

Referee's opinion on the doctoral thesis *Development of knowledge and skills in initial mathematics teacher education and early years of teaching career in Ghanaian Basic Schools* by Marlene Kafui Amusuglo

I express my gratitude to Charles University for the opportunity to be a referee for the PhD thesis of Marlene Kafui Amusuglo. The main rationale and motivation behind this dissertation is to improve the quality of mathematics education in Ghana, particularly by exploring the attitudes and self-efficacy of mathematics preservice and in-service teachers. The work is important for education policymakers in Ghana because it thoroughly analyses some curriculum issues, particularly the coherence of teacher training and public education curricula. It is also intriguing to see how a country, given its traditions, connections, and geopolitical situation, addresses the problems of mathematics education. On the other hand, the dissertation also tackles issues relevant to researchers in mathematics education in general. These include, for example, the analysis of certain affective factors related to teacher self-efficacy. In sum, the dissertation explores topics beyond the local context and enriches the academic literature on mathematics education.

The research questions are as follows:

RQ1: What alignments exist between the early-grade mathematics curriculum implemented by Colleges of Education in Ghana and the National Kindergarten Mathematics Curriculum?

RQ2: How do Ghana's national kindergarten and Colleges of Education early-grade mathematics curricula align with the knowledge and skills outlined by the Global Proficiency Framework?

RQ3: What are pre-service and early career teachers' attitudes toward mathematics in Ghana?

RQ4: How do pre-service and in-service teachers' attitudes towards mathematics relate to their mathematics teaching efficacy beliefs?

RQ5: What content and pedagogical content knowledge do early career teachers and pre-service early-grade teachers possess at the end of their College Education?

Research concerning all research questions but RQ3 was published in journals, including the South African Journal of Childhood Education (Scopus SJR value is 0.283, Q3) and the European Journal for Contemporary Education (Scopus SJR value is 0.331, Q3).

The candidate's knowledge of the literature on the research topics is adequate, and the literature used is comprehensive and provides a solid basis for the thesis.

The research design is thorough, and the candidate provides adequate information. Table 2 provides an informative overview of the research paradigm (qualitative, quantitative, mixed), measurement tools, data sources and related theoretical constructs for each research question. I consider it a minor inconsistency that the column "Instruments" includes both data sources (e.g. "Curriculum Material, CoE", "national early-grade curriculum") and measurement instruments ("Mathematics Teaching Efficacy Beliefs Instrument, MTEBI", "Attitudes Towards Mathematics Inventory, ATMI", "Mathematical Pedagogical Content Knowledge Instrument, MPCKI").

In what follows, I report my opinion on the thesis by research questions.

To address **Research Question 1**, document analysis focused on curriculum objectives and pedagogical approaches. The main finding is that the content and pedagogical approach of the Early Grade Mathematics Curriculum used by the Ghana Colleges of Education and the National Kindergarten (KG) Mathematics Curriculum is consistent with each other, even though specific mathematics content is not prescribed in the KG curriculum. Both curricula emphasise using ICT, creativity, and critical thinking skills. Pedagogical approaches such as problem-solving, scaffolding, creativity, and play-based activities are included in teaching mathematics. The answer to RQ1 provides relevant information on curricular alignment, but further research could be done in the future on its practical implementation, i.e. on the actual implementation of the principles in the curricular documents.

Chapter 4.2 answers **Research Question 2**: How do the Ghanaian National Kindergarten and Colleges of Education Early Years Mathematics curricula fit the knowledge and skills requirements of the Global Proficiency Framework (GPF)? The author used a document analysis method to map both curricula' content, structure, and pedagogical objectives in detail and then compared these with the expectations of the GPF framework. From a research methodology perspective, the method allows for systematic and objective comparisons.

The study reveals that Ghana's early-grade mathematics curriculum and the Colleges of Education's early-grade curricula align with international standards, particularly the Global Primary Education Framework (GPF). This alignment ensures that learners and teachers are well-prepared for national and global assessments, reflecting a commitment to educational excellence. Including theoretical foundations in the curriculum highlights the critical role of teacher training in bridging the gap between subject matter knowledge and effective teaching practices. The results align closely with the thesis's themes, highlighting the interplay between curriculum standards and teacher knowledge in mathematics education. By exceeding the global minimum standards and emphasising pedagogical preparation, Ghana can further enhance mathematical learning outcomes and contribute to global educational development.

Research Question 3 examines the mathematical attitudes of pre-service and in-service teachers. The questionnaire is based on the ATMI questionnaire (Tapia, 1996). The original 5-point Likert scale questionnaire was used in a 4-point version, with the neutral response omitted. This decision is justified in detail by the author in 3.5.1 and is in line with research that considers the 4-point solution to be no worse than the 5-point solution in terms of psychometric indicators (Leung, 2011).

There are several questions about the use of the questionnaire, which the author does not clearly explain in the dissertation. The first such issue is the structure of the questionnaire. The questionnaire, in its first version, contained 49 questions in 5 dimensions: sense of security, value, motivation, enjoyment, and adult perspective (Tapia, 1996), or as other sources refer to it, enjoyment, motivation, self-confidence, value, and parent/teacher expectations (Lim & Chapman, 2013). Based on empirical data, the revealed factor structure of the 49-question questionnaire made the factor of parent/teacher expectations questionable, and these questions were later deleted from the questionnaire. The version of the questionnaire known (and available) today contains 40 questions without questions on the parent/teacher expectation dimension. It is unclear how the author selected the 26 questions

used in the dissertation, sorted them into four dimensions (enjoyment, self-confidence, value, and parent/teacher expectations), and, most importantly, why she kept two questions on parent/teacher expectations. Moreover, the two questions in this dimension ("Mathematics helps develop the mind and teaches a person to think"; "Mathematics is important in everyday life") originally belong to the category "value" (Lim & Chapman, 2013). (Even though they do not seem relevant to the referee in relation to parent/teacher expectations.) I remark that in the Appendix, the author reported 25 questions (versus 26).

The treatment of the questions formulated in the reverse way is not apparent. All the questions in the self-confidence category are reverse-worded. These questions reveal emotional states such as discomfort, fear, nervousness and negative emotional reactions to mathematics, which indicate a lack of mathematical confidence rather than a positive manifestation. Generally, these items are usually reverse-scored so that higher scores reflect more positive self-confidence. The question is whether the values are the original or corrected ones. (If there are no corrections, both groups are more likely to have mathematical anxiety.) This subject is particularly relevant as a methodological issue in the value category because three of the four questions are positively worded, and one is negatively worded: "I would like to avoid using mathematics in college." When calculating overall attitude, this question of scoring becomes particularly critical.

The next problem is that the author does not provide a reliability indicator for the specific data sample. Of course, statistical tests related to developing a questionnaire do not need to be carried out on the data (e.g., confirmatory factor analysis). However, it is desirable to provide some kind of reliability indicator, such as Cronbach's alpha or McDonald's omega (Tavakol & Dennick, 2011).

Finally, the data representation is flawed: the data used in Figure 1 do not correspond to previously reported values. For example, the mean value of "Math Self-confidence" in the figure is about $M=2.5$ for both groups, while in the table, it is $M=3.02$ for teacher candidates and $M=2.96$ for in-service teachers. The graph shows a higher score in the "Math Value" category for the in-service teachers, but the data in the table contradicts this. (The aggregation method may differ in the tables and the figure, but there is no clear indication.) Moreover, the caption of the figure does not refer to the dataset.

The results are analysed by comparing the descriptive statistics of the two groups. No comparison of the difference by statistical method is made in this part of the dissertation, so we do not know whether there is a statistically significant difference between the two groups. This would be important because, for example, in the dimension of self-confidence, the author talks about a "pronounced gap" between the performance of the two groups, but the difference seems negligible compared to the standard deviations. The difference is 0.06, while the standard deviations are $SD=0.47$ and $SD=0.41$. (I note a minor format-type error in Tables 10 and 11: the leading zero before the decimal point is not written out according to the APA7 standard only when the variable theoretical value is between 0 and 1. In the present case, this is not theoretically the case for the standard deviation.) Later, in 4.4.3. the author compares the attitudes of the two groups with an independent sample t-test (see Table 18). The results revealed no statistically significant difference in pre-service and in-service teachers' attitudes. However, I can not interpret the data in Table 18, as the reported means do not coincide with the former data.

The candidate thoroughly and richly analyses the results in light of the literature. The analysis points to the fundamental role of the factors under investigation, even if the difference between the two groups does not appear to be major. However, I cannot interpret the following statement, which I understood as contradictory and inconsistent with the data in Tables 10 and 11: "Both groups demonstrated generally positive attitudes, with pre-service teachers reporting slightly higher mean scores across most dimensions. However, in-service teachers exhibited more positive attitudes on specific sub-scales, including enjoyment, confidence, and perceived value of mathematics." I remark that the enumerated subscales almost cover the whole questionnaire.

This chapter's pedagogical implication is that teacher education curricula in Ghana should prioritise the development of enjoyment, confidence, and appreciation of mathematics's value so that teachers maintain and nurture these positive attitudes throughout their careers.

In Section 4.4, the author investigates **Research Question 4**, which examines the relationship between attitudes toward mathematics and subjective perceptions of teaching self-efficacy in two groups, i.e., pre-service and in-service teachers. The research method used is structural equation modelling with bootstrap sampling. This approach is theoretically justified; the theoretical basis for the relationship between attitudes and teaching self-efficacy is well established. For example, Bandura's (1997) self-efficacy theory suggests that an individual's attitudes influence his or her willingness to act. The author examines how teachers' attitudes towards mathematics (as a latent construct, with indicators such as data from questions on attitudes) affect their beliefs about mathematics teaching self-efficacy (also a latent variable measured by the MTEBI). The main pathway in the model is the effect of attitudes on beliefs about teaching efficacy. The text does not explicitly describe how the author got the data on attitude; however, I suppose it came from the ATMI questionnaire. Additionally, I cannot explain the means in Table 18 based on the previous data.

Overall, the author applies SEM's path analysis to investigate the relationship between two interrelated constructs – attitudes towards mathematics and beliefs about teaching self-efficacy – which is methodologically well justified given the complexity of the issue and the need to address measurement error.

The results indicate no significant difference between the average attitudes of the two groups (Table 18). However, the SEM path analysis revealed a difference. For pre-service teachers, attitudes significantly affect their self-efficacy beliefs, and the standardised path coefficient value of 0.18 shows this. For in-service teachers, the relationship is much weaker (0.07), indicating that other factors, such as practical experience and classroom conditions, dominate. The small R^2 values suggest that the model under consideration has low explanatory power overall, i.e., only a small part of the variance of the dependent variable has been captured, and thus many important factors may be missing, which could be the subject of further research. In the discussion, the author concludes that although the attitudes of the two groups are similar, the relationship between attitudes and self-efficacy beliefs is different in the two groups. For pre-service teachers, attitudes are significant predictors, while for in-service teachers, the relationship is weak, suggesting that teaching experience and other unstudied factors influence self-efficacy.

The study's strength is its rigorous statistical analysis: The method combines descriptive statistics, t-tests, and SEM path analysis, which allows the exploration of complex

relationships. The research's pedagogical implication is that teacher education can strengthen the teacher's perception of self-efficacy by developing a positive attitude towards mathematics.

In relation to the Likert scale questionnaire, as in the previous chapter, I also miss the display of a reliability indicator (e.g., Cronbach's alpha) for the specific data sample. The captions of Figures 2 and 3 seem to be incorrect, and there is also inconsistency in the different naming of variables within the figure.

Evaluation of the answer to **Research Question 5**. The author examines teachers' pedagogical content knowledge based on a thorough literature review. One of the measurement instruments used in this thesis is based on selected questions from the MPCKI instrument (Table 2). I was keen to learn about the MPCKI measurement instrument; however, the thesis lacks a detailed survey description. (Despite the full insight into measurement tools provided in the previous chapters and their inclusion in the Appendix.) I have not been able to find or even identify the reference provided. (The reference is "Martin, A. (2017). Development of a Mathematics Pedagogical Content Knowledge Instrument. *International Journal of Mathematics Education*. 15(3), 123-136." There is no reference to such an article on the ORCID page of the instrument's creator, A. Martin. The only trace is a reference to a PhD thesis from 2017, which presumably contains the questions but was not available in the university's database.) As for the specific questions used, we only know: "To address this question, data was collected using a teacher-made achievement test that assessed the PCK of the participating teachers." In conclusion, this omission reduces the transparency of this chapter.

The quantitative data show that the level of pedagogical content knowledge was lower than expected. Significant differences were seen between the two groups: teacher candidates tended to do better than teachers already working. This fact goes against the reasonable idea that real-life experience helps teachers learn how to teach math.

I note that the horizontal axis in Figure 4 lacks labels or is not visible in the PDF I received. (I clarified this issue based on the publication on which the chapter is based.) The descriptive data reporting is clear and complies with APA7 rules; however, the table reporting for the Levene test and the independent samples t-test is not transparent.

Ten early career teachers participated in the qualitative part of the study. The candidate randomly selected them to be interviewed individually to explore the characteristics of their pedagogical content knowledge. The semi-structured interviews allowed for a comprehensive exploration of their experiences and beliefs. The interviews were designed to explore the main themes related to PCK development: its initial stages, factors influencing it, challenges to it, strategies for it, and support systems and resources.


Although the quantitative results of the research should be treated with some caution due to the small sample size, the qualitative analysis provides a valuable contribution to understanding the topic.

The presentation of the whole dissertation is thoughtful and professional. The logical structure allows the reader to easily understand the different parts of the research. The systematic use of chapters, tables, and figures contributes to the thesis's clarity, while the precise citation of references and sources adds to its academic quality. Although minor formal

corrections may be possible, overall, the formal presentation of the dissertation reflects the author's care and commitment to maintaining high standards of academic research.

Summary of my opinion: Marlene Kafui Amusuglo's thesis is based on original research, and I acknowledge the published results as scientifically valid, having been verified according to established scientific standards. As I reported in my opinion, the dissertation's transparency has certain deficiencies that can be clarified during the defence. Following a successful defence, I support the awarding of the PhD degree.

Eger, 10 March, 2025



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