# PRESERVICE SCIENCE TEACHERS' PERCEPTIONS OF LEARNING TO TEACH UNDER MENTOR TEACHERS IN SENIOR HIGH SCHOOLS

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*ABSTRACT*

*The study examined 150 preservice science teachers' perceptions of learning to teach under the supervision of mentor teachers in Senior High Schools in Ghana during practicum. The study was multiple design that employed questionnaire and focus interviews for data collection. The study found that student teachers had the perception that their mentors had sound knowledge of subject matter, observed mentees' lessons, gave feedback and related well with mentees. However, mentors did not model science teaching for mentees to observe and learn some of the strategies of teaching, rudiments of classroom management and dealing with students' questions. The study recommends that mentors pay due attention to modelling science teaching for mentees to learn how to handle difficult topics and discipline issues when they do occur in class. The study also recommended the need for UEW to train their mentor teachers in specific subject areas apart from generic training given to mentors. This is needful for successful transfer of same skills to their mentees.*

**Key words**: perception, preservice teachers, feedback, mentor, generic

## INTRODUCTION

### Locating a direction for science education reform

To achieve the 'science and technology for living' goal in Ghana requires a focus on science needs that must commence at the basic education level (Anamuah-Mensah, 2002). It is believed that 'the decisive component in reforming science education is the classroom teacher. This requires classroom teachers to 'move beyond the status quo in science teaching. However, most teachers do not have good grasp of the application of the subject in relation to the environment (Erinosho, 2001). It is astonishing to see science, which is exciting and real, being taught at the abstract level and sometimes within the context that does not accommodate the indigenous sub-cultures and worldviews of learners (Erinosho, 2001).

This study holds the view that the education of preservice secondary school science teachers is a place to focus attention in an effort to attain science education reforms. Indeed, delivering and implementing effective programmes for creating change must include collaborative partnerships. The quality and degree of collaboration within practicum programmes can aid the preservice teachers' development. However, Hudson and Skamp (2001) states that, no direct literature has been found to date that record how much practicum or how little practicum (and hence the implied extent of collaboration) is enough to produce a competent primary or secondary school science teacher.

### Generic and specific mentoring of science teachers

Mentoring is typically noted as a relationship between an experienced and a less experienced person in which guidance, advice, support, and feed back are provided (Khan & Saeed, 2009). The two key players at the centre of the mentoring process are the mentor and the mentee. The two are also at the centre of achieving the "science and technology for living" goal in Ghana, as together they are responsible for implementing science education. The mentor's responsibility is leading the mentee to some sort of competency in teaching science. In this way, mentoring can be a means of guiding improvement and change in science education. Despite such promise, mentors are not confident in mentoring secondary science education (Jarvis, McKeon, Coates & Vause, 2001).

Mentoring in a specific secondary science subject is virtually non-existent (Jarvis, et al., 2001). It has been argued that unique mentoring processes are required for effective teaching in specific subject areas (Peterson & Williams, 1998), and so the prospect of mentoring in secondary science education has considerable promise.

### Statement of the problem

The need for developing student teachers' subject knowledge and pedagogical content knowledge is underlined by studies showing that science graduates do not always have a secure knowledge in the areas they will be expected to teach within their own subject specialism (Preece, Postlethwaite, Skinner, Simpson, 2004). For most of our students, the expectation from partnership schools is that they will teach across the sciences (biology, chemistry, physics and integrated science) to senior high school students. On the other hand student teachers tend to depend on their mentors to do *magic* in turning them over night into effective science teachers. Paradoxically, in Ghana and other developing countries where there are frequent changes of curriculum, student teachers and their mentors may be at the same level of knowledge in the profession. Preservice teachers are likely to face some frustrations when mentors are not able to meet their expectations to transform them into experts.

**Research questions**

The study sought answers to the following research questions.

1. What kinds of knowledge and pedagogical skills do student teachers perceived to have learnt from their mentor teachers?

2. What are the perceptions of student teachers concerning the self-efficacy of the mentor teacher during practicum?

**The purpose of this study**

The purpose of this study was to explore, identify, and describe preservice teachers' perceptions of the extent to which they receive the range of mentoring practices that have helped them developed as science teachers.

**Significance**

It was imperative that pre-service science teachers' perceptions about their professional development and growth during a one year practicum be captured. It will help the University of Education-Winneba; take concrete steps to improve upon their mentorship training programme which currently is generic. (Mentors who are non-specialists in particular subject areas are generic). The information will also be useful to the Department of Science Education, Winneba, to decide on what steps to take to provide a new model for effective teacher preparation.

**Research design**

The study was a multi-method design (Robson, 2002) that incorporated survey methodology and interviews. This mixed method approach allowed qualitative data to be collected and collaborated with data from questionnaire.

**Population and sample**

The population was Level 400 preservice students of UEW who were on internship for the 2009-2010 academic year. Purposive sampling was used. One hundred and fifty (n=150) science preservice teachers of the Department of Science Education, Winneba took part in the study. These participants had reported for the last component of their teacher preparation programme called face to face or post-internship seminar in July 2010

**Instrument validation**

The survey was a 35-item questionnaire of the Likert type that had been pilot tested with 75 preservice science interns of the previous year 2008/2009. It has an internal consistency coefficient alpha of .84. Responses to the items were on a five point Likert rating scale (i.e, strongly agree = 1, agree = 2, uncertain = .3, disagree = 4, strongly disagree = 5). Twenty eighty students were also interviewed in four focus groups of seven in a group for the purpose.

**Data collection procedure**

The questionnaire was distributed at the University of Education, Winneba, to the participants (Bachelor of Education preservice science teachers; n=150, response rate =100%) at the end of their final (fourth) year post- internship teaching experiences. Four focus groups discussions with 28 of the participants (7 in 4 groups) provided qualitative information that was used to collaborate with data collected using survey items. This figure forms 18.67% of the sample studied.

The data were also subjected to an exploratory factor analysis (EFA) to assess the uni-dimensionality for each of the five factors suggested from the literature. EFA was used to define possible relationships and then using multivariate technique in SPSS16 to estimate these relationships (Hudson, 2003). EFA statistics were interpreted as follows: items with squared multiple correlations greater than .50 indicated a statistical relationship to the proposed factor; *eigen values* greater than 1.00 were retained, as these indicated the number of possible components (factors) confirmed from an identified set of items, and a Cronbach alpha scale greater than .70 was considered acceptable for the internal reliability of the items associated with each proposed factor (Hudson, 2003). These preliminary FA statistics provided an indication of this study's theoretical proposition that there may be five factors for mentoring in secondary science teaching. The method and data define the nature of the relationships, which is appropriate in EFA (Hudson, 2003).

**Results and analysis**

***Question 1:*** What kinds of knowledge and pedagogical skills do student teachers perceived to have learnt from their mentor teachers? This question was answered by examining the following mentoring practices and attributes: personal attributes, system requirements, pedagogical knowledge, modelling, and feedback.

**Personal attributes**

There are personal attributes a mentor needs to model for the mentee such as being able to display personal enthusiasm for teaching science and being able to inspire the preservice teacher to teach science (Hudson, 2003). Other personal attributes call on the mentor to develop and foster in the mentee confidence and a positive attitude to teaching science. Mentees also require assistance to solve problems that they encounter in teaching science; such as gathering information for completing university assignments during their practicum.

A reflective practicum, according to Schon (1987) requires mentors to provide (using their personal attributes) mentees opportunities for reflection, and assist in the reflective processes for developing teaching practices, including science teaching. In addition, mentors need to be comfortable in talking about science teaching and display ways of addressing teaching anxieties among mentees (Hudson & Skamp, 2001, Tang, 2003).

Table 1 below shows that 54% of mentors appear comfortable in talking to their mentees about science teaching, and nearly half the mentors assist their mentees with university assignments and provide opportunities for reflection on science teaching. When it comes to addressing science teaching anxieties and providing assistance in reducing science teaching problems, this fraction falls to a little more than a third of the mentors who display these mentoring practices. There were indications that mentors (51%) helped their mentees to feel confident to teach science; however, mentors may not necessarily instil positive attitudes towards the subject (39%), or inspire the mentees to teach science (36%). Mean item scores (range: 2.51 to 3.25; standard deviations [SD] range: 1.02 to 1.36) indicate that mentees' responses mainly ranged from "uncertain" (coded 3) to "disagreeing" (coded 4) that their mentors displayed "Personal Attributes". 12

**Table I:** *Mentees (n=150) who perceived their mentors displayed "Personal Attributes" for mentoring secondary science teaching.*

| Personal attributes | Percent | Mean | SD |
|---|---|---|---|
| Felt comfortable talking with mentee | 54 | 2.51 | 1.02 |
| Assisted with university assignments | 49 | 2.85 | 1.30 |
| Assisted mentee in reflecting | 48 | 2.69 | 1.09 |
| Provided opportunities for reflection | 46 | 3.00 | 1.36 |
| Increased their confidence | 51 | 3.10 | 1.32 |
| Instilled positive attitudes | 39 | 2.95 | 1.20 |
| Addressed their anxieties | 37 | 3.03 | 1.13 |
| Inspired them to teach | 36 | 3.25 | 1.29 |

**Percentages refer to the total number of respondents who "strongly agreed" or "agreed" that they experienced the mentoring practice.*

**System requirements**

Secondly, it has been argued that mentors require science content expertise and knowledge of aims, policies, and procedures within curriculum documents (Hudson & Skamp, 2001). Such knowledge is linked to the education (e. g. state, national, regional) syllabus that aims towards quality control in teaching and learning secondary science. Indeed, understanding policies and procedures is considered a professional mentoring ability (Riggs & Sandlin, 2002).

As can be seen in Table 2, more than half the mentors in this study (64%) were perceived as displaying science content knowledge related to secondary science teaching, but only 24% of mentors discussed the aims, policies, and procedures for teaching science. The results also showed that most mentors do not outline science curriculum documents to mentees that would aid them towards implementing departmental directives. Only a few mentors (30%) did so. Mean item scores (range: 2.55 to 3.64; standard deviations range: 1.13 to 1.19) indicate that most mentees generally "disagreed" to "strongly disagreed" that the mentor discussed with them "system requirements" for science teaching. Even at this foundational level of learning about "System Requirements", mentees received minimal mentoring experiences towards planning for teaching secondary science. The result is that these mentees, if they have not had previous practicum experiences in planning for teaching secondary science (using "system" documents), may lack the practical knowledge of essential planning and, therefore, may not be able to teach science effectively at the secondary school level. Although previous practicum and tertiary education may have covered these elements, the final year of preservice teacher education may be the last opportunity to develop (and/or reinforce) "System Requirements" for secondary science teaching in the field before entering the profession. If a science syllabus is mandatory then about three quarters of teachers who enter secondary science teaching may have no or little practical understanding of mandatory requirements such as aims, curriculum and policy, and hence, departmental directives in secondary science education may be lost on many of the future teachers.

**Table 2:** *Mentees who perceived their mentors displayed "System Requirements" for mentoring secondary science teaching.*

| System Requirement | Percentage | Mean | SD |
|---|---|---|---|
| Showed secondary science content | 64 | 2.55 | 1.17 |
| Outlined curriculum documents | 30 | 3.37 | 1.17 |
| Discussed the aims | 24 | 3.54 | 1.13 |
| Discussed policies and procedures | 24 | 3.64 | 1.19 |

**Pedagogical knowledge**

Thirdly, it is argued that the mentor needs to have practical knowledge for implementing effective teaching strategies. For example, strategies for classroom management and questioning techniques (Feiman-Nemser, 1992) are necessary for the mentee's implementation of science teaching. A mentor with knowledge of programming can also assist the mentee in sequential planning for the teaching of science. As observed by Hudson & Skamp (2001), mentors' knowledge of where to obtain science equipment, and knowledge of assessment and evaluation methods of science teaching provides valuable information for science teaching by the mentee.

In this study, a small majority of mentors (51%) discussed science programmes and assisted the mentee in preparing for science teaching. However, such assistance appears to be limited as only 37% of mentors developed the mentee's problem-solving strategies and 32% of mentors assisted the mentee with obtaining science equipment. One of the most common needs for mentees is learning effective classroom management strategies, which is also perceived by mentors as the most changed practice of mentees during a practicum (Riggs & Sandlin, 2002). Classes that require more management strategies than others can reduce the amount of teaching time, and so classroom management becomes significantly important for preservice teachers; yet only 44% of mentees claimed that the mentor had assisted them to develop classroom management strategies. Mean item scores (range: 2.98 to 3.69; standard deviations range: 0.95 to 1.47) indicate that the majority of mentees "disagreed" that the mentor displayed "Pedagogical Knowledge" in their mentoring practices for science teaching. Fundamental teaching strategies such as discussing assessments (30%) and questioning techniques (25%) were given a low priority by mentors (see Table 3). As a consequence, mentees may not raise the students' level of thinking with higher order questions, and assessment and evaluation procedures may not be implemented for devising further teaching and learning activities for secondary science.

**Table 3:** *Mentees who perceived their mentors displayed "Pedagogical Knowledge" for mentoring secondary science teaching*

| Pedagogical Knowledge | Percent | Mean | SD |
|---|---|---|---|
| Guided preparation in science | 51 | 3.29 | 1.30 |
| Discussed mentee's programme | 51 | 2.98 | 1.47 |
| Assisted with classroom management | 44 | 3.42 | 1.21 |
| Assisted with time-tabling | 41 | 3.12 | 1.40 |
| Assisted with teaching strategies | 37 | 3.47 | 1.29 |
| Assisted in solving/reducing problems | 37 | 3.07 | 1.22 |
| Gave clear expectations | 36 | 3.54 | 1.26 |
| Developed mentee's problem solving skills | 32 | 3.69 | 0.95 |
| Obtained equipment for mentee | 32 | 3.25 | 1.24 |
| Discussed equipment | 32 | 3.25 | 1.24 |
| Discussed assessment | 30 | 3.41 | 1.26 |
| Discussed questioning techniques | 25 | 3.41 | 1.18 |

**Modelling**

Fourthly, literature on mentoring (Feiman-Nemser & Parker, 1992) show that mentors need to model effective teaching practices. Such modelling aims to demonstrate for the mentee teaching knowledge (Jean & Evans, 1995), the teaching of science (Feiman-Nemser & Parker, 1992), and the syllabus language for teaching science. The mentor also needs to display enthusiasm for science teaching and model ways of coping with teaching demands (Hudson & Skamp, 2001).

Modelling teaching provides mentees with examples of how to teach, yet in this study, three quarters of mentees (75%) said that they did not see their mentor model the teaching of science, let alone more difficult topics in science (83%). The relatively simple process of showing the mentor's programme for science teaching was viewed by only 24% of mentees (see Table 4). Modelling how to programme for science may imply expectations for planning to teach science and may also show the mentee how to link "System Requirements" and science teaching practices.

Sixty four percent (64%) said their mentors displayed enthusiasm for science teaching. These results are not be consistent with the limited "Modelling" reported of the mentor and the fact that the majority of mentors were perceived not to have practised over 28 items on the survey. Also the mentee's knowledge of the science syllabus language can assist in understanding the mentor's articulation of secondary science teaching practices, however, only 39% of mentors modelled such language, and discussing science teaching knowledge and skills can lead the mentee towards purposeful planning and teaching, yet 59% of mentors did not do this.

Overall, analysis of these results on face value show that, other than mentors displaying enthusiasm for science teaching, most mentors do not model the teaching of science. Mean item scores (range: 2.98 to 3.69; standard deviations range: 0.95 to 1.47, see Table 4) also indicate that the majority of mentees were "uncertain" to "disagreeing" that their mentors were "Modelling" secondary science teaching practices.

**Table 4:** *Mentees who perceived their mentors displayed "Modelling" for mentoring secondary science teaching*

| Modelling | Percent | Mean | SD |
|---|---|---|---|
| Displayed enthusiasm | 64 | 2.41 | 1.40 |
| Discussed teaching knowledge | 41 | 3.51 | 1.09 |
| Coped with demands | 40 | 2.86 | 1.04 |
| Used syllabus language | 39 | 3.00 | 1.23 |
| Modelled science teaching | 25 | 3.66 | 1.27 |
| Showed examples of programming | 24 | 2.98 | 1.47 |
| Modelled the teaching of difficult topics | 17 | 3.85 | 1.14 |

**Feedback**

Finally, it is argued that effective mentoring occurs when mentors provide feedback to the mentees, which commences with observing the mentees' science teaching, and then through oral and/or written communication, providing constructive advice (Peters, 2007). Undoubtedly, a powerful form of feedback would be for the mentor to model what was discussed in the mentee's feedback, so that the mentee can observe first hand successful secondary science teaching practices.

In this study, a high percentage of mentors (90%) observed their mentee's science lessons, which enables mentors to gather practice information towards purposeful discussions with the mentee. Furthermore, 81% of mentors provided oral feedback on the mentee's performance as a teacher of secondary science. Even though written feedback may be less frequent than oral feedback, which can be expected as it generally takes less time to provide oral feedback than it would to provide written feedback; the majority of mentors (61%) provided written feedback on their mentees' science teaching.

Conversely, there were 39% of mentees who received no written feedback; 19% who received no oral feedback, and 10% who were not observed teaching science during their one year professional experience (i. e. practicum). This may mean that as many as 19% of mentees received no feedback on their science teaching at all, and that as many as 10% may not have had any experience in teaching science before they enter the profession the following, year. Mean item scores (range: 1.78 to 2.53; standard deviations range: 0.87 to 1.28) indicate that the majority of respondents were "agreeing" to "strongly agreeing" that the mentor provided *feedback* as part of their mentoring practices for science teaching.

**Table 5:** Mentees who perceived their mentors displayed "Feedback" for mentoring secondary science teaching.

| Feedback | Percent | Mean | SD |
|---|---|---|---|
| Observed their science lessons | 90 | 1.78 | 0.67 |
| Provided oral feedback | 81 | 2.00 | 0.89 |
| Provide written feedback | 61 | 2.53 | 1.28 |

Feedback from mentors aids mentees to reflect upon teaching practices (Beattie,2000)

Despite providing oral and written feedback; it was shown that the majority of mentors (64%) (see Table 3) did not provide expectations related to science teaching, which tends to diminish the quality of feedback being provided by the mentors. Nevertheless, the results of providing feedback in this study were positive and may be capitalised upon to develop other needed aspects in the mentoring process.

**Exploratory Factor Analysis (EFA)**

An initial exploratory factor analysis (EFA) entering the hypothesised five factors with the associated items as derived from the literature produced squared multiple corrections (SMC), Cronbach alphas, and eigen values for each factor (i.e. personal attributes, system requirements, pedagogical knowledge, modelling, and feedback (see Table 6).

The purpose of EFA in this study was to assess the unidimensionality for each of the proposed constructs (i.e. five factors). Eight items (see Table 1) associated with the factor "Personal Attributes" were entered in SPSS 10 factor reduction, which extracted only one factor (eigen value = 5.4) to explain 68% (variance) of this relationship. However, a squared multiple correlation of .42 (less than the .50 rule of thumb (Hair, Anderson, Tatham, & Black,1995) for the item "assisted with university assignments" indicated that this item may not be significantly related to the factor "Personal Attributes".

The four items (see Table 2) associated with "System Requirements" provided only one eigen value greater than 1.00 and 73% of variance. However, the twelve items (see Table 3) linked to "Pedagogical Knowledge" produced a second eigen value greater than 1 (with 10% of variance), which indicated more than one factor associated with these twelve items. Using the Varimax rotation method in SPSS 16 factor reduction, the item "Obtained equipment" indicated it was responsible for the extraction of a second factor, as it was improved by dropping this item and consequently, only one factor was extracted with 69% of variance and a higher

Cronbach alpha (0.94), thus improving the model. Assigned items entered into (Modelling and Feedback) extracted only one factor each. The seven items (see Table 4) associated with "Modelling" had 65% of variance while the three items (see Table 5) associated with "Feedback" returned 75% variance. After one re-specification (dropping the item "obtained equipment"), the five factors, namely, personal attributes, system requirements, pedagogical knowledge, modelling, and feedback had Cronbach alpha coefficients of internal consistency reliabilities of .93, .78, .94, .90, and .81 respectively ($p < .001$, see Table 6).

**Table 6:** Exploratory factor analysis for the five hypothesised factors.

| First component extracted | | | Second component extracted | | |
|---|---|---|---|---|---|
| Factor | Eigen Value | Percent of variance | Eigen value | Percent of variance | Cronbach alpha |
| Personal attributes | 5.41 | 68 | 0.68 | 8 | 0.93 |
| System requirements | 2.93 | 73 | 0.66 | 16 | 0.78 |
| Pedagogical knowledge | 6.80 | 69 | 1.14 | 10 | 0.94 |
| Modelling | 4.54 | 65 | 0.75 | 11 | 0.90 |
| Feedback | 2.24 | 75 | 0.48 | 16 | 0.81 |

(All factors were significant, $p < .001$)

***Question 2:*** What are the perceptions of student teachers concerning the self-efficacy of the mentor teacher during practicum? This question was answered during focus group interviews with interns. A mentor teacher with higher self-efficacy tends to exhibit greater levels of enthusiasm, be more open to new ideas, more willingly to try a variety of new methods to better meet the needs of student teachers and more devoted to teaching. They also tend to be less judgmental of students and work longer with students who are struggling (Tschannen-Moran & Woolfolk, 2001).

A summary of the findings are reported below which collaborated well with findings of the survey.

"The mentor teachers freely communicated with us and gave us the freedom to call them on phone anytime we needed their help. They were also good advocates for us when dealing with administrators of the school, other teachers and university personnel on visit. Mentors gave us feedback whenever they observed our lessons. However they never modeled science teaching for us to observe and see how they will handle difficult concepts and stubborn students. Some of our mentors failed to tell us our weakness, perhaps they did not want to displease us''.

**Discussion**

Although this study explores a relatively small sample (n=150), and only tentative conclusions may be drawn, this cohort of mentees represented all of the secondary preservice teachers at the end of a four-year Bachelor of Education degree in a University of Education of Winneba. The picture that emerges is mixed with a considerable number of future teachers (maybe as high as 50%) having received a limited mentoring experience in relation to teaching secondary school science, and with a small percentage (but maybe as high as 30%) obtaining little, if any, assistance in this regard. Despite the positive signs of proving feedback to mentees, there were few mentors who seemed to take a proactive role in exemplifying specific science teaching strategies. The question remains, how can science for all be achieved if it is not achieved in the mentoring of future teachers of secondary school science?
By determining it there are "factors" (i.e. personal attributes, system requirements, pedagogical knowledge, modelling, and feedback) and associated mentoring attributes and practices in secondary science teaching, mentoring may become more focused. However, further research is needed to validate the existence of these five factors and their associated attributes and practices.

**Conclusion**

Secondary science education reform has not been successful to date as many secondary teachers tend not to change their teaching practices, and yet secondary science education reform is necessary if society is to progress towards being a more scientific community. There is great variability between Ghanaian schools in the quality of science education (Azure, 2005) and educating preservice teachers is only part of the solution for implementing basic and secondary science reform. For reform to occur there must be more experienced and expert overseers, who have clear reform expectations and requirements. This is why secondary science reform strategies need to reach teachers in their roles as mentors, since mentors are the ones to guide teacher mentees' secondary science teaching through on-the-spot training. To do so, the mentor must be well prepared and informed on successful and effective mentoring practices.

Formal mentoring programmes are considered to be a planned and intentional process (Long, 1997). However this does not appear to be so for secondary science teaching. This study argues that mentors need to be aware of specific attributes and practices in order to develop their mentoring of secondary science teaching. Indeed, the breadth of a mentee's practicum in science rests substantially with the mentor. The duration of a practicum necessary to produce effective science teachers may also be linked to the degree and quality of their mentoring. For mentoring to remain a viable and valued component of preservice teacher science education, it is believed that clearly identified subject-specific mentoring practices need to be incorporated into the mentoring process. Subject-specific mentoring may be the reform measure needed to materialise the "science for life" goal of African nations.

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