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Strategies Influencing Competence In Soft Skills Development Through Mathematics In Technical Institutions In Kenya

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Abstract: *Mathematics plays an important role in developing students' logical, creative and critical reasoning, optimize industrial processes, solve problems, function with linear and non-linear thought processes and communicate solutions briefly and precisely among other soft skills. Despite the critical role played by mathematics, low competence in soft skills had been witnessed. Low competence in soft skills had been a source of concern to stakeholders in technical and vocational education because the input was not commensurate with the output. Low competence in soft skills was associated with instructional challenges. Activity-based instructional processes and learning in mathematics could improve competence in soft skills. Yet, the use of multi-disciplinary approaches which depend on using students' experiences in mathematics and science, project-based teaching and industrial-based activities had not been fully exploited. The purpose of the study was to establish what activities in multi-disciplinary approaches could stimulate interest in mathematics for development of physical, social and mental well-being skills in technical institutions in Kenya. The findings and recommendations were expected to inform policy decision in establishing quality and relevance in training and accreditation in mathematics in technical colleges in Africa and world over. The study was carried out by a descriptive survey design. Lecturer's questionnaires were administered to collect data on teaching styles. The strategy of multi-disciplinary approach for improving students' competence in soft skills in technical institutions in Africa and world over was recommended.*

Key terms: *Mathematics, multi-disciplinary approaches, Competence in soft skills*

1. Introduction:

Mathematics is foundational in scientific, technical, vocational and entrepreneurship training in technical, industrial, vocational and entrepreneurship training (TIVET) institutions in Kenya and world over. It plays an important role in critical thinking, logical thinking, effective decision making, and communication. Learning of mathematics is expected to be based on experimental and manipulative activities for competence-based training and assessment (CBTA) as well as competence in soft kills for creative problem-solving, critical thinking and effective decision making (Jackson, 2009; Jackson, Dukerich & Hestenes, 2008). Despite the critical role played by mathematics in daily life, students' achievement in mathematics technical and vocational institutions in Kenya (Bukhala, 2009; Amuka, Olel and Gravenir, 2011) and world over had persistently been low (Absi, et al., 2011; Jackson, 2009 and CRS, 2007).

Students in Kenya and the world over viewed learning of mathematics as mere reproduction of abstract concepts and non-practical applications making the discipline difficult (Absi, et al., 2011 and Khakala, 2009). Hence, low achievement in mathematics had been associated with deficiencies in instructions (Jackson 2009; Khakala, 2009). Dominative teaching and learning approaches observed in institutions of learning had a display of the knowledge and skills of the instructor while students became passive recipients of the mathematical theories, principles, working procedures and algorithms making mathematics learning boring and unfruitful. Activities drawn from familiar surrounding could raise questions. The process of seeking for answers could lead to construction of knowledge (Muthoni, 2012). Activity-based learning in multi-disciplinary approaches could develop students' conceptual understanding in mathematics. However multi-disciplinary approaches that incorporate activity-based learning as a source of content and pedagogical strategies for developing students' conceptual understanding in mathematics has not been fully exploited. Hence, the impetus for this study was justified.

In Kenya, the National Council of Science and Technology (NCST) visions is a multi-disciplinary approach in meeting the need for competent-based training and assessment through science, technology, engineering and mathematics (STEM) scholars' development. Similarly, research in STEM was heralded by Congressional Research Service (CRS) Report (2007) in institutions of learning in USA. STEM was initially responding to students' low achievement in science and mathematics in USA compared to their counterparts from Hong Kong, Singapore, and Chinese Taipei. The research project aimed at equipping students with a competitive edge for the 21st century creative innovations; prepare scientists, technologists, engineers and mathematicians who were globally and strategically placed for technological and scientific advancement. Low achievement in mathematics as well as low competence in Kenya and world over had been a source of concern to the industries as consumers of scientific and technological knowledge and skills, student, parents or guardians, instructors, educators, government among other stake holders because the graduates output was not commensurate with investment. Hence, a multi-disciplinary teaching strategy could be necessary and urgent.

2. Literature:

The global view of provision of instructions in TIVET in the developed countries such as Britain, Germany, Japan and USA among others was anchored on the advent of: digital simulation for learning in engineering, creative designing, architect, and actuarial science (Zachary, 2009); robot teachers (Gatonye and Mathenge, 2009); mobile phone learning (Nyantino, 2009), and the need for instructional activities that could help students to effectively use the physical tools for enjoyment, nurturing social interactive, creative and innovative learning (Zachary, 2009 and Origa, 2000). The industrially upcoming superpowers had an enduring integration of recreation and sports in the TIVET instructions (Sriharikota, 2009 and Shobon, 1978). According to Zachary (2009) digital simulation overemphasis on TIVET instruction with out physical and hands-on activities could produce creative and innovative graduates who were not in touch with the physical world.

The achievement of Japan to have modern education for scientific and technological progress promoting industrialization and economic growth faster than her peers such as: former West Germany, Israel, and United States of America (USA) had been associated with practical teaching and learning processes done in real-life situations (Kerre, 2010). Similarly, Shobon (1978) in Social Education Council recommended Practical training that involved students in activities done on the job and group activities in Japan institutions encouraged development of scientific and technological expertise. According to Kombo (2005) interactive teaching involving instructional activities could:

stimulate intellectual inquiry and the critical thinking skills necessary to serve the needs of the future. Schools events such as academic forums, science congress, seminars, and debates encourage critical thinking in students. (p.135)

Hence, cooperative learning activities that encourage limitless exchange of ideas among students in the institutions, across institution and academic staff through the use of ICT platform could play an important role in developing understanding of mathematics (Kearney, 2010). The use of ICT in teaching and learning could play an important role in games and simulations. However, professors in those areas thought that too much digital simulations with out students' hands-on activities involving use of physical hand-tools could make them loose touch with the physical world (Zachary, 2009). The concern about lack of hands-on activities and having overuse of digital simulation in American Technical, Industrial, Vocational and Entrepreneurship Training (TIVET) arose as a result of the frustration of engineering, architect and creative design professors who found out that their best students had never taken apart a bicycle or built a model of an airplane (Zachary, 2009). According to the same report, overuse of digital simulation could make creative designers and engineers rebel against their alienation from the physical world.

The study by Kombo (2005) suggested that there exists a strong link between the cooperative learning and motivation to be competent by saying that:

the more the students and teachers care about each other, the harder they will work to achieve mutual learning goals. Long-term and persistent efforts to achieve come from the heart not from the head. Individuals seek opportunities to work with those they care about. As caring increases, so do feelings of personal responsibility to do ones share of work, a willingness to take on difficult tasks, motivation and persistent in working toward goal achievement, and a willingness to endure pain and frustration on behalf of the group. All these contribute to group productivity. The success experienced in working together to get the job enhances social competencies, self-esteem and general psychological health (p.149.

That meant that the more the involvement of students in instructional activities the higher the chances of developing an all round person. The practice of multi-disciplinary approach in science, technology, engineering and mathematics STEM was desired (Earnest, 2009). Mathematics learning based on apprenticeship had been missing in Kenyan technical and vocational institutions. That might call for integration of teaching and learning experiences in Mathematics lessons by actualizing mathematical problems in activities in games and simulations as well as hands-on, minds-on and hearts-on. **A**ctivities carried out by **S**tudents in **E**xperiments through **I**mprovisation could serve an important role in developing soft skills.

The teachers had to: **P**lan for teaching, **D**o (present the lesson), **S**ee (make observations on the students progress) and **I**mprove (their strategies) through the **(ASEI/PDSI)** approach as an intervention strategies was proposed to arouse and sustain curiosity and improving students' competencies such as problem solving, analysis, synthesis, and application of relevant information in mathematics and science was used in secondary schools level by Strengthening Mathematics and Science in Secondary Education (SMASSE) (GoK, 2010). Hence, instructional activities such as track and field athletics could play a key role in skills and knowledge acquisition for creative innovation. Hence, the impetus for this study is justified.

Small-groups-based instructional activities play important role in soft skills development (Kombo, 2005; Muthoni, 2012; Obonyo 2011 and Origa, 2000).The soft skills included: critical thinking, psychological health; creative problem-solving; synthesis of knowledge; promoting self-esteem and facilitating teaching of meaningful content. Hence, students' achievement in mathematics could be improved through instructional activities which also develop soft skills. Hence, collaborative learning could also sustain students' motivation in learning Mathematics. This view was reinforced by Kombo (2005) and Muthoni (2012) who observed that collaborative learning could promote creative thinking. The studies by Kombo (2005), Muthoni (2012) and Origa (2000) further observed that collaborative learning could lead to increase of ideas, quality of ideas, encourage feelings of self fulfillment, stimulation to enjoyment, creative innovations, problem-solving, psychological health, warmth in friendship that could sustain competence motives. Hence, collaborative learning activities could also help teachers to shift from over-reliance on text question-and-answer to instructional activities which develop an all- round person and encourage instructors experiment on instructional alternatives. Kombo (2005) and Muthoni (2012) concurred that students' competence motivation could be sustained by encouraging the weak students to collaborate with their peers on instructional tasks. Collaboration could arouse and maintain curiosity for increased motivation and academic improvement. Similarly, Origa (2000) and Khakala (2009) found that use of concrete objects and activity-based approaches encouraged deeper understanding of Mathematics concepts compared to approaches based on chalk and talk.

Village-centered craft oriented technical training in colleges was desired because the experiences from the informal sector commonly known as *Jua Kali* sector in Kenya contributed to creative innovations. Gatonye (2009) observed that:

although universities have proven the most prolific in publishing research papers, with 194% growth in the last five years, it is the informal sector which leads in patenting of practical innovations. The Permanent Secretary Ministry of Trade and Industry, Prof. Lonyangapuo, said that out of 10 patents registered since 2001, none were from local universities. Out of the 50 expected patents in the next 3 years, he said that most of them would come from Jua Kali sector.

That meant that involvement of students in the informal (Jua-Kali) sector activities could complement provision of instruction in technical colleges and improve students' achievement in mathematics, develop on-the-job soft skills employability skills needed as well as encourage creative innovations. That was because *Jua Kali* could provide greater opportunities for self-employment of the technical college students (Gatonye, 2009 and Obonyo, 2011). Yet, the area on the role of informal sector as instructional activities for equipping trainees with soft skills had not been fully exploited.

Sustaining students' motive in mathematics could go beyond meeting the physiological needs. That called for helping the students to identify another reason for pursuit of excellence in mechanics. The study by Gross (1996) postulated that:

the master reinforcer which keeps most of us motivated over a long period of time is the need for a sense of personal competence, defined as our capacity to deal effectively with the environment. It is intrinsically rewarding and satisfying to feel that we are capable human beings to understand, predict, and control our world (a major aim of the study of science). The need for competence is seen to be continuous, ongoing motive. It cannot be satisfied fully. It is satisfied then it appears again because it not rooted in any physiological need (p. 97).

That meant that when the desire to be competent was sustained, individuals' productivity in terms of modeling mathematical relations, generating ideas, and problem-solving could be guaranteed. As soon as such individuals accomplished one task the sooner they embarked on improving it or creating a new one. Hence, educators of mathematical calculation in mathematics would need to learn to trigger that need so as to sustain students' curiosity that would make them mathematicians for life and researchers. Hence, the impetus for this study was justified.

The need for competence in workers, trainees or students discharging their responsibilities in technologically competitive and intensive market conditions was necessary and urgent. The scores attained in curriculum based assessments in theoretical training was not sufficient evidence of competence without successful completion of On-the-Job-Training (OJT) programs. Competence standards gained by trainees in the workplace include all awareness, knowledge, skills and attitudes which were useful in bridging the gap between curriculums based training, help gain insight into what was provided in the course materials as well as practical training programs Khakala (2009) and Mustafa (2012). Instructors and their trainees' collaborative activities in industrial settings (Kairu, 2012) as where the instructors were also producers, life-long learners, supervisors, role models of professionalism and partners in developing apprentices is desired.

3. Results and Discussion:

The results from the questionnaires and interviews were analyzed and reported in a condensed for with agree, unsure or disagree. The purpose of Table 1 was to show the lecturers opinion on the students' achievement in mathematics in technical institutions in Kenya.

A-Agree U- Unsure DDisagree

Achievement in mechanics includes:	**A**	**U**	**D**
a) Ability to analyse situations and come up with a hypothesis	62	18	20
b) Make graphical and diagrammatical representations of phenomenon	76	6	18
c) Collect data, organise and analyse data, interpret data make conclusions	69	11	20
d) Form algebraic equations used in problem	57	10	33
e) Provide brief explanations of the mathematical results	30	3	67
f) Ability to work-out problem solving in class exercise	66	14	20
g) Solving problems in real life situations	75	2	23
h) Passing internal and curriculum based examinations in mathematics	96	3	1
Factors found to influence achievement in mathematics includes	**A**	**U**	**D**
a) Students view of mathematics as a mare reproduction of abstract ideas	90	4	6
b) Opportunities for practical applications	56	13	31
c) Qualifications of teaching staff	61	3	36

d) Attitudes towards mathematics	77	3	20
e) Involving students in teaching and learning activities	96	2	2
f) Availability of teaching/learning materials	92	2	10
g) Instructors and trainees industrial-based activities	78	6	16
h) Use of audio-visual resources charts, diagrams, models	95	3	2

Table 1: Achievement in Mathematics

The current study findings concurred with what Bukhala (2011), ILO (2010), Kerre (2011) and Kerre (2010) asserted that on-the-job and off-the-job activities motivated students to develop soft skills such as: working hard, problem-solving, industrial precautions and safety in the work place to protect the internal and the external public, critical thinking, modeling mathematical relations and capacity to innovate. Similarly, the findings of the current study concurred with what Kerre (2011), Khakala (2009) and Mustafa (2012) asserted that development of soft skills could encourage designing systems that were environmental friendly, ability to work with green technology, ability to take risks in an enterprise, use of mathematical thought processes to discuss and explain reasoning, use mathematical and numeracy skills to provide evidence for informed decisions, answer questions from assessors. The current study, Kerre (2010) and Absi et al (2011) concurred that soft skills were also needed in maintenances, repair and operations (MRO) as used in the supply chain management. The purpose of results in Table 2 was to show the lecturers' opinion related to competence in soft skills developed in mathematics in technical institutions.

Development of Competence in soft skills is necessary because:	F %	M %
a) Promote physical and mental wellbeing	78	76
b) Help promote healthy interpersonal relationships and form lasting friendship (psychological health)	89	90
c) Help make informed and effective decisions	76	74
d) Develop full potential	68	72
e) Translate knowledge, attitudes, skills and values into action	73	74

Table 2: Competence in Soft Skills

The current study and the work by Davidson (1991), Kombo (2005), Muthoni (2012), Sanni (2007) and Origa (2000) agreed that there was need for soft skills development and those soft skills were developed through instructional activities. The work by Kombo (2005) and Muthoni (2012) concurred with the current study that mental well-being; physical well being, interpersonal relationships, effective communication and team workmanship were prioritized in work-place competence.

The purpose of Table 3 was to show the specific soft skills developed through activities in mathematics in technical institutions in Kenya.

Soft skills include:	F %	M %
a) Critical and creative thinking skills	60	69
b) Problem solving skills	49	60
c) Coping with stress	59	68
d) Negotiation skills	75	74
e) Entrepreneurship skills	51	49
f) Information handling skills	65	69
g) Effective communication skills	68	65
h) Conflict resolution skills	54	57
i) Assertiveness	45	42
j) Team-work skills	47	53
k) Sales and marketing skills	78	72
l) Ability to engage in community service	65	67
m) Instructional activities can develop soft skills	34	31

Table 3: Soft Skills developed through Collaborative Activities in Mathematics

The current study, Chaffins (2010) and Nunes, Schliemann and Carraher (1993) concurred that included: job readiness skills such as: effective workplace communication; interpersonal skills which include conflict resolution, active listening, negotiations, ethical behavior, getting along with co-workers, assertiveness and managing stress. They also included job search skills such as finding job openings, resume writing, interview skills, and networking and financial management to help trainees manage the money they earned. Similarly, the work by Mustafa (2012) was similar to the current study in that students taking technical and vocational training needed to develop specific soft skills such as motivation, reflection, self-evaluation, self-guidance, critical and cross-disciplinary thinking, teamwork and problem-solving skills. The soft skills developed through mathematics include problem-solving, critical thinking, logical thinking (GoK, 2010; Jackson, 2009 and Khakala, 2009). The current study and Mustafa (2012) agreed that the skills developed through mathematics can train people to respond to complex demands, communicate with and understand others, plan ahead, make innovative choices and take risks and accept the consequences. The current study, Hiedemann and Jones (2010) and Kerre (2011) concurred that industrial-based activities develop hard and soft skills. The purpose of Table 4 was to show the students' opinion on the influence of instructional activities on students' soft skills development.

Influence of instructional activities on students	**A**	**U**	**D**
a) They are more actively involved	72	5	23
b) Students show great interest and responsiveness	87	1	12
c) Attend lessons more punctually and promptly	83	2	15
d) Carry discussion beyond class time	63	2	35
e) Students' interest and curiosity are aroused and sustained	59	12	29
f) Able to relate mathematics to real life experiences	78	11	11
g) Industrial activities can motivate trainees to keep working	93	3	4
h) Encourage team work	72	12	16
i) Provide opportunities to develop key competencies such as problem-solving, analysis, synthesis, and application of relevant information	87	6	7

Table 4: Influence of instructional activities in mathematics

The report by ILO (2010) concurred with the study current findings that most African TIVET institutions had been unable to cope up with technological changes in the workplace and consequently producing graduates that were not suited to the industry. However, the industrial-based activities that involve academic staff and industrial staff and students could reduce the impact of inadequate or limited training facilities. The current study and the work by Kairu (2012) concurred that those instructors in industrial attachment could work as producers, life-long learners, supervisors, role models of professionalism and partners in developing apprentices. Supervised farming activities like visits to the market by TIVET students could provide students with opportunity to learn data handling techniques that were essential in market information process sing skills and experiences such as customers and clients handling.

4. Conclusion and Recommendation:

The link between mathematics and soft skills was best illustrated by instructional activities that encouraged problem-solving skills development. The activities could develop problem-solving if they required creativity, insight, original thinking, imagination and application of the previously learnt knowledge and skills. Problem-solving that was in both mathematics and soft skills involved analyzing the situation, translating the results, illustrating the results, and seeing the alternative solutions. Problem-solving in mathematics was critical in soft skills development because it encourage reflective thinking, continuous monitoring and evaluation through continuous re-learning experiences (CRE). Supervised farm produce related activities like visits to the market by TIVET students could provide students with opportunity to learn data handling techniques, market information processing skills and experiences and customers and clients handling experiences. Games and simulation could encourage enterprise orientations and negotiations skills to students. Instructional approaches that encourage on-the-job-training and off-the-job-training activities; activities in the informal sector; games and simulations; small-group discussions and collaboration between students and trainees could post higher scores in mathematics and develop soft skills among TIVET graduates. Competence in soft skills developed through mathematics activities included: critical and creative thinking skills, problem solving skills, coping with stress, negotiation skills, entrepreneurship skills, information handling skills, effective communication skills, conflict resolution skills, assertiveness, team-work skills, sales and marketing skills, ability to engage in community service and instructional activities in mathematics can develop soft skills. The results showed that multi-disciplinary approach with problem-solving in projects with team-work involving academic staff and industrial staff and small group discussions of case studies in class deepened understanding of mathematics concepts served as the basis for industrial competence in soft skills and on-the job training for employability. The strategy of multi-disciplinary approach for improving students' acheievement in mathematics and competence in soft skills in technical colleges in Africa and world over is recommended.

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