: Are the quantitative conversion plans of 70:30 policy matched with its quality demands? How is physics, one of the few critical subjects to the whole of the 70% professional fields, contributing to the quality demand in terms of teachers' competency?

Scope and Delimitations

The gap between the policy demand and the input quality in this research was inferred from the policy documents as well as the Education Statistics Annual Abstract 2002 E.C. (2009-2010 G.C) and the Education Sector Development Program IV (ESDP IV) which covers the years from 2010/2011 to 2014/2015. Therefore, the dilemma established here is based on secondary data as perceived by the researcher. Besides, the national examinations, whose results are reported in the two documents prepared by the Ministry Office (MoE, 2010a; 2010b), were not developed with the aim of inspecting the quality of input within the 70:30 policy. As a result, the evidence of the existing gap should be taken as indicative of the problem rather than as conclusive.

In the two case studies, participants were selected based on availability of and inconformity to the purposes of the case studies, but not with the assessment of quality of physics teachers in Ethiopia. Samples drawn were comprised of graduating and graduate students from one college and a university. A claim of representativeness of all Ethiopian teachers is, therefore, amply unjustified. Hence, the existing evidence illustrates that the low profile of the Ethiopian Physics Teachers should be understood with care. The result neither indicates the quality of the phasing out of teacher education nor related to the new program, as data was collected before the beginning of the new one.

Methodology

This is a case study of the status of secondary school students' achievement in science which is at the root of the 70:30 policy as impacted by the physics teachers' basic subject matter competency. Secondary school students' previous achievements in national examinations in the year 2002 E.C. (2009/10) were taken and their meaning in the light of the policy had been investigated. After the implication of the national examination results to the overall vision of the 70:30 policy has been identified, physics as a problematic subject in students' achievement and to the 70:30 policy is illustrated. Then, two case studies, one on graduating trainee physics teachers and the other one on graduate students in few physics programs were presented to demonstrate the possible cause of problematic physics in the Ethiopian schools.

The first case study was conducted on graduating physics trainee teachers (N=30) of the Kotebe College of Teacher Education. Mesfin Tadesse (2010) conducted the study on the graduating physics trainee teachers with Electricity Concept Test. The result of this study was used as one indicative data about the shaky understanding of physics teachers from teachers colleges. This data was also compared with results obtained elsewhere (e.g. Turky). The second case study was conducted on graduate students (both PhD and M.Sc Programmes) physics students who had teaching experience of 2 to more than 20 years. The data was collected over a one year period from beginning from November 2010 to January 2011. The participants were identified when they were available for class contact with the researcher. The total number of participants in the second case study is 52. The researcher designed and administered a test on their conception of the shape of the earth to all of the participants.

Instruments

1. **Electricity Concept Test (ECT)**

This test was developed by E. Bilal and M. Erol (2009) to investigate physics students' conceptual understanding at an introductory college/university level. The concept test was originally consisting of eight sub-topics, including 23 two-tier conceptual questions. However, in the recent study conducted by Mesfin (2010), it had been adapted to retain the 22 multiple choice items.

2. Earth Concept Test

This test was developed and used by several researchers, including the well known Stella Vosniadou (1994) and Joseph Nussbaum (1985). Some of the diagram completion problems pertaining to gravity in relation to the shape of the earth and the organization of space have been selected and adapted for our purpose. Therefore, one question with nine diagrams was given to the participants to respond by showing diagrammatically about how a body dropped at the edge of a hole through the body of the earth would move. The responses of participants were marked, classified and compared with concept progression steps found from literature. Five steps (Notions as she calls them) were identified by Nussbaum. By making comparison with the progression steps where our physics teachers are have been identified.

Results and Discussion

1. **Student Enrolment into Science and Technology Streams**.

According to the 70:30 policy, by the year 2003, the conversion plan reaches its full magnitude and, therefore, there will be 110,000 students who entering into the Ethiopian HEIs (MoE, 2008). The distribution of these students among the six bands (disciplines) will be as shown in the following table.

Table 1 – Distribution of Students' Disciplines and Intake Plan by Types of Band.

Type of Band	Discipline	Intake Plan	%
Band 1	Engineering and Technology	44,000	40.0
Band 2	Natural and Computational Sciences	22,000	20.0
Band 3	Medicine and Health Sciences	5,500	5.0
Band 4	Agriculture and Natural Resources	5,500	5.0
Band 5	Business and Economics	22,000	20.0
Band 6	Social Science and Humanities	11,000	10.0
Total		**110,000**	**100.0**

Source: Adopted from MoE, 2008.

According to the above table, there should be 77,000 students assigned into science, technology and related fields from those who sat for the Ethiopian Higher Education Entrance Certificate Examination (EHEECE). All of these students are expected to have very good preparation in all the science (i.e. biology, chemistry, and physics) subjects in their secondary school years. As expressed in the introduction, the Policy is anticipating graduates with very good knowledge and skills from their undergraduate education to be more adaptive and competent not only locally but also regionally. Besides, their secondary school preparations at least for most of these new entry students will continue to learn the basic science subjects in their subsequent training in HEIs. The learning of physics, at least at an introductory level is apparent for the top 65% (students of Band 1, Band 2, and Band 3).

Table 2 - Graduates from Ethiopian Schools

Institution Level	**Student Population (2002)**	**Student population (2003, Estimate)**	**Estimated Science and Technology**
Grade 10 (EGSECE)	327,501	376,954	263,868
Grade 12 (EHEECE)	102,398	127,793	89,455
Undergraduate	66,999	85424	59797
Post Graduate	4,724	6415	4490

Source: MoE, 2010a, *Education Statistics Annual Abstract (2009/10).*

As illustrated in Table 2, there were a total of 102,398 students who had sat for EHEECE by the end of 2002 E.C. This size of student population is already below the expectation of the 70:30 policy which estimates to reach the maximum intake of 110,000 by the beginning of 2003 E.C (MoE, 2008). Besides, though it is reasonable to expect most of these students to pass to HEIs, it is absurd to expect all to go on into that level. However, there are also students who are unaccounted for in the national educational statistics, but will join the HEIs. Perhaps, these students will compensate for the short fall, to some extent, but not to all of it.

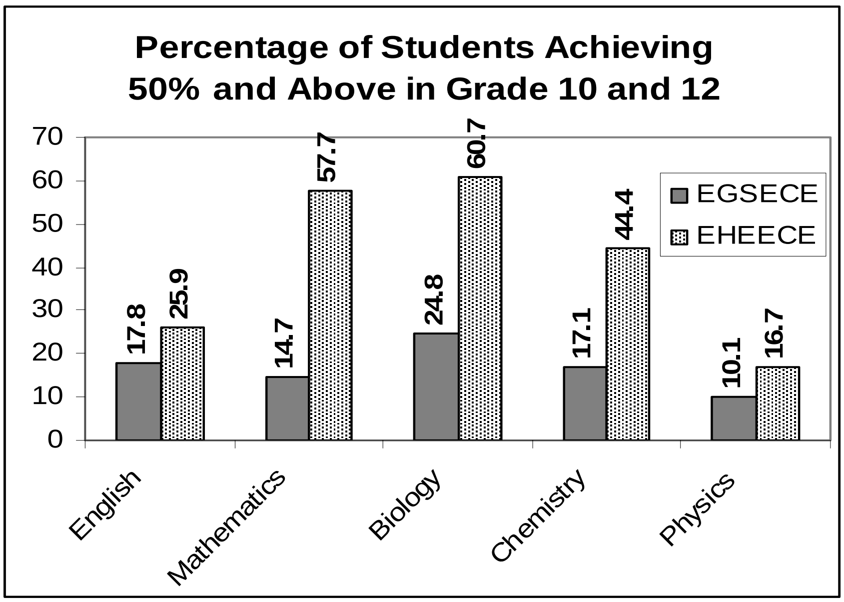
As presented in Table 2, the maximum intake seems guaranteed for the 2004 E.C. (2011/12) academic year. The growth rate for the number of graduates from grade 12, as indicated in the Education Annual Statistics Abstract is 24.8% (MoE, 2010a). It is fair to assume that the increase will be at least the same as that for the year 2002 E.C. Hence, with this projection, there will be 127,793 students who are going to sit for the EHEECE. This means that the quantitative goal of the 70:30 policy is 100% attained or exceeded by the end of 2003 E.C. if not by 2002 E.C. According to this Growth and Transformation Plan (the 70:30 policy), 70% of those who would go to the HEIs will be enrolled in science and technology fields. That means every year to follow nearly 90,000 students will join science and technology fields.

2. National Examination Results of 2002 E.C (2009/10) and Intake of 2003

The 70:30 percent policy, on one hand, requires large population of science and technology students in the HEIs and high quality graduates, on the other hand. Both of these trends of the Policy are recognized to have profound impact on the science and mathematics education in the secondary schools. In this regards, the Ethiopian Policy says (MoE, 2008):

> *This in turn (the conversion in HEIs) takes us to the critical issue of the relevance and quality of science and mathematics education in our general secondary and preparatory schools. We anticipate challenges, although processes have been underway already to overcome the weaknesses of secondary as well as primary education. The point is challenges have to be identified and resolved at all levels so that the converted system functions effectively and not that the conversion has to be postponed until the relevance and quality of science education improves across the primary and secondary education system* (p. 15).

The quality issue in the general education (1st cycle secondary education) and in preparatory schools has become prominent for every stakeholder in the education sector (MoE, 2010b). With these assumptions of the Policy and the policy context described in the introduction, it is worth looking at the quality of outputs of the secondary education. Particularly, we did this in relation to science and mathematics education and as reflected by achievement scores of students in the two national examinations – EGSECE for grade 10 and EHEECE for grade 12. The achievement scores for five subjects in these examinations are presented in terms of the number of students who scored 50% or more. The cut point 50% is the standard set by the Education and Training Policy (TGE, 1994). This achievement records in the two examinations for the year 2002 E.C. (2009/10) is shown using the following bar chart.



Source: Adopted from MoE, 2010b.

The national average percentage passed at the end of 2002 E.C. was found to be 13.8% for EGSECE and 34.9% for EHEECE. One should note that these scores are for the subjects basic for any science and science related fields. This means that even if at the exit point (Grade 12) bigger number of students passed the national examination. Nevertheless, it is still very low by any standard and by the requirements of the 70:30 policy. By 2003 E.C., if we assume that all of the 102,398 students will have been allowed to enter into the HEIs, then we have 71,680 students in the Technology, Natural

Science, Medical and Agricultural Faculties of the HEIs. Out of these, only 25,016 students passed the national examination in science and mathematics. This obviously means a blow to the 70:30 policy which has expected a total of 77,000 competent students to be enrolled in the science and technology fields.

Therefore, the existing gap at the input side of the 70:30 policy (to the HEIs) can only be offsite if the teaching environment and the instructors in the HEIs considerate the background of the new entering students and commit to bring up their standards. The very low profile of students entering into the HEIs with such large proportion (65.1% by our estimate) does make the effort of the institutions nullified. Given the massive quality improvement activities observed in the secondary schools (Otore, et al., 2009; MoE, 2010b), one may hypothesize that this is an isolated incident. However, the EGSECE (Grade 10) score is also demonstrating such a grim picture which has suggested the problem will persist at least for some years in the future as well. As indicated by the results of the National Learning Assessment (NLA) conducted on the ESDP IV (MoE, 2010b; Shibeshi, et al., 2009) the worsening student achievement in science and mathematics had become cornice in Ethiopian school system.

The other unpleasant picture we can observe from the bar chart of the national examination achievement is what has occurred in the case of physics. Physics, as one of the core subjects in secondary schools makes the background preparation of students to the HEIs. Even if there may be relatively lowest proportion of students majoring in it (Semela, 2009), the 70:30 policy which has attributed the largest proportion (40%) for technology made it one of the critical subjects. Physics is taken as a minor as well as co-minor area compared to several other fields as well. Besides, medicine also needs at least those students with introductory physics background. But, unlike all this widespread demand of good preparation in physics background, the achievement level is the lowest of all the subjects. Only 16.7% of those students who had sat for EHEECE scored pass mark in physics. Being a subject with the worst achievement, on one hand and being such a critical subject for the larger proportion of the 70%, on the other hand, physics is pointing to the shaky ground on which the implementation of the Policy is standing.

Case Studies about Physics Teachers

It is a commonsense knowledge that a good teacher matters for good student achievement. Besides, several research reports indicated that students' achievements had been highly correlated with teachers' quality (Yip, Chung, and Mak, 1998; Ball, Thames, and Phelps, 2008; Cekbas et al., 2009). Moreover, Sarkim (2004) suggests that in order to understand what teachers have done and have not done in terms of impact on students' learning, it is necessary to investigate teachers' knowledge. According to Schulman, teachers' knowledge can be classified into three distinct but overlapping areas. These are: (1) teachers' Subject Matter Knowledge (SMK); (2) teachers' Pedagogical Content Knowledge (PCK); and (3) teachers' Pedagogical Knowledge. While PCK is considered as distinct from the other two areas, it is also considered as a bridge between the two or something resulting from the unification between the two areas. However, it is SMK that is considered as basic of the three areas and crucial for acquisition and development of PCK (Rollnick et al., 2008).

With this background, we cannot help asking if the Ethiopian physics teachers' subject matter knowledge (SMK) is not responsible for the incredibly of the low achievement level. Several other factors, in fact, claimed to explain the low achievement and disappointment with physics which had been identified by researchers (Semela, 2009; Shibeshi, et al., 2009). However, teachers' subject matter knowledge in physics seems to be taken for granted that seldom researches in this direction were conducted. The following two case studies which are conducted to investigate physics teachers' SMK in basic physics concepts will be used to illustrate the not any better case than the students.

Graduating Trainee Teachers Physics Achievement

Mesfin Tadesse (2010) designed and conducted a small-scale empirical study on conceptions of graduating students in physics at the KCTE. The total number of participants in the study was 30 and all of them were in their final semester to complete their three years university education to become physics teachers. By the time the trainee teachers took the ECT, the participants had already taken two courses in Electricity and

Magnetism. Therefore, they were expected to be at a much higher levels with respect to basic concepts of electricity and magnetism.

As reported, the maximum point score in the ECT test was found to be 15 out of 22. The mean score was 6.93 (31.5%). In this test in which about 90% of the graduating physics students failed, it had been observed that the majority of them failed to attain at least the national pass mark of 50% (TGE, 1994). It is fair to take this result as devastatingly depressing as the test is on just basic concepts of electricity and the participants (examinees) have been those who will be teaching the same concepts to school children in the Ethiopian secondary schools beginning from the coming year.

At this juncture, it is important to compare this result with results obtained elsewhere. Cekbas and Kara (2009) had also conducted similar research on trainee physics teachers in Turkey. Except that the study was on other basic concepts of physics than those of Mesfin research, the study was also conducted using basic concepts test. Besides, Cekbas and Kara tested not only graduating students but also other students starting from the 1st year of university. Thus, fair comparison could not be made between the achievement levels of the two studies. But, a general comparison revealed that such a low achievement in basic concepts of physics had been expected. The Turkey teachers, for instance, showed a decline of 24.84% from the first year (70.25%) to the graduating year (45.41%). Still, one can see that the Ethiopian trainee teachers have lower score (31.5%) than their Turkey counterparts. The lower score of the Ethiopian trainee teachers in the final year suggests that either the decline in our case has been faster or the beginning score has also been very low.

Case Study Two (Practicing Teachers Physics Achievement)

The other study on teachers' knowledge of basic physics concepts was conducted on practicing physics teachers who had been graduate students in some physics and physics education areas. The 52 participants had 2 to 20 years of experience with a mean of 8.6

years. This means that these teachers, who had been teaching in secondary and university levels, had a very good experience of basic concepts in the physics curriculum.

In this case study, the test was on concepts related to the shape of the earth. The problem was particularly focused on concepts of gravity, up-down organization of space, flatness of the earth, and motion under gravity. Based on the study of children, Stella Vosniadou (1994) had developed a scheme of progression of conception from "Initial Model" to "Scientific Model" into three levels. Vosniadou was of opinion that all school children progress along these levels at different rate, depending on the quality of instructions they receive and their experience. Thus, it may seem unexpected to find physics teachers stranded before reaching the scientific conceptions. Nevertheless, it is a common knowledge in the field of misconception research that students will keep their alternative conceptions even after instructions. Besides, Yip and his co-workers (1998) demonstrate that physics teachers may remain with some of their naive ideas from their school years. Thus, it is not by accident that we find physics teachers trying to teach the curriculum scientific ideas while they still strongly held some "Synthetic Model".

Table 3 - Graduate Students (Physics Teachers) Scores on Earth Concept Test

Types of picture	Correct	Incorrect	Success (%)
Picture-1	11	41	21.15
Picture-2	19	34	36.54
Picture-3	11	39	21.15
Picture-4	12	40	23.08
Picture-5	15	37	28.85
Picture-6	14	38	26.92
Picture-7	10	42	19.23
Picture-8	9	41	17.31
Picture-9	10	39	19.23

Source: Own case study results, 2011.

The test contained nine diagrams in which the earth was represented by a circle with a hole dug through its body. Participants were simply asked to show in the pictures how a body dropped at the edge of the hole would move. The scores of the 52 teachers are presented in Table 3. As can be seen from the table, responses with picture-2 had greater number of participants (36.54%) who had correctly responded, while the frequency of correct response to picture-8 was found to be the least (17.31%). The average correct response frequency in this test was 23.72%. This means, the participants in the case study found this diagram completion task difficult. The question was very simple; it was actually set up to establish children's ideas about the shape of the earth. Teachers of these children and their teacher educators are supposed to answer it completely without much difficulty. However, only four participants who had pursuing their MSc and PhD studies answered practically all of the questions.

Nusebaum (1985) categorized the different alternative conceptions in this area into five notions (categories) with respect to three basic ideas. The basic ideas include: earth's shape, nature of sky and space, and organization of space (up-down). Nusebaum's concept categories in their order of progression are the following:

Notion 1: The earth we live on is flat and not spherical like a ball.

Notion 2: The earth is like a ball but with two hemispheres on/in one of which people live on the flat side.

Notion 3: The spherical earth is surrounded by unlimited space organized in absolute up-down directions.

Notion 4: Objects fall to the surface of the earth not towards the center of the earth.

Notion 5: Scientific conception that the earth is spherical in an isotropic space and objects fall towards the center of the earth.

The responses of the 52 participants were classified according to these categories. Only 7.7% of those teachers who answered all the questions correctly were taken as having reached the fifth level-scientific conception. The other teachers were distributed on the other two conceptions, that is, 30 (59.6%) of them were found to hold earth's surface referenced gravity idea (Notion 4) and 17 teachers (32.7%) were found to hold the absolute up-down directions in space (Notion 3).

The fact revealed in this study, even though it was not serious about its sampling and data collection procedures, it had been an indicative of a series problem in our education system. The shape of the earth and concepts related to the earth as a cosmic body is found in our school curriculum from about grade 2 to university postgraduate levels. Such concepts, like gravity are the most recurrently appearing themes in the physics curriculum of the secondary schools and junior university levels. Despite their familiarity with such concepts in their teaching practices, physics teachers in Ethiopia are teaching them to school children with a very confused understanding.

Summary and Conclusion

There were two research questions this research aspired to answer in relation to the 70:30 policy overall goals. These are: (1) whether the quantitative conversion plans of 70:30 policy matched with its quality demands or not? (2) How is physics, as one of the few critical subjects to the whole of the 70% professional fields, contributing to the quality demand in terms of teachers' competency? The analysis of data collected from the National Educational Annual Statistics as a source of secondary data were used to establish the existing gap between the demands of the policy and the quality of input to the HEIs. In addition, based on the implications of the problems identified from the analysis, for example, the case of physics teachers' preparedness to make 70:30 achieve its ambitions had been investigated using two case studies. The summary of the results obtained are thus as follows:

The 70:30 policy envisaged to attain full intake capacity of the Ethiopian HEIs at the beginning of 2002 E.C. (2009/10). This goal appears to be achievable even though there are some indications that success may not be 100%. Consequently, nearly 44,000 students were enrolled into Engineering and Technology Faculties, nearly 22,000 into the

Faculties of Natural and Computational Sciences, and 11,000 into Medicine and Agricultural Faculties.

Out of all those students, only 34.9% of them passed the national examination in sciences and mathematics subjects which had been prepared in the EHEECE. This is expected to have compromised the quality demand of the 70:30 policy. Thus, by implication, this research conclude that a lot of upgrading and readjusting have been required in the secondary schools as well as in the universities before one can confidently say that the policy is a success story.

The National Examination results at grade-10 (EGSECE) and grade-12 (EHEECE) indicated that students achievement in sciences and mathematics were found to be very low (13.8% and 34.9% respectively). In addition, it has been demonstrated that the very critical subject – physics - is the one with the least achievement. The implication of the very low achievement in physics has been demonstrated to affect about 65% of the goal of the 70:30 percent policy, as physics is going to be important in one way or the other critical for that percentage. As there are several other inputs to quality education in Ethiopian that secondary schools seem to have been addressed (Otore, et al., 2009; MoE, 2010a; MoE, 2010b), this research only focused on the investigation of those possible factors affecting physics teachers' quality.

The case study conducted with graduating trainee teachers showed that achievement in basic physics concept tests was found to be very low (even when compared with international results). The mean score found was only 31.5%, whereas the national policy requires 50% (TGE, 1994) and the result from similar study elsewhere was 45.41% (Cekbas and Kara, 2009). Even if the comparison is not fair for validity reasons, such low profile of our physics teachers is indicative of a grave problem in our education system. Besides, it is attributable to the lowest achievement of the students in physics in the national examinations. Hence, the physics teachers' quality has a very serious implication to the success of the 70:30 policy. It is advisable to contemplate into the recruitment, training and practice of physics teachers if the high stake goals of the policy are to be achieved.

Recommendations

1. Large-scale research and assessment of implementation of the 70:30 policy, which focused on quality, should be conducted to identify problem areas and suggest appropriate remedies. The quality assessment should not only be about curricular inputs and students' achievements, but it should also critically investigate teachers' knowledge and practice.
2. Enrolling students who did not at least achieve the minimum requirement will adversely affect the output of the 70-30 policy. Therefore, remedial measures by way of improving the standards of enrolling students into the HEIs should be devised and implemented.
3. The research report with which our teachers' scores have been compared (Cekbas and Kara, 2009) demonstrated that as physics teachers take more and more advanced courses their achievement on basic concept tests declines. This may be interpreted as that preoccupation with higher level physics is not a guarantee for good SMK for teaching. Thus, the physics curriculum for teachers (the would be teachers) must be assessed carefully in terms of which concepts are incorporated into it and which are not. Furthermore, the curriculum should be revitalized in such a way that it will be broadened at the bottom to incorporate basic concepts and flattened at the top to let trainee teachers have time and give their due attention to focus on how they are going to teach basic concepts.

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