THE ROLE OF SELF-EFFICACY INFORMATION IN INFLUENCING SECONDARY SCHOOL STUDENTS' SCIENCE SELF-EFFICACY BELIEFS

by

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ABSTRACT

This article presents the findings of an investigation into how various sources of self-efficacy information influence secondary school students' perceptions of self-efficacy in science. Forty-two students of three different Form levels, namely Form 2, Form 4 Science and Lower 6 Science from an urban coeducational secondary school in Kuching, Sarawak, Malaysia, participated in this study. The students, who were of three different science self-efficacy (SSE) levels, were interviewed to obtain insights into how various sources of self-efficacy information influenced their self-efficacy beliefs. They were also asked to indicate which source of self-efficacy information had the greatest impact on their self-efficacy beliefs. Implications of the findings on teaching and learning approaches are discussed.

INTRODUCTION

In recent years, self-efficacy beliefs have received increasing attention in educational research, particularly in studies on academic motivation and self-regulation (Multon, Brown, & Lent, 1991; Pintrich & Schunk, 1995; Schunk, 1991, 1994). The concept of self-efficacy is based on Bandura's (1986) Social Cognitive Theory of human behavior, which posits that humans are self-reflecting and self-regulating beings and these abilities have a profound impact upon affect and behavior. Bandura (1986, p. 391) defined self-efficacy beliefs as referring to "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances." Self-efficacy beliefs influence people's thoughts and actions; how much effort they will expend and how long they will persevere in the face of obstacles. Over the past two decades, research has been carried out on aspects such as the link between self-efficacy beliefs and college majors and career choice (Hackett, 1985; Matsui, Ikeda & Ohnishi, 1989; Pajares & Miller, 1995), motivation to learn, use of self-regulated learning strategies and academic achievement (Chye, Walker & Smith, 1997; Zimmerman & Bandura, 1994; Zimmerman & Martinez-Pons, 1990), and teacher efficacy (Ashton & Webb, 1986; Woolfolk, Rosoff & Hoy, 1990). Another area of interest to self-efficacy researchers is what influences people's judgment of self-efficacy.

According to Bandura (1986), four main sources of self-efficacy information influence people's self-efficacy beliefs.

Sources of Self-Efficacy Information

People's conceptions of their self-efficacy, whether accurate or faulty, are developed and verified through various sources of self-efficacy information. These include enactive attainments, vicarious experiences, verbal persuasions, and physiological states or emotional arousal (Bandura, 1986). Researchers (Bandura, Adams, & Beyer, 1977) have found that enactive attainment or actual experience is the most influential source from which individuals develop self-efficacy beliefs. This is because enactive attainments provide the most authentic evidence of whether one can muster what it takes to succeed (Bandura, 1997). Success raises self-efficacy and failure lowers it, especially if failures occur before a sense of efficacy is firmly established. A resilient sense of efficacy requires experience in overcoming obstacles through perseverant effort.

Another source of self-efficacy information is vicarious experiences. Vicarious experience is second hand experience produced through observing the actions of others. Vicarious experience is weaker than enactive attainment, but when people are uncertain about their own abilities or when they have limited prior experience, they are more sensitive to it (Bandura, 1986). The strength of the effect of vicarious experiences on a person's self-efficacy appraisal depends on social comparison processes. Studies on social comparative modeling (Brown & Inouye, 1978, Schunk, 1983b) have found that comparison among peers is an influential and vicarious source of one's perceived self-efficacy. As Bandura (1986) observed, seeing similar others succeed or fail at a task can affect such individual's self-efficacy beliefs. Seeing a skilled person fail by the use of insufficient strategies can boost self-efficacy in observers who believe they have more suitable strategies at their command. Conversely, observing a similar person barely succeed despite the most adroit tactics may lead observers to reevaluate the task as much more difficult than they had previously assumed it to be.

Verbal persuasions also play an important part in the development of self-efficacy beliefs. Bandura (1986) noted that it is widely used to get people to believe they possess capabilities that will enable them to achieve what they seek. Bouffard-Bouchard (1989) found that teachers can raise or inhibit students' percepts of efficacy by suggesting whether or not they have the capabilities to succeed in a given task. According to Bandura (1997), persuasory efficacy information is usually conveyed in evaluative feedback. For example, evaluative feedback highlighting personal capabilities raises efficacy beliefs, and feedback that children have improved through effort enhances perceived efficacy. Just as positive persuasions may work to encourage and empower, negative persuasions may work to defeat and weaken self-beliefs. As Pajares (1997) observed, it is usually easier to weaken self-efficacy beliefs through negative appraisals than to strengthen such beliefs through positive encouragement.

A fourth source of self-efficacy information is emotional arousal or physiological states. According to Bandura (1997), somatic indicants (such as sweating, tension, shakes), physiological indicants (such as fatigue, windedness, aches and pains) and mood states also provide information about self-efficacy beliefs. Such emotional arousal affects a person's self-efficacy beliefs and hence their performance at tasks. The efficacy value of the arousal depends on the individual's judgment of the situation. It is not the sheer intensity of emotional or physical reactions that is important but rather how they are perceived or interpreted by the person concerned. For example, Ehlers, Margraf, Roth, Taylor and Birbaumer (1988) found that people with cognitive biases on interpretations of physiological states (e.g., panic disorder patients) were more likely to feel inefficacious due to the physiological arousal and begin to worry about this lack of control and possible consequences, and increase their actual levels of physiological and psychological distress. As Bandura (1986) observed, those who are inclined to perceive their arousal as stemming from personal inadequacies are more likely to lower their self-efficacy than those who regard their emotional arousal as a common transitory reaction that even the most competent persons experience.

Research on the relative impact of these four sources of self-efficacy information on students' self-efficacy beliefs has yielded some interesting findings. For example, Lopez and Lent (1992) found that 9th grade students' maths self-efficacy beliefs were influenced by performance accomplishments (i.e., enactive attainments) and emotional arousal, but not vicarious learning or verbal persuasions. Meanwhile, Hampton (1998) found that performance accomplishments and vicarious experiences predicted students' academic self-efficacy beliefs for both students with learning and non-learning disabilities. Researchers who studied the relation between self-efficacy perceptions and selection of maths-related majors and careers also reported similar findings. For example, Matsui, Matsui, and Ohnishi (1990) reported that performance accomplishment, vicarious learning and physiological state, but not social persuasions, predicted students' maths self-efficacy perceptions. Lent, Lopez, and Bieschke (1991) found that compared to the other three sources of self-efficacy information, students' performance accomplishments were a more important source of self-efficacy information for maths self-efficacy. In general, the findings of the above studies support the views of Bandura (1986), that performance accomplishment or enactive attainment is the most influential source of self-efficacy beliefs. As the above review shows, studies in this area have focused mainly on students' maths self-efficacy. There have been hardly any documented reports of similar studies that focused on self-efficacy beliefs in science. The present study therefore aimed to explore how the various sources of self-efficacy information influenced students' self-efficacy beliefs in science.

Purpose of the Study

The purpose of this study was to inquire into how various sources of self-efficacy information influenced students' perceptions of self-efficacy in science. Students were also asked to indicate which source of self-efficacy information had the greatest impact on their self-efficacy beliefs.

METHOD

Sample

Purposive sampling procedure was used to select 42 students (i.e., 21 boys and 21 girls) from a pool of 312 students of three Form levels, namely Form 2, Form 4 Science, and Lower 6 Science who were involved in a study on the relation between SSE beliefs and self-regulated learning. The average age of Form 2 students was 13.9 years, that of Form 4 students was 15.8 years, while the average age of Lower 6 students was 17.5 years. The 42 students consisted of 14 low SSE, 14 average SSE, and 14 high SSE students. Students' SSE level was earlier determined through administration of a Science Self-Efficacy Scale. Students who attained a score of more than one standard deviation (SD) below the mean (i.e., < 50%) were categorized as low SSE, those who attained a score of between one SD below and one SD above the mean were categorized as average SSE, and those who attained scores of more than one SD above the mean (i.e., > 83%) were categorized as high SSE.

Instruments

Science Self-Efficacy Scale

A Science Self-Efficacy Scale consisting of 10 science items covering a range of science topics familiar to students of the three Form levels was developed to assess students' SSE. In keeping with how academic self-efficacy is assessed (Pajares, 1996a; Zimmerman & Bandura, 1994; Zimmerman & Martinez-Pons, 1990), students were not required to write down the answers to the items in the scale. They were only required to give realistic estimates of their confidence in answering such science items correctly. The items in the scale represented three science domains (Biology, Physics and Chemistry) and five levels of questioning, namely knowledge, comprehension, application, analysis, and synthesis (Bloom's Taxonomy, cognitive domain). The scale consisted of the type of items that students commonly encounter in learning science, that is, doing calculations, analyzing graphs, diagrams, charts and texts, and designing experiments. An initial pool of 30 items (i.e., three items for each of the 10 topics selected) was drawn up and subjected to the scrutiny of three experienced secondary school science teachers with 10 to 15 years experience in teaching at least two of the three above-mentioned Form levels of secondary school science. Selection of the 10 items for the scale was based on the teachers' comments and suggestions concerning the suitability of the items for Forms 2, 4 and Lower 6 students. The scale was initially formulated in English before being translated into Bahasa Malaysia, the official medium of instruction in all government secondary schools in Malaysia. Brislin's (1986) back-translation procedure was employed to check on the accuracy of the translation. Three experienced university lecturers further checked the scale for face validity. The resultant scale was pilot tested on a representative sample of students (N = 111) who were not involved in the actual study. Each student's SSE score was obtained through summing his or her confidence ratings for the 10 items in the scale. Following that, measures

of internal consistency and stability (after two weeks) were computed. The alpha reliability coefficient was .80, the item-total-correlations ranged from .46 to.73, $p < .001$, while the inter-item-correlations ranged from .40 to .64, $p < .001$, and the test retest stability coefficient was .89, $p < .01$.

Interviews

Interviews were conducted to gain insights into selected students' self-efficacy in science. A semi-structured interview approach was used in preference to highly structured or unstructured interviews because semi-structured interviews, while retaining the main objective of eliciting equivalent information from a number of interviewees, also provide a more flexible style that can be suited to the personality and circumstances of the interviewees. It also permits the researcher to probe and expand the interviewee's responses where and when appropriate.

The interview questions drawn up for the interview were based on suggestions put forward by Bandura (1986) concerning the various sources of self-efficacy information that influence a person's self-efficacy beliefs. These questions served as a guide for probing into how the various sources of self-efficacy information, namely enactive attainments, vicarious experiences, verbal persuasions, and physiological state or emotional arousal affected students' self-efficacy beliefs, and, subsequently, their efforts in learning science. Students were asked to explain how various sources of self-efficacy information such as (a) their attainments in science (enactive attainments), (b) observations of or comparisons with the science attainments of their peers (vicarious experiences), (c) teachers', parents' and peers' comments regarding their attainments in science (verbal persuasions), and (d) their feelings when faced with a science task or test (emotional arousal or physiological state), affected their confidence and efforts in learning science. In addition, students were asked to indicate which one of the above sources of self-efficacy information had the greatest impact on their confidence regarding science.

The interview protocol was prepared in both English and Bahasa Malaysia and the back-translation procedure (Brislin, 1986) was used to check on the equivalence of the two versions. The interview protocol thus drawn up was piloted on a representative sample of students consisting of three Form 2, three Form 4 Science, and three Lower 6 Science students not involved in the actual study. While conducting the interviews, the researcher made an effort to check on the suitability of the interview protocol through taking note of interviewees' perceptions of the questions asked. Following that, weaknesses identified in the protocol were corrected.

Procedure

Students were interviewed individually for about 30 minutes. The interviews were conducted by one of the researchers in this study in a room provided by the school authorities. Before the interview proper, the interviewer took time to establish friendly rapport with the students. They were informed of the purpose of the interview and assured that their responses would be kept

confidential. They were also told that there were no right or wrong answers and were encouraged to respond as honestly as they could to the questions asked. They were allowed to choose to converse in the language they felt most comfortable with, that is, Bahasa Malaysia or English. In order to avoid bias on grounds of their perceptions of themselves, the interviewees were not informed as to whether they were low, average, or high SSE students. All the interviews were audio-taped.

Data Analysis

The audio-taped interview responses were transcribed verbatim and content analyzed using the 'framework' technique of qualitative data analysis (Ritchie & Spencer, 1994). This method is systematic, thorough, and grounded in the data. This involved (a) initially reading through all the transcripts in order to be familiar with the data, (b) re-reading the transcripts and identifying recurring themes or categories, (c) indexing or coding data into themes or categories, (d) charting or creating a framework of categories, (e) refining and reducing categories through grouping them where appropriate, and (f) checking and re-coding responses using the refined framework of categories.

As a check on the reliability of the coding of interview data, two coders coded 20% of the interview transcripts separately. Three low SSE, three average SSE, and three high SSE students' transcripts were randomly selected for the reliability check. Each of the nine transcripts was given a number and the identity of the students was not revealed to the coders. Cohen's (1988) kappa values obtained were .83 (Coder 1*Coder 2), .86 (Coder 1*Coder 3), and .81 (Coder 2*Coder 3). (Coder 1 was the researcher in this study.) Discussions were carried out between coders to resolve differences in the coding of some of the responses and following that, the necessary adjustments were made.

FINDINGS AND DISCUSSION

This study sought to investigate how various sources of self-efficacy information influenced students' perceptions of SSE and learning behavior. Content analysis of the verbal data obtained showed that for each of the four sources of self-efficacy information, students' responses could be classified into a number of categories as discussed in the following paragraphs. Table 1 presents the categories identified and the number of low, average, and high SSE students' responses in each category.

Enactive Attainments

Students' responses to questions concerning the influence of their attainments in science on their SSE beliefs could be classified into two categories. Most of the students interviewed (i.e., 13 low SSE, 14 average SSE, and 14 high SSE students) indicated that their attainments in science affected their confidence in science. For example, a low SSE Form 2 student said, "My confidence in science is kind of low because I am not so good in science. When I get higher marks, I feel more confident. I try to read more and work harder". A high SSE Lower 6 student said, "Usually when I have good grades in science, I feel

more confident". Only one low SSE student gave a response of the second category, that is, getting low marks did not affect self-efficacy and subsequent actions. The low SSE Form 2 student said, "My grades in science are usually below average. Doesn't really affect my confidence. I just carry on as usual". Further probing revealed that the Form 2 student concerned was rather indifferent to his attainments in science because previous attempts at improving his own performance had not been successful.

Vicarious Experiences

Students' responses to questions concerning the influence of vicarious experiences were classified into four different categories (refer to Table 1). Many of the students interviewed (i.e., 7 low SSE, 9 average SSE, 9 high SSE students) said that when they compared their achievement with that of their peers who scored higher marks, they felt confident that they could do so too and this caused them to resolve to try harder the next time. For example, an average SSE Lower 6 student said, "When I compare my marks with those who did very well, I feel that I can do it too if I try harder. I don't give up. I work harder to improve myself." Seven low SSE students, however, gave responses that fell into the second category, that is, comparison with students who attained marks higher than theirs lowered their self-efficacy. For example, a low SSE Form 2 student said, "Usually I compare with those who got the highest scores. I feel bad and less confident because my marks are so low." Further probing revealed that this was because she felt that she could never quite make it no matter how hard she tried. One of them resorted to comparing only with those who attained marks slightly higher than hers so that she felt better. As the low SSE Form 2 student said, "I try not to compare with the top scorers. I compare with friends who get slightly higher marks than mine." However, these low SSE students said that they did not give up completely but continued to work hard to improve their results. Only one average SSE student gave a similar response while as expected, no high SSE student gave responses of this category. For the third category, one low SSE and four average SSE students reported that comparing their attainments with that of high achievers did not affect their SSE and learning behavior. For example, one average SSE Form 2 student said, "Comparing with my friends who do better than me does not affect my feelings and confidence in science. I continue to work as usual." Five of the high SSE students' responses were classified under the fourth category, that is, they didn't compare with others. They either compared their achievement with their previous achievement or worked towards a personal target. For example, a high SSE Lower 6 student said, "I don't compare with others. I have my own goal and I try to achieve it." A high SSE Form 4 student said, "I usually don't compare with others. I try to get a better mark than my previous mark." None of the low SSE or average SSE students gave such responses. High SSE students probably had fewer others to compare with because according to them, they were usually among the top scorers in the class or they had set certain standards of achievement for themselves.

Table 1

Influence of Various Sources of Self-Efficacy Information on Students' SSE Beliefs

Sources of Self-Efficacy Information		Category of Responses	Number of Responses		
			Low SSE (*n* = 14)	Average SSE (*n* = 14)	High SSE (*n* = 14)
Enactive attainments	1	Attain high marks, high SSE Attain low marks, low SSE Work harder to get better marks	13	14	14
	2	Attain low marks, does not affect SSE and actions, carry on as usual	1	0	0
Vicarious experiences	1	Compare with high-achievers, feel confident that they can do it also Work harder to get better marks	7	9	9
	2	Compare with high-achievers, feel less confident, lowers SSE Work harder to get better marks	6	1	0
	3	Compare with high-achievers, does not affect SSE, carry on as usual	1	4	0
	4	Don't compare with anyone, set own target or compare with previous achievement Work towards target or to improve achievement	0	0	5
Verbal persuasions	1	Positive comments raise SSE Work harder to maintain or improve achievement	9	11	10
	2	Negative comments lower SSE Work harder to get better marks	4	1	0
	3	Not affected at all, whatever the comments, carry on as usual	1	2	4
Emotional arousal/ Physiological state	1	Slight fear or anxiety, lose confidence for a while Work harder to get better marks	14	13	11
	2	Very fearful or anxious, lose confidence, forget facts/fall sick/ hands tremble Work harder or try to forget fear	0	0	2
	3	No fear or anxiety at all, carry on as usual	0	1	1
Source of self-efficacy information with the greatest impact on SSE	1	Enactive attainments	4	7	8
	2	Vicarious experiences	3	2	0
	3	Verbal persuasions	6	4	2
	4	Emotional arousal/Physiological state	1	1	4

Note. SSE = Science Self-Efficacy

Verbal Persuasions

Responses to questions concerning how students' SSE was influenced by verbal persuasions were classified into three categories (refer to Table 1). For most of the students interviewed (i.e., 9 low SSE, 11 average SSE, 10 high SSE students) positive comments regarding their science attainments raised their SSE and encouraged them to work harder in order to maintain or improve their achievement. For example, a high SSE Form 2 student said, "When I get lower grades than usual, my parents encourage me to try harder the next time. They don't say negative things or punish me. This makes me try to learn more." Responses of the second category, that is that negative comments lowered their self-efficacy but nevertheless they continued to work hard to try and do better, were from four low SSE students and one average SSE student. For example, a low SSE Form 2 student said, "My father always says my science marks are low compared to my brothers' marks. This makes me feel bad and even less confident but I try to work harder." As expected, no high SSE student gave such responses. Compared to low SSE students and average SSE students, there were more high SSE students (i.e., 4 students) who gave responses of the third category, that is that verbal persuasions did not affect their SSE and learning behavior. One high SSE Lower 6 student said, "Usually my grades are above average. If there is a lapse in my performance, my parents tell me to try harder. Their comments don't really affect me. I will continue to try my best anyway." This is to be expected as high SSE students said that they had confidence in themselves and were not affected by the comments of others, whether positive or negative.

Emotional Arousal

The responses to questions on emotional arousal or physiological state were classified into three categories. A large number of the students interviewed (i.e., 14 low SSE, 13 average SSE, and 11 high SSE students) reported that they had slight fear or anxiety and loss of confidence for a while when confronted with a science task such as preparing for a test, an experiment, or assignment. These feelings motivated them to work harder to solve the problem or take up the challenge. For example, a high SSE Form 4 student said, "Sometimes I feel nervous if there's going to be a test, but it doesn't affect me much. A bit of anxiety is good as it makes me get started on the work faster." Two of the high SSE students, however, reported that they experienced a high level of anxiety and loss of confidence in themselves to the point of not being able to recall facts, falling sick, or experiencing their hands trembling while doing experiments. To counter this, they tried to work harder, do something to forget the fear, or constantly reminded themselves that they could do it. One of them said, "I do have fears until I fall sick or my hands tremble when I do the experiment. I try to work harder to make myself less nervous when it comes to science experiments." Further probing revealed that they were anxious to do well and this could have resulted in their high level of emotional arousal. No low SSE or average SSE students mentioned having problems with such feelings. Perhaps the need to maintain a high level of achievement or to do better than others was not so intense for them. While two high SSE students reported a high level of anxiety, there was also a high SSE student who reported that she had no fear or anxiety at all when

confronted with a science task. The high SSE Lower 6 student said, "I usually have no fear at all. I am quite confident regarding science". Only one average SSE student mentioned this while no low SSE student gave responses of this category.

Most Influential Source of Self-Efficacy Information

Students were also asked to indicate which one of the four sources of self-efficacy information affected their SSE most. As shown in Table 1, four low SSE, seven average SSE, and eight high SSE students reported that their enactive attainments affected their self-efficacy the most. For example, a high SSE Lower 6 student said, "The marks I get affect my confidence most. If my marks are high, I feel more confident. If my marks are low, my confidence is low too. What other people say does not matter." More high SSE students appeared to rate this source of self-efficacy information as most important to them, probably because of the need to maintain or improve their level of achievement or to do better than others. The results also showed that three low SSE students were most affected by vicarious experiences or social comparisons. For example, a low SSE Form 4 student said, "Comparing my marks with my friends' marks affects my confidence most." However, none of the high SSE students indicated that vicarious experiences were important in affecting their SSE perceptions. This could be because as mentioned earlier, high SSE students (i.e., 5 of them) said they didn't compare with anyone but rather compared with their previous achievement or worked towards a personal target. A comparison of the number of responses for verbal persuasions (i.e., 6 low SSE, 4 average SSE, and 2 high SSE students) showed that low SSE students appeared to be more affected by verbal persuasions. One low SSE Form 2 student said, "My parents' remarks concerning my science marks matter a lot. If they are angry, I feel scared and less confident. If they say 'good', I feel more confident." This could be because low SSE students were usually the ones who received more comments that were negative or fewer comments that were positive regarding their science achievement because according to them, usually their achievement was only average. A comparatively large number of high SSE students (i.e., 4 students) indicated that they were more affected by emotional arousal while only one low SSE student and one average SSE student seemed to be affected by this source of self-efficacy information. For example, a high SSE Lower 6 student said, "I think it is my fear that affects me most. Sometimes I get so nervous I forget the facts and cannot write anything. Then I lose confidence in myself." The reason for this could be that high SSE students were more anxious to do well or better than others and this could have resulted in high emotional arousal.

Summary

The above findings show that probes on how each source of self-efficacy information influenced students' SSE beliefs yielded some interesting findings. In keeping with Bandura's views (1986) concerning enactive attainments, it was found that most of the students interviewed (i.e., 41 out of 42 interviewed) said that attaining high marks in science raised their SSE and vice versa. Meanwhile, 25 out of the 42 students interviewed appeared to benefit from

social comparisons. Seeing similar others do well in science gave them the confidence that they could do just as well if they worked harder. However, some of the low SSE students (i.e., 6 out of 14 low SSE students interviewed) were negatively affected by such comparisons, claiming that it made them even less confident. These low SSE students appeared to judge their own capability as inferior to that of their high-achieving peers. Findings concerning the effect of verbal persuasions were also in agreement with Bandura's view (1986) that positive comments raised self-efficacy while negative comments lowered it. This is especially true for low SSE students who appeared to be more sensitive to verbal persuasions. Most of the students interviewed (i.e., 38 out of 42 students) were not much affected by emotional arousal and viewed it as a temporary experience. High SSE students who reported having problems with emotional arousal were also able to overcome the effects when they recognized that this was a problem they had to deal with objectively. Inquiries into which source of self-efficacy information affected students' self-efficacy perceptions most showed that for about half of the average SSE students (i.e., 7 students) and high SSE students (i.e., 8 students) interviewed, enactive attainments contributed most in shaping their self-efficacy beliefs. This finding supports the findings of other researchers (Bandura, 1986; Hampton, 1998; Lent et al., 1991; Lopez & Lent, 1992; Matsui et al., 1990) that attest to the fact that enactive attainment is the most influential source of self-efficacy information because it is based on authentic mastery experiences. However, only four of the low SSE students interviewed gave the above response. It appeared that for low SSE students, verbal persuasions were more influential than enactive attainments in shaping their self-efficacy beliefs. Six of the low SSE students interviewed indicated that verbal persuasions had the greatest impact on their self-efficacy beliefs. This finding suggests that compared to average and high SSE students, low SSE students were more sensitive to verbal persuasions.

CONCLUSION

The findings of this study support Bandura's view (1986) that people's self-efficacy judgments are formed based on information conveyed enactively, vicariously, persuasively or physiologically. Low SSE students appeared to be negatively affected by vicarious information. Seeing some of their classmates perform better than them made them feel less confident about their own ability. Low SSE students seemed to have low judgments of their own capabilities. Average and high SSE students were either unaffected by such comparisons or felt confident that they could do so as well. Students of different SSE level appeared to be affected most by certain sources of self-efficacy information. For about half of the average SSE students (i.e., 7 students) and high SSE students (i.e., 8 students) interviewed, enactive attainments appeared to have greater impact on their perceptions of self-efficacy. But for low SSE students, only four of the 14 students interviewed indicated enactive attainments as having the greatest impact on their self-efficacy perceptions. There were more low SSE students (i.e., 6 students) who indicated that their perceptions of SSE were more affected by verbal

persuasions. Low SSE students appeared to be more sensitive to verbal information concerning their attainments in science.

Implications of the Study

A number of important implications can be drawn from the findings of this exploratory study. The findings suggest that special attention should be given to low SSE students regarding their formation of self-efficacy beliefs based on vicarious information and verbal persuasions. As low SSE students have indicated that comparing with high-achievers made them feel even less self-efficacious, it is important that teachers encourage these students to compare their attainments with average-achievers instead of high-achievers. In addition, teachers might want to guide low SSE students to set attainable goals for themselves so that success in attaining these goals will raise their self-efficacy beliefs. This approach has been found to help low-achieving students develop a higher sense of self-efficacy (Schunk, 1983b).

The finding that low SSE students were more sensitive to verbal persuasions suggests that there is a need for teachers and parents to exercise caution when commenting on low SSE students' attainments. These students have indicated that positive or encouraging comments raised their self-efficacy beliefs and spurred them on to try harder while negative comments had the reverse effect. It is important also for teachers to give attributional evaluative feedback about low SSE students' ongoing performance when undertaking learning tasks. Studies by Schunk (1982, 1983a) have found that giving evaluative attributional feedback periodically to children who lacked arithmetic skills instilled efficacious self-beliefs. Progress that was credited to their ability or effort raised their self-efficacy beliefs and caused them to expend more effort at the task and accomplish more.

As for average and high SSE students, the findings suggest that enactive attainments play an important role in influencing their self-efficacy beliefs. Teachers might want to encourage average and high SSE students to study hard and improve their achievement in science as this would then raise their SSE beliefs.

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