Hacettepe Üniversitesi Eğitim Fakültesi Dergisi 21 : 105-112 [2001]

PRESERVICE BIOLOGY TEACHERS' PERCEIVED EFFICACY BELIEFS IN TEACHING BIOLOGY

BİYOLOJİ ÖĞRETMEN ADAYLARININ BİYOLOJİ ÖĞRETİMİNE İLİŞKİN ÖZYETERLİLİK İNAÇLARI

Ayşe SAVRAN*, Jale ÇAKIROĞLU**

ABSTRACT: Self-efficacy beliefs have received increasing attention in educational studies. According to Bandura's Social Cognitive Theory, self-efficacy was measured as two distinct constructs, personal self-efficacy and outcome expectancy. Self-efficacy can be defined as the teachers' belief in his/her ability to perform teaching; and outcome expectancy reflects a teacher's belief that student achievement can be influenced by effective teaching. The purpose of this study is to assess preservice biology teachers' self-efficacy beliefs with regard to biology teaching. For this purpose, Biology Teaching Efficacy Belief Instrument (BTEBI) was administered to 29 preservice biology teachers at the Middle East Technical University. The results indicated positive efficacy beliefs expressed by the most of the preservice teachers regarding their ability to teach biology.

KEY WORDS: Self-efficacy, outcome expectancy, biology teaching, preservice biology teachers.

ÖZET: Son yıllarda öğretmen öz-yeterlilik inancına (teacher efficacy beliefs) eğitim araştırmalarında geniş yer verilmiştir. Bandura'nın sosyal bilinşsel teorisine göre, öz-yeterlilik iki farklı boyutta incelenebilir: kişisel öz-yeterlilik ve sonuç beklentisi. Birincisi, öğretmenlerin etkili bir öğretme için gerekli davranışları gösterecekleri konusundaki sahip oldukları inanç ve yargılarıdır (self-efficacy). İkinci boyut ise öğretmenlerin öğrencilerin başarılarının etkili öğretme yöntemleriyle arttırılabileceğine olan inanç ve yargılarıdır. Bu araştırmanın amacı biyoloji öğretmen adaylarının biyoloji öğretimindeki öz-yeterlilik inançlarını belirlemektir. Bu amaçla, Orta Doğu Teknik Üniversitesinde, biyoloji öğretmenliği bölümünde okuyan 29 öğrenciye "Öğretmen Yeterlilik İnanç" anketi uygulanmıştır. Araştırmanın sonuçlarına göre biyoloji öğretmen adaylarının biyoloji yeterlilik inançları yüksek çıkmıştır.

ANAHTAR SÖZCÜKLER: Öz-yeterlilik, sonuç beklentisi, biyoloji öğretimi, biyoloji öğretmen adayı.

1. INTRODUCTION

Self-efficacy beliefs have received increasing attention in educational studies. Much of the recent studies examining teachers' self-efficacy emphasize that teachers' expectations and beliefs about their effectiveness play a critical role in relating to student outcomes such as student motivation and achievement (Armor et al., 1976, Gibson & Dembo, 1985). Furthermore, teacher efficacy has been shown to positively influence teachers' classroom behaviors. For example, research on teacher efficacy indicates that, relative to teachers with a low sense of efficacy, teachers with a high sense of efficacy devote more time to academic instruction (Gibson & Dembo, 1984), take greater responsibility for educating students who have difficulty learning (Soodak & Podell, 1993). In addition, Czerniak and Lumpe (1996) noticed that levels of science teaching efficacy were found to be related to science teaching anxiety and the instructional strategies. In fact, highly efficacious teachers more likely to use open-ended, inquiry, student-directed teaching strategies, while teachers with a low sense of efficacy are more likely to use teacher-directed teaching strategies such as lecture and reading from the textbook. In sum, teacher efficacy has been linked to teachers' classroom behaviors, their openness to new ideas, and their attitudes toward teaching (Tschannen-Moran et al., 1998).

* Pamukkale University, Faculty of Education, Department of Elementary Education.
** Dr., Middle East Technical University, Faculty of Education, Department of Secondary School Science and Mathematics Education.

2. THEROTICAL FRAMEWORK

The conceptualization of teacher efficacy has been based on Bandura's (1977) theory of self-efficacy. Bandura (1982) defines self- efficacy as judgements of how well one can execute courses of action required to deal with prospective situations. In his theory, Bandura (1977) theorized that behavior is based on two sources; outcome expectations and self- efficacy expectations. He defined outcome expectancy as a person's estimate that a given behavior will lead to certain outcomes whereas an efficacy expectation is the conviction that one can successfully execute the behavior required to produce the outcomes. Bandura (1982) suggested that in any given instance behavior would be best predicted by considering both self efficacy (belief that one has the necessary skills to perform the outcome) and outcome expectancy (belief that behavior will lead to desirable outcomes). Bandura (1977) hypothesized that people with both high outcome expectancy and self- efficacy will act in an assured, decided manner. Low outcome expectancy paired with high personal efficacy may cause individuals to temporarily intensify their efforts but eventually lead to frustration. Persons low on both variables will give up more readily if the desired outcomes are not reached immediately.

Many researchers in education have applied Bandura's social cognitive theory and his construct of self-efficacy concepts to teachers. Based on Bandura's (1977) construct, Ashton and Webb (1986) were among the first researchers to develop a multidimensional model of teacher efficacy for assessing two dimensions of teacher efficacy by using two items that were developed by the Rand studies (Armor et al., 1976; Berman et al., 1977). Teacher's level of agreement with the first statement was labeled as *teaching efficacy* that corresponded to Bandura's outcome expectations. Teacher's level of agreement with the second statement was labeled as *personal teaching efficacy* that corresponded to Bandura's efficacy expectation. They also found a positive relationship between teachers' sense of efficacy and student achievement (Ashton & Webb; 1986). Similary, Ashton (1984) states that "..no other teacher characteristic (teacher efficacy) has demonstrated such a consistent relationship to student achievement (p.28)."

In an attempt to further the development of teacher efficacy belief instrument Gibson and Dembo (1984) developed a 30-item Likert type Teacher Efficacy Scale to measure the two dimensions of teacher efficacy. Factor analysis of responses from 208 elementary school teachers confirmed the existence of two factors that corresponded to Bandura's two component model of efficacy. The development of the Gibson and Dembo Instrument has become a more extensive and reliable measurement in the study of teacher efficacy to explore the impact of teachers' sense of efficacy on their behaviors and attitudes and on student achievement. Gibson and Dembo (1984) asserted that if Bandura's theory of self-efficacy is applied to the construct of teacher efficacy, outcome expectancy would essentially reflect the degree to which teachers believed the environment could be controlled, that is, the extent to which students can be taught given such factors as family background, IQ, socioeconomic status (SES), and school conditions. This dimension is clearly represented by the second factor, *teaching efficacy*. Bandura's (1977) self-efficacy beliefs would be teachers' evaluation their abilities to perform the necessary tasks to bring about positive student change. This dimension is clearly represented by the first factor, *personal teaching efficacy*. Gibson and Dembo (1984) concluded that teacher efficacy is multidimensional, consisting of at least two dimensions and may influence certain patterns of classroom behavior.

Science educators have conducted extensive research to investigate the effects of teacher efficacy on science teaching and learning by modifying Gibson and Dembo Instrument grounded on Bandura's (1977) definition of self-

efficacy as a situation specific determinant of behavior not a global personality trait. Based on this hypothesis, Enochs and Riggs (1990) noted that specificity is especially necessary when studying elementary science teaching beliefs, and behavior, since elementary teachers teach all subjects and may not be equally effective in teaching all of them. Consequently, teachers' overall level of self-efficacy may not accurately reflect their belief about their ability to affect science teaching and learning. Thus, Riggs and Enochs (1990) developed an instrument by using Gibson and Dembo's (1984) Teacher Efficacy Scale to specifically assess science teacher self- efficacy and outcome expectancy beliefs of inservice and preservice elementary teachers- the Science Teaching Efficacy Belief Instrument (STEBI). Consistent with Gibson and Dembo (1984), they have found two distinct dimensions, the first of which was named *Personal Science Teaching Efficacy Belief* (PSTE) scale while the second was named *Science Teaching Outcome Expectancy* (STOE) scale.

In extending to further the understanding of elementary teachers' sense of efficacy studies Enochs and Riggs (1990) found that teachers with a higher sense of PSTE devoted more time to teach science with regard to teachers with a low sense of PSTE. Furthermore, higher sense of PSTE among elementary teachers was related to more humanistic orientations toward control or manegement in classroom and those preservice teachers were most capable of activity-based science teaching (Enochs et al., 1995). Conversely, the same researchers report that teachers with high sense of teaching self-efficacy believe in their ability to teach science and those teachers believe students can learn science given effective instruction (Enochs et al., 1995). Thus, Riggs and Enochs (1990) suggest that teacher educators must be aware of their students' beliefs and plan for experiences which will have positive impact on teacher self-efficacy and outcome expectancy. Therefore, by placing the burden of improving science education on teachers and teacher education programs, it is important to examine teachers' self-efficacy beliefs. The investigation of preservice teachers' self-efficacy beliefs is the important key in understanding how to increase teachers'sense of efficacy in teacher education programs, to motivate teachers to teach biology, and to have effective biology teaching in the high schools.

3. PURPOSE

In reaction to the importance of fostering science teaching, the purpose of this study was to explore preservice teachers' self-efficacy beliefs regarding biology teaching. Secondly, this study examined the relationships, if any, between teachers' sense of efficacy beliefs regarding biology teaching and their gender, university cumulative grade point average (GPA), number of university and high school biology courses completed, preference to be a biology teacher, advocacy of activity-based instruction, and self-rating of effectiveness as a future teacher.

4. METHODOLOGY

4.1. Sample

Twenty-nine preservice teachers of Secondary School Science and Mathematics Education Department enrolled in SCE 322: Curriculum Development in Science Education and SCE 401: Methods of Science Teaching participated in this study during the Fall semester of the 2000-2001 academic year. Both SCE 322 and SCE 401 are required courses for preservice teachers at the Middle East Technical University in Ankara. The sample included 13 males and 16 females with the average age of 23.

4.2. Instrument

The data for this study were collected by means of Biology Teaching Efficacy Belief Instrument (BTEBI). A questionnaire was also

used to gather demographic information about the participants.

The Biology Teaching Efficacy Belief Instrument (BTEBI) was modified from the Science Teaching Efficacy Belief Instrument Form B (STEBI-B) developed by Enochs and Riggs (1990) for preservice elementary teachers.

The instrument that was used in this study includes some modifications: removal of one item from the original instrument and substituting "science" for "biology". Then, final form of the BTEBI consists of 22 statements, 13 positively-written and 9 negatively-written. As in Enochs & Riggs' instrument, the BTEBI is comprised of two subscales; the first subscale measures personal biology teaching efficacy beliefs (PBTE) containing 12 items, whereas the other measures biology teaching outcome expectancy (BTOE) containing 10 items. This instrument is a 5 choice, Likert- type scale ranging from strongly agree to strongly disagree. Scoring was accomplished by assigning 5 to positively worded items receiving "strongly agree" down to 1 for "strongly disagree". Negatively worded items had their scores reversed.

Riggs and Enochs (1990) reported that the STEBI (Science Teaching Efficacy Belief Instrument) is a valid and reliable instrument to measure the science teaching efficacy of preservice elementary teachers. Reliability analysis of the Personal Science Teaching Efficacy (PSTE) scale produced an alpha coefficient of 0.90 and the Science Teaching Outcome Expectancy (STOE) scale produced an alpha coefficient of 0.76.

For the present study, the alpha reliability coefficient for PBTE scale was found to be 0.83 and for BTOE scale, it was 0.60.

The questionnaire was also administered to gather information about: how many biology related courses the participants completed in university and high school, gender, cumulative GPA, preference to be a biology teacher, advocacy of activity-based instruction, and the effectiveness of the preservice teacher in teaching biology.

5. RESULTS

As mentioned in the literature review, biology teaching efficacy is composed of two independent dimensions: (1) personal biology teaching efficacy (PBTE), which is the teachers' belief in his/her ability to perform biology teaching, and (2) biology teaching outcome expectancy (BTOE) which reflects a teacher's belief that students can learn biology. For this study, percentages for each item of responses were categorized into three collapsed groups: agreement, neutral, and disagreement. Percentages greater than fifty were considered meaningful enough to warrant consideration. Table 1a and Table 1b display percentages of responses to each item that fell into three collapsed categories for personal biology teaching efficacy (PBTE) and biology teaching outcome expectancy (BTOE) scale respectively.

The preservice teachers indicated generally positive self-efficacy beliefs regarding biology teaching. Raw scores ranged from 28 to 58, with a mean score of 44.8 and a standard deviation of 6.7. About 83% of the participants indicated a confidence in their ability to teach biology effectively (83% strongly disagree and disagree to the negatively written item 7). Only 52% of the participants felt they knew the steps necessary to teach biology concepts effectively and 66% indicated that they know how to help the student when a student has the difficulty to understand a biology concept. Only 69% claimed to understand biology concepts well enough to be effective in teaching biology. However, slightly less than half of the participants (45%) indicated that they have the necessary skills to teach biology concepts. This data may lead to conclusion that the prospective teachers harbor little doubt regarding their ability to teach biology at a conceptual level. About the same percentage of participants (41%) also indicated less willingness to be observed while teaching biology which

indicated slightly less self-confidence for teaching biology.

Furthermore, respondents seemed generally willing to assume that student learning in the content area of science is the responsibility of the teacher. Raw scores for the outcome expectancy ranged from 29 to 44, with a mean score of 36.4, and a standard deviation of 3.9. About 90% of the participants indicated that good teaching could overcome the inadequacy of a student's biology background and 93% believed that the teacher is generally responsible for the achievement of students in biology. That is, the respondents generally believe that they can increase students' achievement with effective teaching.

A t-test was used to evaluate the relationship between female and male mean scores on the BTEBI. A significant difference was not found between male and female scores at the 0.05 level for both PBTE and BTOE.

Pearson correlation were computed to consider the relationships between the surveyed preservice teachers' self-reported data such as cumulative GPA, number of high school and university biology courses, biology teaching self ratings and their PBTE and BTOE scores (Table 2). There was a statistically significant correlation between cumulative GPA of the respondents and PBTE scores (r=0.37). However, no significant correlation existed between number of high school and university biology courses completed and their PBTE and BTOE scores. These results suggest that completing a greater number of more biology related courses in high school and in university is not related to the preservice teacher's biology teaching efficacy beliefs. Additionally, PBTE positively correlated with self-rating of effectiveness as a future teacher of biology (r=0.64). However, no other correlations were found to be between all criteria and both PBTE and BTOE scores.

Table 1a. Percentages of Respondents along Three Collapsed Categories of the Personal Biology Teaching Efficacy (PBTE) Items.

Items	Description	Positive-Negative	Agree (%)	Neutral (%)	Disagree (%)
Item 2	I will continually find better ways to teach Biology.	P	86	14	-
Item 4	I know the steps necessary to teach Biology concepts effectively.	P	52	34	14
Item 5	I will not be very effective in monitoring Biology experiments.	N	14	3	83
Item 7	I will generally teach Biology ineffectively.	N	7	10	83
Item 11	I understand Biology concepts well enough to be effective in teaching Biology.	P	69	17	14
Item 16	I will find it difficult to explain to students why Biology experiments work.	N	10	7	83
Item 17	I will typically be able to answer students' Biology questions.	P	90	3	7
Item 18	I wonder if I will have the necessary skills to teach Biology.	N	41	14	45
Item 19	Given a choice, I will not invite the principal to evaluate my Biology teaching.	N	41	17	41
Item 20	When a student has difficulty understanding a Biology concept, I will usually be at a loss as to how to help the student understand it better.	N	24	10	66
Item 21	When teaching science, I will usually welcome student questions.	P	86	7	7
Item 22	I do not know what to do to turn students on to Biology.	N	14	10	76

Table 1b. Percentages of Respondents Along Three Collapsed Categories of the Biology Teaching Outcome Expectancy (BTOE) Items

Items	Description	Positive-Negative	Agree (%)	Neutral (%)	Disagree (%)
Item 1	When a student does better than usual in Biology, it is often because the teacher exerted a little extra effort.	P	76	3	21
Item 3	When the Biology grades of students improve, it is often due to their teacher having found a more effective teaching approach.	P	76	14	10
Item 6	If students are underachieving in Biology, it is most likely due to ineffective Biology teaching.	P	55	17	28
Item 8	The inadequacy of a student's Biology background can be overcome by good teaching.	P	90	7	3
Item 9	The low Biology achievement of some students cannot generally be blamed on their teachers.	N	49	21	31
Item 10	When a low-achieving child progress in Biology, it is usually due to extra attention given by the teacher.	P	62	24	14
Item 12	Increased effort in Biology teaching produces little change in some students' Biology achievement.	N	31	10	59
Item 13	The teacher is generally responsible for the achievement of students in Biology.	P	93	7	-
Item 14	Students' achievement in Biology is directly related to their teacher's effectiveness in Biology teaching.	P	69	24	7
Item15	If parents comment that their child is showing more interest in Biology at school, it is probably due to the performance of the child's teacher.	P	83	10	7

TABLE 2. Relationships between Biology Teaching Efficacy Beliefs and Preservice Teachers' Self-Reported Data (N=29)

	PBTE (r)	BTOE (r)
Cumulative GPA	0,37*	- 0,31
Number of High School Biology courses	- 0,02	- 0,26
Number of University Biology Courses	0,04	- 0,35
Choice to be a Biology teacher	0,06	0,05
Use of Activity-Based Teaching	0,01	0,31
Biology Teaching Self Ratings	0,64*	0,27

*p <0,05

6. DISCUSSION

It seems that the successful implementation of science education programs in schools may depend on teachers' self-efficacy beliefs, that is, their personal beliefs about their ability to teach science and their ability to produce positive outcomes in science for students. The results from the self-efficacy survey showed the generally positive efficacy beliefs expressed by the most of the preservice teachers regarding their ability to teach biology. Many of the participants confirmed that they understand biology concepts well enough to teach biology effectively to the students. However, about half

of the participants also indicated less willingness to be observed by the principal while teaching biology. They also seem generally to be optimistic and believe that they will indeed be effective biology teachers in the future.

Furthermore, it does appear that these prospective teachers are willing to assume the responsibility for student's biology achievement because they believe that student learning in the content areas of biology is the responsibility of the teacher.

A number of studies recommended that preservice teachers should undertake more science content and methods courses (Tilgner, 1990; Enochs & Riggs, 1990). However, Wenner (1993) reported an insignificant relationship between the number of high school and college science courses completed and teachers' confidence regarding science teaching. Conversely, Stepans and McCormack (1985) found a negative relationship. Data of this study suggests that biology related courses completed in high school and university do not appear to have influenced subjects' self-efficacy beliefs regarding biology teaching. This suggests that science teacher educators should structure existing (and any new courses) to include experiences that make students aware of, and able to confront, their existing beliefs about their ability to teach biology. This can be accomplished by well-planed science methods class which should be activity based and hands-on. Preservice teachers need to learn in an inviting, collegial, and noncompetitive atmosphere. Indeed, in their Science Teaching Efficacy Belief Instrument study Enochs and Riggs (1990) suggest that early detection of low self- efficacy in science teaching can be valuable in providing specific activities for preservice students such as field experiences, peer teaching, and the self- evaluation of microteaching have promise in the enhancement of science teaching self- efficacy.

Bandura (1986) advocated strategies such as modeling, verbal persuasion, and provision of successful experiences in the improvement of efficacy beliefs. These strategies could be integrated in methods courses in the training program to help biology teachers increase their self-efficacy beliefs in biology teaching. Science teacher educators must, therefore, be aware of their students' beliefs and structure the existing methods course or any new courses to allow preservice teachers to gain the biology teaching skills which will have positive impact on teacher self- efficacy and outcome expectancy.

In order to provide quality science education, preservice teachers will have to become better prepared to teach science. Teacher education programs need to evaluate efficacy levels of their teacher education students and begin to find ways to enhance their efficacy beliefs regarding science teaching in general, and biology teaching particularly. Only then can these programs begin to launch future teachers who are ready, willing, and able to meet the needs of their students.

Although the importance of teachers' sense of efficacy has been identified, further investigations should be done to construct and measure biology teachers' self-efficacy more accurately in implementing change to improve biology teacher education program to be more effective in teaching it. That is, internal and external factors that influence biology teachers' efficacy should be investigated to enhance teachers' efficacy such as the effect of teachers' characteristics and school settings. Indeed, the relationship of teacher efficacy to classroom management, teachers' behavior, selecting biology teaching methods should be examined to enhance student achievement in biology.

REFERENCES

[1] Armor, D., Conroy-Oseguera, P., Cox, M., King, N., McDonnell, L., Pascal, A., Pauly, E., and Zellman, G. (1976). *Analysis of the school preferred reading programs in selected Los Angeles minority schools.* (R-2007-LAUSD). Santa Monica, CA: RAND. (ERIC Document Reproduction Service No. 130243).

[2] Ashton, P. T. (1984). Teacher efficacy: A motivational paradigm for effective teacher education. *Journal of Teacher Education*, 35 (59), 28-32.

[3] Ashton, P. T., & Webb, R. B. (1986). *Making a difference: Teachers' sense of efficacy and student achievement*. New York: Longman.

[4] Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*". Englewood Cliffs, NJ: Printice-Hall

[5] Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change". *Psychological Review*, 84 (2), 191-215.

[6] Bandura, A. (1982). "Self-efficacy mechanism in human agency". *American Psychologist*, 37 (2), 122-147.

[7] Berman, P., McLaughlin, M., Bass, G., Pauly, E., and Zellman, G. (1977). *Federal programs supporting educational change: Vol. VII. Factors affecting implementation and continuation*. (Rep. No. R-1589/7-HEW). Santa Monica, CA: RAND. (ERIC Document Reproduction Service No. ED140432).

[8] Czerniak, C. M., and Lumpe, A. T. (1996). Relationship Between Teacher Beliefs and Science Education Reform. *Journal of Science Teacher Education*, 7 (4), 247-266.

[9] Enochs, L. G., & Riggs, I. M. "Further development of an elementary science teaching efficacy belief instrument: A preservice elementary scale. *School Science and Mathematics*, 90 (8), 695-706, (1990).

[10] Enochs, L. G., Scharmann, L. C., & Riggs, I. M. (1995). The relationship of pupil control to preservice elementary science teacher self-efficacy and outcome expectancy. *Science Education*, 79 (1), 63-75,

[11] Gibson, S., and Dembo, M. H. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology*, 76 (4), 569-582.

[12] Gibson, S., and Dembo, M. H. (1985). Teachers' sense of efficacy: An important factor in school improvement. *The Elementary School Journal*, 86 (2), 173-184.

[13] Riggs, I. M. & Enochs, L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education*, 74 (6), 625-637.

[14] Soodak, L., and Podell, D. (1993). Teacher efficacy and bias in special education referrals". *Journal of Educational Research*, 86 (4), 247-253.

[15] Stepans, J., & McCormack, A. (1985). *A study of scientific conceptions and attitudes toward of prospective elementary teachers: A research report* (ERIC Document Reproduction Sevice No. ED266024).

[16] Tilgner, P. J. (1990). Avoiding science in the elementary school. *Science Education*, 74, 421-431.

[17] Tschannen-Moran, M., Woolfolk- Hoy, A., and Hoy, W. K. (1998). Teacher Efficacy: Its Meaning and Measure. *Review of Educational Research*, 68 (2), 202-248.

[18] Wenner, G. (1993). Relationship between science knowledge levels and beliefs toward science instruction held by preservice elementary teachers. *Journal of Science Education and Technology*, 2, 461-468.