Savage, E. (1991). Determinants of advanced technological content in technology education curriculum. In M. Hacker, A. Gordon, & M. de Vries (Eds.), *Integrating advanced technology into technology education* (Series F, Vol. 78). New York: Springer-Verlag.
Savage, E., & Bosworth, F. (1992). *Secondary grades technology education: Technology literacy and problem solving in action*. Reston, VA: International Technology Education Association.
Smith, W. H. (1994). Application of technology systems. In *Technology education graduation outcomes: Questions and answers. The Donald Maley Monograph Series (Monograph 1).* Reston, VA: Industrial Technology Education Association.
U.S. Department of Labor. (1991). *What work requires of schools: A SCANS Report for America 2000*. Washington, DC: U.S. Department of Labor, The Secretary's Commission on Achieving Necessary Skills.
Wright, R. T., & Lauda, D. (1993). Technology education—A position statement. *The Technology Teacher, 52*(4), 3–5.

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6. A Learning Styles Instrument to Enhance Learning in Technology

by Larry D. Kuskie and Marlene M. Kuskie

The technology curriculum has been defined and redefined, and it continues to evolve to keep pace with technological discoveries. As a consequence, most states have written and implemented technology programs within schools, which have acquired impressive equipment. But, the technology teacher needs to address how the technology equipment and curriculum can be utilized to best enhance student learning.

We believe that matching students to their learning styles can be the vehicle to the successful implementation of curriculum and the appropriate use of technology equipment to meet student learning outcomes. The student learning inventory discussed in this article was developed to demonstrate how the creation of an easy-to-understand inventory and minor adjustments in the teaching-learning process can make a significant difference in the learning process.

Learning styles or modalities are the manner in which students learn or change as the result of an experience (Roundtree-Wyley, Frusher, & Ficklin, 1988). Research shows that attention to teaching methodologies that address student learning styles increases learning and develops the potential ability of students to learn (Carbo, Dunn, & Dunn, 1986; Foriska, 1992; Henak, 1992). According to Jenkins (1988), when teachers begin to adjust instruction to diagnosed learning style differences, academic achievement increases and attitude toward learning is more positive. As a result, many learning style inventories (James & Galbraith, 1985; Kolb, 1985; Myers & McCaulley, 1985) have been developed for a wide variety of populations.

For the purpose of this project, information processing and instructional categories of learning styles were considered. Interestingly, Johnson and Thomas (1994) discovered that novice learners without a knowledge base concerning a particular problem relied upon the senses to guide the learning process. Johnson and Thomas also found that the ability to select an appropriate strategy is an essential element of the problem-solving process. Assisting students to use the appropriate learning modality of visual, auditory, or psychomotor senses has the potential of enhancing problem solving and student learning outcomes.

After a review of the literature (Flaherty, 1992; Geisert & Dunn, 1990; James & Blank, 1991; Loper, 1989; Orsak, 1990; Roundtree-Wyley et al., 1988) and in an attempt to develop a learning style inventory that would be compatible in the technology classroom and that would be readily understood by a variety of students, the authors chose and developed the categories of visual, auditory, and psychomotor for their instrument, the Learning Channels Inventory(LCI). Waetjen (1993) stated that all three modes are used in the technological process of learning. All modes are equally important, but each style has advantages and disadvantages for the student learner.

The uses of the LCI for the technology classroom is multifaceted. The primary goals are (a) to enhance the learning of the technology curriculum, (b) to consider how students might most effectively learn and use the technology equipment, and (c) to expand the instructional methods of the technology teacher. By considering learning styles, students become more involved in the learning process, cooperative learning groups can be structured to value the diversity of learning styles, and students can be more successful in the learning process.

LEARNING CHANNELS INVENTORY

We developed the LCI for technology teachers in the middle and secondary school classroom. We administered the inventory twice to students over a period of a semester for a test-retest reliability of 80. Although students have the ability to learn in all three styles, the inventory will indicate a predominant style or modality.

A visual learning style is used by those students who would rather see the ideas on the printed page, on an overhead, or be shown how to do an activity. These students profit best by reading materials (textbooks or other such materials rather than lectures), by taking notes and writing reports, and by demonstration and observation. These students will seek information by reading rather than by asking another person. These students will take notes to better remember the concepts but often need to be shown how to do an activity.

The auditory learning style, described

as learning that occurs through hearing, is often the least developed channel but is the most often used method of instruction (lecture format) at the secondary level (O'Brien, 1989). For students who prefer the auditory channel, talking and listening become very important. Reading aloud and discussing their thoughts are vital to the learning process. Such students learn most optimally in small groups and by having other students listen to what they have to say and how ideas sound. Lectures by teachers can become boring if the students are not able to talk and respond to the ideas.

The psychomotor or haptic/kinesthetic learning style refers to students who learn best through hands-on activities. Learning must be action oriented. The technology laboratory becomes an ideal environment for these students. Often the technology equipment limits the number of students in the classroom, which also enhances the opportunity for psychomotor students to be actively involved in the learning process. Psychomotor-oriented students can be frustrating to the technology teacher because they are often punching keys or buttons without taking the time to read the manual or asking for assistance.

USE AND IMPLEMENTATION OF THE LCI

The LCI (see Table 1) should be administered at the beginning of the learning term so that results may be reviewed by the students and the teacher. Students are encouraged to respond to each item as it relates to their particular preference. There are no right or wrong answers. If needed, each item can be clarified by the teacher using additional examples. The final profile or clusters of responses indicate what is true for the students as they have perceived the statements. The profile is interpreted, with the lowest number of responses being their predominant learning style and the highest number of responses being their least preferred learning style. The Interpretation Guide for the LCI (see Table 2) might then be distributed to students for future reference.

A profile that has a similar number of responses in each category indicates (a) that the student has developed all three learning modalities and probably adapts to the learning situation and the modality of the material being taught or (b) that the student has not discovered a learning channel that is most efficient or effective and often does not achieve well since the student does not know how to adapt or choose a learning style that best fits the situation. The LCI can become a teaching/learning device to help the student begin to discover and develop a more efficient way to learn or problem solve based on that particular situation.

A discussion of the Interpretation Guide with either the individual student or within the classroom becomes the opportunity for the technology teacher to talk about the problem-solving process and how learning can occur most effectively. The learning style will often determine how the student may best learn on a particular piece of equipment. The students are not only encouraged to consider predominant learning style, but also the development of other modalities.

The technology teacher needs to record the profiles of each student so that learning groups and teaching methodologies are adapted for the particular class. Different teaching methods can be adapted depending on the nature of the learning module. Table 3 is an example of adapting the learning style to a particular learning module.

Another use of the LCI is to place students in cooperative learning groups consisting of students with all three predominant learning styles. The learning objective may be to have the students develop a learning methodology/aid according to each learning style for a particular piece of technology equipment. For example, if the cooperative learning group was responsible for developing a visual method to teach someone how to use a particular piece of equipment, the students with a predominant visual learning style in the group would be consultants to the group in the development of the learning device (i.e., drawing a step-by-step diagram or developing a videotape demonstration). The problem-solving process of how the group members functioned in the role as consultant and creator also needs to be evaluated.

In order to better link the information gained from the LCI, the students might be assigned to evaluate other classes and determine how different learning styles may need to be utilized and adapted depending on the situation.

The students might also learn by creating new items for the inventory that are more relevant to identifying the categories of visual, auditory, or psychomotor considering the specific experiences in the classroom. In particular, the students need to be encouraged to supplement other ways and means to learn in the various styles using the Interpretation Guide. The Interpretation Guide is meant to stimulate discussion and understanding and to guide the learning process.

HINTS AND CAUTIONS

The technology teacher should plan the learning process to involve the learning modalities of seeing, hearing, and doing. At the same time, if the teacher teaches and evaluates only in one learning modality (which is often the teacher's predominant learning style), the teacher is accurately assessing only those students who prefer that mode (Loper, 1989). Teaching in only one predominant modality will meet only a portion of the students' needs and creates unnecessary stress and confusion which reduces student motivation and restricts student performance (Roundtree-Wyley et al., 1988). Thus, students and teachers need to explore a variety of methods of teaching and learning.

Knowledge of the predominant learning style is important for the technology teacher in planning activities for both the student and the group (James & Blank, 1991). Individually, activities and modules can be matched to a student's predominant learning style and the student can be encouraged to develop another learning style depending on the particular module. But even more important, the technology teacher needs to incorporate the knowledge of predominant learning styles into how cooperative learning groups, other small groups, and dyads are formed. For example, by matching different learning styles on a module, the students will use each other's talents to discover how to use the equipment for further problem solving. In a problem-solving sequence, the learning perspectives—which introduces more information into the process—will cause solutions to be reached

Table 1

Learning Channels Inventory

Directions: Read each item and prioritize the activities according to your first, second, and third preference. Be sure you enter a different number in each blank to indicate the order in which you ranked them 1 = first choice, 2 = second choice, and 3 = third choice.

1. You are a member of the new Technology Student Association (TECA). As a member you would rather
   _____ a. serve as secretary and keep written records.
   _____ b. plan future meetings/projects by talking to the other students.
   _____ c. set up paraphernalia for meetings and gather any other materials for meetings and projects.
2. When putting together a robotics model, you would
   _____ a. follow the directions found in the instruction book.
   _____ b. prefer that another student read the directions while you put the model together.
   _____ c. begin putting the robot together relying on your past knowledge and what seems to fit or work.
3. When studying for a test, do you
   _____ a. write summaries to help you remember important items?
   _____ b. read over your notes aloud to assist you in remembering or have someone quiz you?
   _____ c. draw pictures or find a pneumonic device that would help you remember?
4. When memorizing the numbers to a G code on a CNC machine, you would
   _____ a. form a picture in your head of the code.
   _____ b. repeat them over and over to yourself.
   _____ c. write the number down on a piece of paper.
5. A new student is introduced to your class. How would you remember his or her name?
   _____ a. relate their name to some particular characteristic about them.
   _____ b. relate their name to something that rhymes.
   _____ c. write their name down over and over on a piece of paper.
6. Your technology teacher has asked you to respond in class. Which method is more comfortable to you?
   _____ a. refer to what you remembered in the book.
   _____ b. talking about what you heard the teacher/students say.
   _____ c. use a piece of equipment to demonstrate your answer.
7. The technology teacher is presenting information in class concerning different uses of satellites. Would you rather
   _____ a. have the instructor give you written directions to follow?
   _____ b. listen to the instructions that are given by the instructor only?
   _____ c. explore how the satellite works and experiment to make it operate?
8. Your instructor has just received a complete stereo system for the technology laboratory. The instructor has asked you to put it together. You would
   _____ a. read the written directions to solve a problem.
   _____ b. make a phone call to the company to get a problem solved.
   _____ c. keep moving wires around until the problem in the stereo system is solved.
9. When listening to a new hit song that has just swept the country, you would
   _____ a. look at the lyrics on the package.
   _____ b. sing along with the lyrics.
   _____ c. write the lyrics down on a piece of paper and tap your foot to the beat.
10. The technology teacher has just received word that the students in the class have been selected as the most outstanding students in the school. The teacher is very excited and happy. How could you tell?
    _____ a. observe the teacher's body language.
    _____ b. listen for the teacher's voice inflection.
    _____ c. notice the teacher shaking hands with the students.
11. You have just finished your module work on lasers. Your teacher just told you that the next 30 minutes are free time to work on individual interests in the lab. You would
    _____ a. start reading the next assigned module or figuring out something else you've wondered about.
    _____ b. use the time to talk to other students about their projects.
    _____ c. use the time to construct or build something new.
12. The technology teacher has just presented some very important information concerning problem solving. You would
    _____ a. concentrate deeply on the reading material handed out.
    _____ b. concentrate deeply on what the instructor was saying.
    _____ c. concentrate deeply on the task required to complete the assignment.
13. A friend of yours has just won a gold medal in the state track meet. You would
    _____ a. congratulate the friend by writing a note.
    _____ b. call the friend on the telephone.
    _____ c. give the friend a hand shake the next time you see him or her.
14. Which one of the following games would you rather play?
    _____ a. Scrabble
    _____ b. Wheel of Fortune on TV
    _____ c. Slap Jack
15. You are en route to a friend's house when you become lost. You would
    _____ a. get a map out to find your way to the location.
    _____ b. stop and ask for directions from someone on the street.
    _____ c. keep driving and guessing until you find your way.

Scoring Directions:
Have the students add all the numbers in Category A. Then have students add the numbers in Categories B and C. The category with the lowest number would indicate their learning style. Category A indicates that the student is a visual learner, B indicates an auditory learner, and C indicates psychomotor tendencies. If two categories are tied or very close, this indicates that the student has not developed one area over another or uses the style that is needed by the particular learning situation.

Profile Total	Category A	Category B	Category C
	_____	_____	_____

Table 2

Interpretation Guide for the Learning Channels Inventory

Visual Preferences	Auditory Preferences	Psychomotor Preferences
• Reading a textbook	• Prefers lecture to reading a book	• Learns best by moving and experience
• Rules and lists	• Likes discussion in small groups	• Likes hands-on activities
• Likes charts, graphs, and pictures	• Likes videos	• Likes to do rather than read
• Takes notes	• Reads out loud	• Reads for meaning not detail
• Likes overheads and slides to supplement lecture	• Often first to answer questions	• Usually does not read for pleasure
• Wants quiet to learn	• Thinks out loud	• Often has illegible handwriting
• Needs handouts and worksheets	• Listens to tapes	• Tendency to stand close to people
• Prefers written tests and reports for assessment/evaluation	• Likes to hear explanations	• Poor test taker
• Likes demonstrations	• Prefers oral assessment	• Talent for working with hands
• Visualizes on computer		• Often likes vocational classes
		• Needs more time to finish projects
		• Likes to use computers instead of reading

Table 3

Adapting learning style to a particular learning module.

Learning Module	Robotics
Visual	Use of the manual, videotape, demonstration
Auditory	Prerecorded message of instructions, collaborative learning group, lecture
Psychomotor	Experimentation with basic lab instruction, simultaneous use of robot with videotape

sooner. Students will begin to respect each other's styles and value their contribution to the process. By matching students with similar learning styles, the students can help each other prepare for tests and learn from each other since students with the same predominant learning style will speak the same language. Technology teachers need more than observation to determine the dominant learning style of the student. The LCI provides the tool to assist the teacher and student.

The LCI is a springboard to encourage the technology teacher to integrate learning process concepts into the technology classroom. Technology is not only learning a piece of equipment, but it is a study of the learning process. The more students can become aware of the learning process, the better the student can transfer learning concepts and continue learning independently as technology equipment changes. As the technology teacher becomes creative in different teaching approaches, the more students will expand their potential to learn.

References

Carbo, M., Dunn, R., & Dunn, K. (1986). *Teaching students to read through their individual learning styles*. Reston, VA.

Flaherty, G. (1992). The learning curve: Why textbook teaching doesn't work for all kids. *Vocational Education Journal, 67,* 32–34.

Foriska, T. (1992). Breaking from tradition: Using learning styles to teach students how to learn. *Schools in the Middle, 2,* 14–16.

Geisert, G., & Dunn, R. (1990). Learning styles and computers. (ERIC Document Reproduction Service No. ED 332 268)

Henak, R. M. (1992). Addressing learning styles. *The Technology Teacher, 52,* 23–28.

James, W. B., & Blank, W. (1991). A comparison of perceptual learning styles of adult high school graduates and non graduates. *Adult Basic Education, 1,* 98–106.

James, W. B., & Galbraith, M. W. (1985). Perceptual learning styles: Implications and techniques for the practitioner. *Lifelong Learning, 8*, 20–23.

Jenkins, J. M. (1988). A learning style approach to effective instruction. In J. W. Keefe (Ed.), *Profiling and utilizing learning style* (pp. 41–44). Reston, VA: National Association of Secondary Principals.

Johnson, S., & Thomas, R. (1994). Implications of cognitive science for instructional design in technology education. *The Journal of Technology Studies, 20*(1), 33–45.

Kolb, D. (1985). *The learning style inventory and interpretation booklet.* Boston: McBer.

Loper, S. (1989). Learning styles and student diversity. *Educational Leadership, 46,* 6.

Myers, I. B., & McCaulley, M. H. (1985). *Manual: A guide to the development and use of the Myers-Briggs Type Indicator* (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.

O'Brien, L. (1989). Learning styles: Make the student aware. *NASSP Bulletin, 73,* 85–89.

Orsak, L. (1990). Learning styles versus the Rip Van Winkle Syndrome. *Educational Leadership, 48*, 19–21.

Roundtree-Wyley, J., Frusher, S., & Ficklin, T. (1988). A comparison of learning styles in traditional and non-traditional students. (ERIC Document Reproduction Service No. ED 310 671)

Waitjen, W. (1993). Entropy and technological learning: A cognitive approach. *The Journal of Technology Studies, 19*, 2–29.

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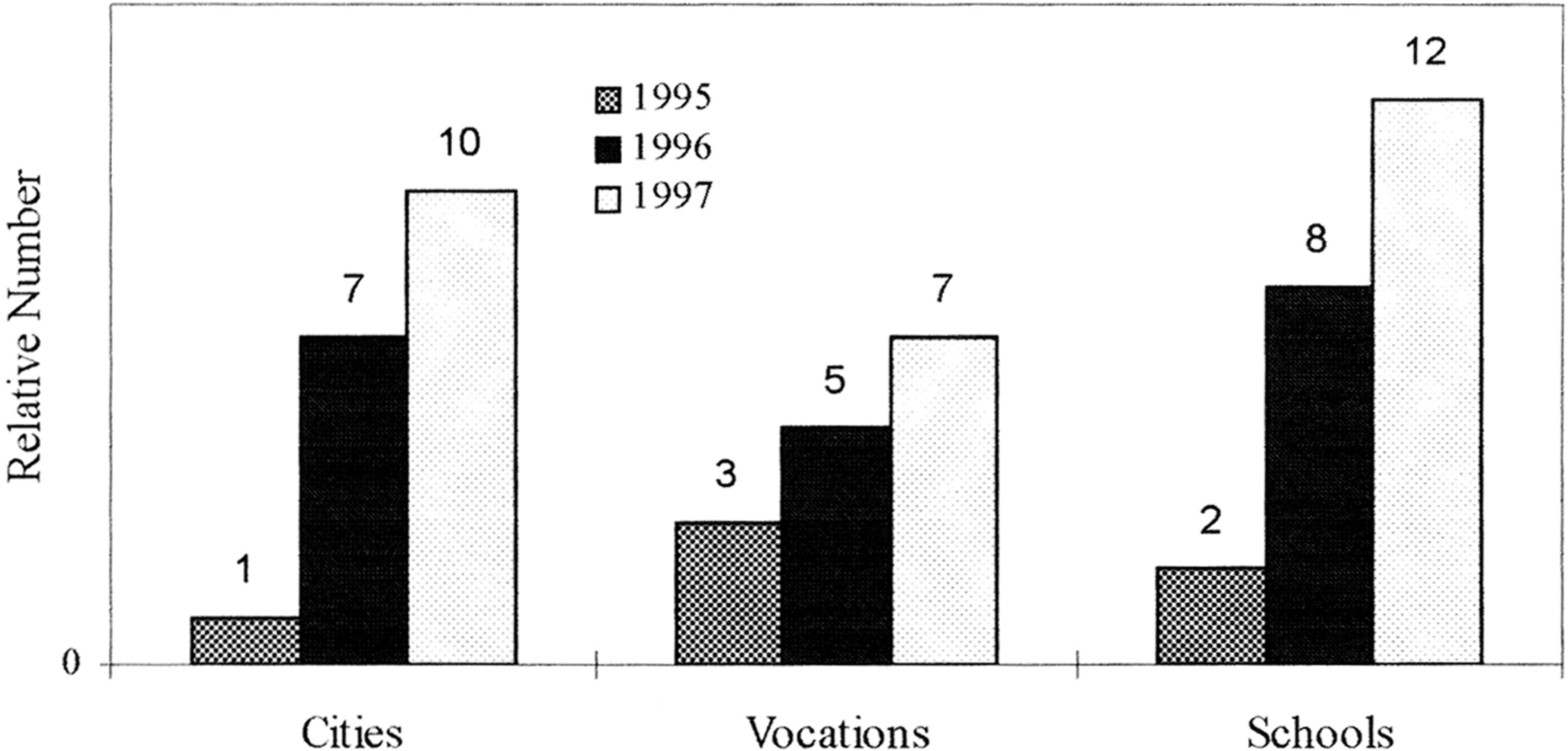
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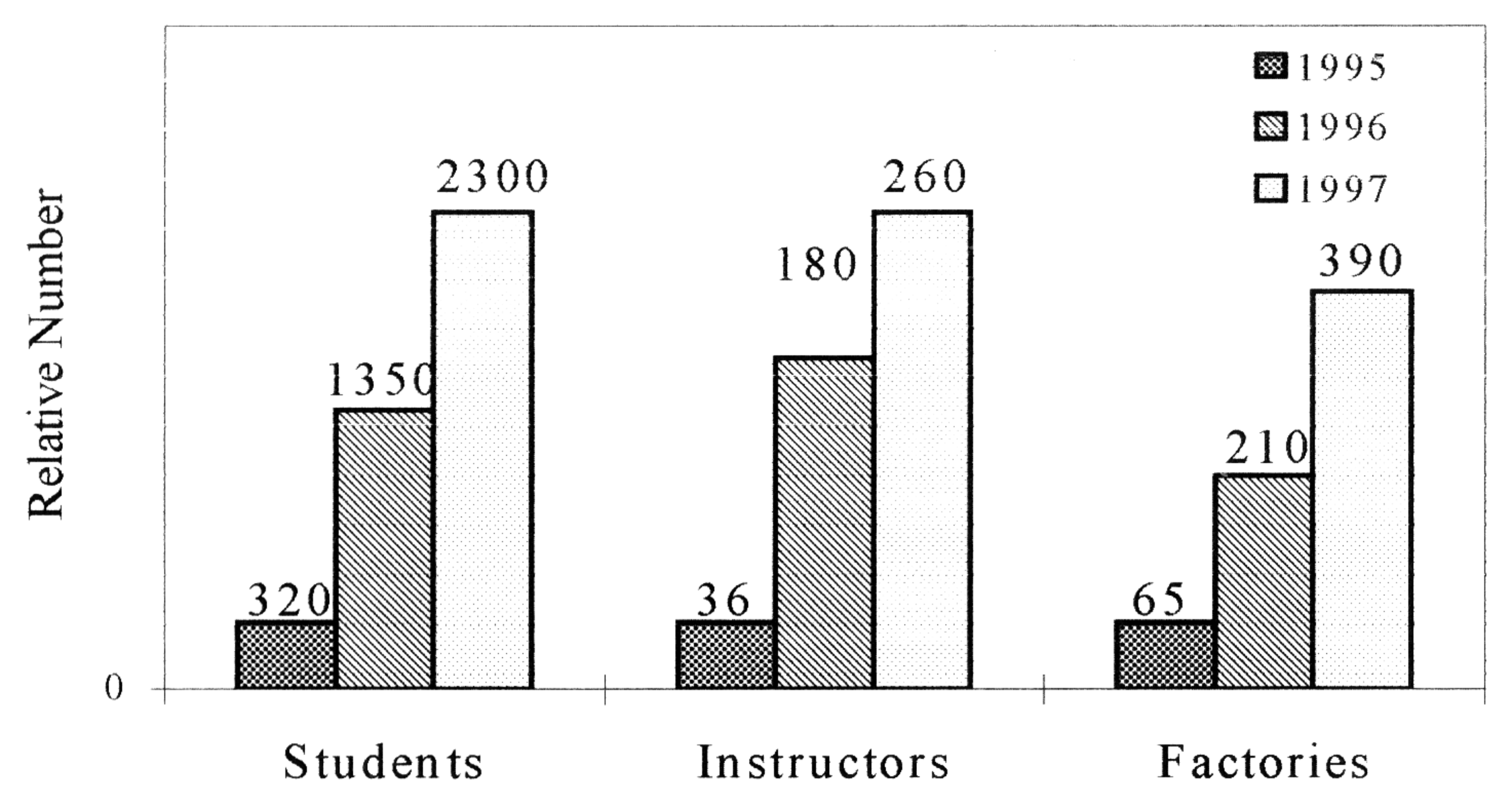
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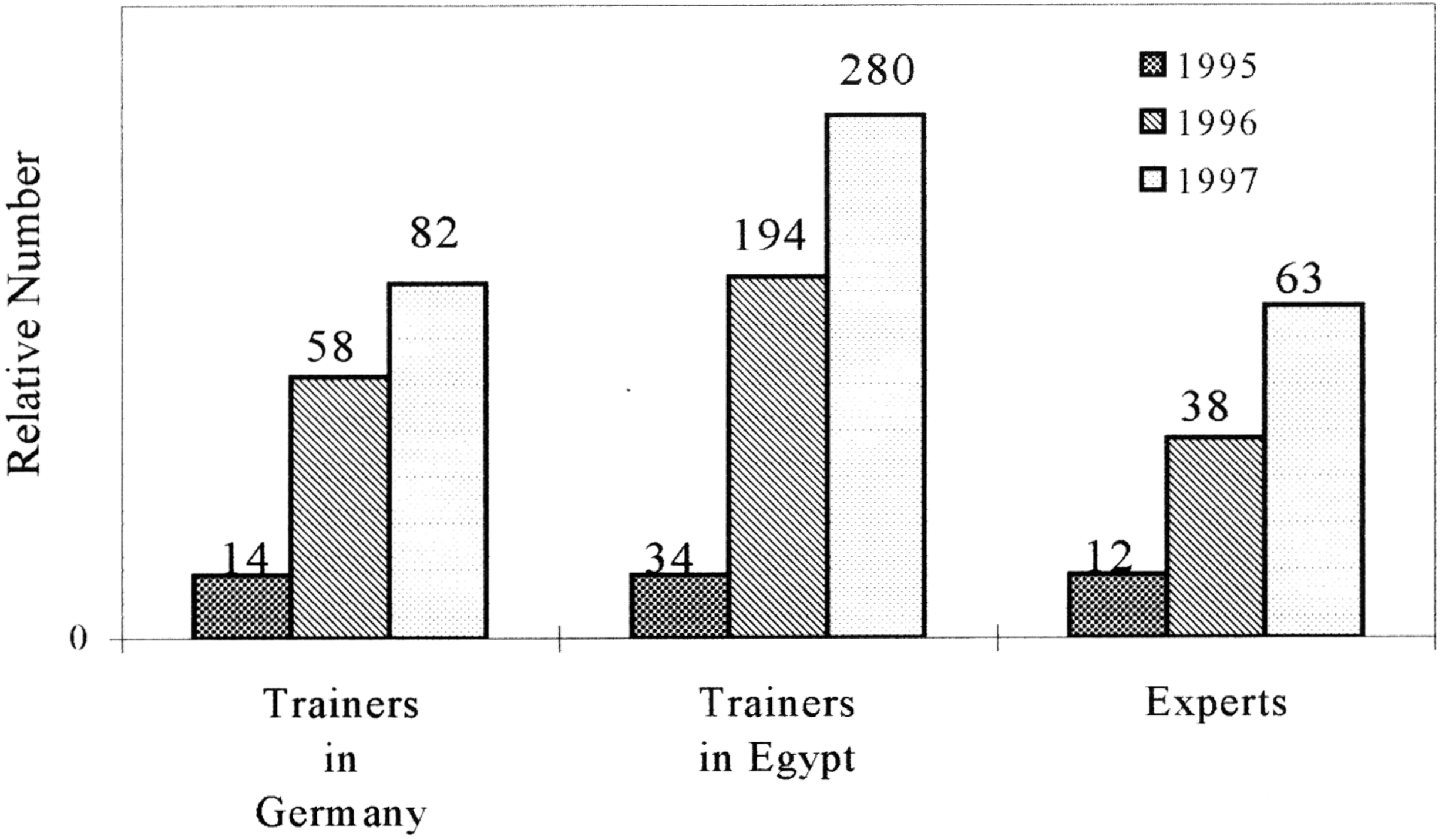
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