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ANALYSIS OF MOTIVATIONAL ORIENTATIONS IN SCIENCE EDUCATION

ABSTRACT. Pupils' motivation and interest are identified as important influences on learning. Motivational orientation is a construct that links motivation and epistemology. This study attempted to explore motivational orientation as it relates to science education and two different instructional approaches. A published instrument standardized with a population from the United Kingdom that purports to identify students' preferred motivation orientations as social, consciousness, effort, or curiosity was applied to two instructional contexts (traditional school program and field centre program) in primary schools in Slovakia. Results indicated that a very high percentage of the pupils could not be classified into one of the four categories, that the traditional classroom sample differed significantly from the United Kingdom population, and that the preferred motivational orientations expressed by the pupils in the field centre sample did not differ significantly from those expressed by the pupils in the traditional classroom sample.

KEY WORDS: field education, motivational orientations, primary science education

INTRODUCTION

Schooling involves a complex relationship between people, ideas, experiences, and sociocultural factors. Pupils are influenced by several factors in today's schools and communities; and they often assimilate the opinions of teachers, parents or peers as their own (Mares, 1998; Spaulding, 1992). Pupils perceive these people's opinions in a complex way, but before accepting them, they analyze and evaluate the opinions against their own value system and priorities. Usually the strongest influence on pupils' social development comes from their peer group. Pupils compare their own behaviour with the behaviour of their schoolmates, especially their best friends; and, on the basis of these comparisons, they adjust their behaviour (Spaulding, 1992). The demands from different sources can be in conflict, leading to contradictory influences. How pupils' behaviour develops and how pupils decide between the demands depend on many factors, such as their motivational orientation. The relation between instructional context and motivational orientation is the central focus of this study.

International Journal of Science and Mathematics Education (2006) 4: 669–688

BACKGROUND

Motivation plays a key role in students' learning processes and achievement (Givvin, Stipek, Salmon & MacGyvers, 2001). Traditionally, two basic types of motivation are recognized-intrinsic and extrinsic (Barbuto & Scholl, 1998). These types of motivation are based on different reasons or goals that give rise to an action (Ryan & Deci, 2000). Intrinsic motivation refers to doing something because it is inherently interesting or enjoyable, while extrinsic motivation refers to doing something because it leads to a separate, external outcome. Intrinsic motivation results in high-quality learning and creativity, and it is well documented that it is more effective to teach students in lower secondary schools who have high intrinsic motivation (Hanrahan, 2000).

The importance of intrinsic motivation in the learning process has led to an increasing number of studies that have examined factors affecting motivation phenomena in educational settings (Anderman & Young, 1994; Bergin, 1999; Cherubini, Zambelli & Boscolo, 2002; Glennon-Salisbury & Stevens, 1999; Hanrahan, 1998; Hassandra, Goudas & Chroni, 2003; Nolen, 2003; Stefanou & Parkes, 2003). Real-life and relevant problem situations appear to increase intrinsic motivation of pupils toward the related learning. Pupils are naturally guided by their curiosity and interests, and they try to use their prior knowledge to understand new ideas or to solve problems. In such situations, pupils appear to spontaneously use ideas they already know to understand the observed phenomenon-mathematics, science, etc. Furthermore, intrinsic motivation increases in situations where they can manipulate concrete objects.

Much of science education content is focused on the world that surrounds us, nature-living things, non-living things, and their interactions. This context is potentially rich in real-life, relevant situations. Living successfully in this complex, interesting world requires an understanding of the environment, how we can make change in the world, and the factors that influence adaptation. Following on from this need, we become more curious and the intrinsic motivation increases. Intrinsic motivation is a phenomenon naturally connected to science education that is associated with pragmatism. It is very difficult to maintain intrinsic motivation in some cases where the science instruction is just about abstract science theory without connections to real-life applications. Positive motivation appears to be closely linked to practical work, which plays an important role in pupils' learning (Gott & Duggan, 1996). Science education centres like museums, marine aquariums, and field stations that emphasize active learning may be expected to promote higher pupil motivation than occurs in traditional classroom settings with teacher-directed learning (Salmi, 2003). On the other hand, perhaps the complexity of a learning environment promotes interaction effects among factors related to students' motivation and produces differential relationships between motivational types and context (Lin, McKeachie & Kim, 2001).

Few motivational orientation instruments are readily available for science classrooms using different instructional approaches. Johnstone and Al-Naeme (1995) developed a simple instrument by which they examined pupils' motivational orientations that may be affected by practical science. They report that their investigation established the test as valid and reliable with United Kingdom (UK) children, but no other study has generated population norms or examined changes in motivation orientation using this instrument with other groups of pupils from different nationalities and cultural backgrounds. This instrument distinguishes four different motivational orientations: *social oriented* (social), *consciousness oriented* (conscientious), *effort oriented* (achiever), and *curiosity oriented* (curious).

Social oriented pupils demonstrate an inclination to engage in interpersonal relations. Members of this group believe that belonging is the highest priority. They are focused on activities in the social community. The main reason for their lack of preparation for a lesson is not a low ability in learning but rather too high a priority on the development of social relationships. Their preference is for learning with friends rather than learning alone at home. Learning for them is better in a group of schoolmates, with at least one friend (Kempa & Ayob, 1995). These pupils surprise their teachers with very clever behaviour and an unexpected high level of thinking if the pupils are afraid of low marks. Normally, they seem like average or slightly below average achievers. Social oriented pupils are lively and prefer discussions and group work. They speak frequently and have unique ideas if allowed to work in their preferred way that involves divergent thinking (Bertrand, 1993).

Consciousness oriented pupils are characterised by an inclination to conform at school. These pupils' behaviours are guided by their conscience. Teacher and parent requests are the most important influences on their school behaviour. Consciousness oriented pupils are not the best learners. Their effort is high, but it is determined by externally set demands of extrinsic motivation. Their learning is not for themselves but for parents or teachers. They prefer teacher-directed lessons, because this method of teaching provides explicit demands and expectations. They can learn only if a task has defined instructions and goals with a known level of effort required. Hard work and good preparation for lessons is the strength of these pupils. Their thinking is mostly convergent, and they have problems with tasks that require more divergent thinking. Consciousness oriented pupils usually cannot express themselves clearly, which is why they try to memorize the subject matter-remembering expressions without understanding the meaning of these expressions. Their interests do not influence their success in school very much; but, if their parents are working in a particular discipline, these pupils are inclined toward this subject area because they want to satisfy their parents. Similar situations occur when a teacher shows enthusiasm and interest toward a topic; consciousness oriented pupils are the first to join the teacher.

Effort oriented pupils look for explicit rules in every new situation. Their behaviour is guided by the rules, and they usually try to do better than others and better than the stated standard. Usually they have problems with self-confidence. If teachers or schoolmates express any doubt in their abilities, they go to extremes to try to prove that they are the best pupil in the classroom. Effort oriented pupils are clever, bored in social settings, and their behaviour is sometimes asocial or antisocial. They need to believe in some kind of precedence and that they are better than others. Their competitive stance is to take all, or nothing at all, and they perceive compromise as a weakness. These pupils prefer teachers who present clear requirements and instructions as to what has to be done. They like challenges and competition with schoolmates in reaching higher grades and performance at school and in extracurricular activities. They do not like it when less clever pupils limit them in the learning process, which is why they do not like group work. They do not like to share their knowledge with other pupils or to accept tutoring from peers. They react negatively when a teacher is speaking about their mistakes and how to improve their knowledge. The best learning environment for them is built upon clearly set tasks where they can work on the tasks alone. Unfortunately, they usually demonstrate convergent thinking; but they can be the best in any school subject regardless of their interest in the topic.

Curiosity oriented pupils are focused on their own needs. These pupils like freedom in their learning and searching for reasons and explanations of observed phenomena. They enjoy problem-solving tasks, discussions, dealing with dilemmas and do not like strict instructions or directions for a task. They frequently demonstrate divergent thinking, and they can be the best in any subject because they are able to increase their intrinsic motivation more easily than pupils with other motivational orientations. The level of their effort is closely related to their interest, and they are self-oriented. Other orientation-types, unlike curiosity, are dependent on the outside circumstances and conditions of the learning environment but not internal conditions related to self. Curiosity-oriented pupils are lively; they are able to start class work with a high level of enthusiasm, and they are group leaders who others follow. They usually have strong enthusiasm for particular subjects, and they have the ability to motivate other pupils to be interested as well. They are able to learn alone at home, but they like sharing acquired knowledge with other pupils. They do this not because they like to show how able they are or how much they know, but rather just because it gives them pleasure. They easily accept tutoring by teachers and peers, but they are demanding of teachers. They have a good sense of humour, and they like any kind of change in the learning environment because it increases their efforts.

Motivational orientation helps define pupils' attitudes, emotional dispositions, and effort toward education. Motivational orientations have influence on a pupil's general behaviour in a school. Different motivational orientations appear to need different instructional requirements for an effective learning environment (Mares, 1998). Even if pupils need a specific educational environment, it may not be possible within the constraints of schools to match the specific orientation of each pupil in a class with specific teaching-learning approaches. Therefore, pupils need to be given opportunities to use their preferred orientations while developing their less preferred orientations (Mares, 1998). Some teachers recognize this pedagogical problem by implementing a wide variety of instructional activities in an attempt to match each pupil's preferred orientation style occasionally. Other teachers use a systematic approach that switches from one approach to a different approach during a unit of study to stretch and flex pupils so they adapt to less preferred orientations and styles (McCarthy, 1985).

Offering pupils a flexible, dynamic learning environment with various stimuli (like the inspirational environment of nature) might encourage partial change of their learning orientations. Such a climate will at least provide supportive conditions so that a preferred learning orientation can be freely expressed and not be repressed by the current orientation being presented. The possibility of changing pupils' learning orientation over a short time appears to be low, since many cognitive attributes are resistant to change. However, very little is known about this topic because the majority of related research has studied learning styles as independent variables (Bochner, 1996; Felder & Henriques, 1995; Holden & Yore, 1996; Smits, Verbeek, Nauta, Ten Cate, Metz & van Dijk, 2004). Farkas (2003) demonstrated that instructional method significantly affected students' attitudes and achievement while learning about the Holocaust. Stutsky and Laschinger (1995) found that preceptorship experiences affected learning styles, adaptive competencies, and other variables in Baccalaureate nursing students. Recent knowledge about learning, motivational styles, and instructional environments suggests a probable relationship; and potential applications remain intriguing.

Collectively, the review of research indicates that the classification of motivational orientations is not precise since categories overlap, but pupils usually show a stronger inclination toward one defined motivational orientation over others. This study explored the range of motivational orientations in a Slovakian sample of pupils to verify an existing motivational orientation instrument and explored the influence of two instructional approaches on the expressed motivational orientation of pupils.

METHODOLOGY

The central foci of this study were to verify the motivational orientations diagnostic test (MODT) (Johnstone & Al-Naeme, 1995) with a different cultural and school population from the original population and to investigate the potential influence of two different science education environments on pupils' expression of a preferred motivational orientation measured by the MODT. The following research questions were addressed:

1. Is a sample of elementary pupils' preferred motivational orientations distributed similarly to the sample of pupils used in the original development of the MODT?
2. Does experience in different educational settings-traditional classroom instruction and a science education field centre-influence elementary pupils' expressed preferred motivational orientations?

A large-group, survey design with comparisons to established distributions was used to verify the MODT. A quasi-experimental, two-group design was used to explore the educational environments' (traditional classroom instruction and field centre experiences) effect on the primary school pupils' expressed motivation orientations.

Considering the simplicity of the MODT used as a measure of motivational orientation, it was decided that the test effect from asking pupils to do the same tests before and after completing the short course of study at the science education field centre would be too great. The possibility of remembering and reproducing the pre-test responses on the post-test was high. Therefore, the exploration of potential changes in motivational orientation could not be achieved by using a pre-test-post-test design; instead, it was decided to use non-random comparison groups of pupils from the same participating schools. The selected schools were divided into two groups: one experimental group (one class per school with pupils who completed the course at the field centre) and the control group (all remaining classes of pupils from the same school who did not participate in the field centre course). The selection of pupils who participated in the experiment was not based upon their interests. This approach helped to eliminate the potential effect of the pupils' previous experience and attitudes toward science education. All pupils in the field centre courses (experimental group) were instructed by the authors.

EDUCATIONAL ENVIRONMENTS

The science education field centre was established as a science laboratory in the field to provide pupils with a residential learning experience in a natural setting. Pupils come to the science education field centre for 3–10 days to study natural sciences. They live near the field laboratory during their stay. The field centre is situated on a mountainside. The mountains are part of a protected landscape area, and it is possible to explore many interesting natural phenomena suitable for making observations of different ecotopes (an isolatable integrated ecological unit consisting of a community of living organisms and their physical environment at a given time): limestone carst with caves, granite bluffs, streams, lake, meadows with different fauna and flora, etc. The water of the streams is very clean and contains animals that are very sensitive to pollution. In the nearest small lake, pupils can observe the life in a clean water ecotope. This setting allows pupils to observe nature in all four seasons. In the meadows and in the forest, it is possible to find representatives of protected plants. It is also possible to visit an astronomical observatory situated in the hills within about a one-hour walk. Pupils spend the most time seeking problems, forming research questions, and searching for answers in nature and in the well-equipped field laboratory. They are supported by a well-educated and experienced field staff.

Courses at the field centre offer not only changes in physical environment but also new teaching and learning approaches. The science education field courses are based on experiential pedagogy (Fontana, 1995). Research about learning from direct experiences involving observing and experimenting with objects and phenomena in a natural environment and in natural circumstances appeared to result in better understanding (Mantle & Heath, 1986; Tomkins & Tunnicliffe, 2001; Tunnicliffe, 2000). While at the field centre, pupils explore natural phenomena and objects found in their surroundings. If they need to investigate a phenomenon or object in greater depth, they take samples and investigate them in a field laboratory using experimental methods. They use new and authentic experimental tools, technologies, and methods to solve problems and locate needed information. Pupils use their own experience and prior knowledge as a foundation for a better understanding of the target phenomenon or object, and try to understand the world around them by applying the knowledge gained at school (Bertrand, 1993). The pupils are more curious when they are able to explain the existence of observed phenomena in nature and to explore why the phenomena exist.

Pupils can choose to explore ideas from a list of science topics offered at the science education field centre. The topics are posed in a very simple way (e.g., spiders, ants, photosynthesis, plant pigments, etc.). The specific content of the topics is dependent on a pupil's interests, abilities, and motivation. There are several experiments for every topic area that address some part of the phenomenon under consideration. The program of study is flexible and open-ended. Pupils do not need to complete or attempt all activities in a topic area, but some core activities are required. The actual experimental procedure or inquiry depends on each pupil's thinking, prior knowledge, and experience with the phenomenon and motivational orientation.

In Slovakia, a traditional science lesson for primary school pupils typically follows a teacher-directed approach in which the teacher specifies instructions involving a textbook and some posters. The pupils are required to assimilate large amounts of information, and they have little possibility to see the connection of the knowledge to real-life situations or relevant problems. Infrequently during a school year, the pupils may do experiments; but as they are not accustomed to such activities, and they have difficulty with them, they cannot connect these experiences to prior knowledge. Pupils like to do the experiments, but this is mostly because it is something new compared to a traditional science lesson.

A traditional science lesson about photosynthesis requires the pupils to comprehend textual materials and the diagrams provided in their textbook, supplemented with their teacher's interpretation or lecture. But after a short time, the knowledge retained is limited: they usually remember that photosynthesis is a very important phenomenon in nature and it is something about changing carbon dioxide into sugar. In some cases, they remember that oxygen, water, and sunlight are involved.

In contrast, the photosynthesis topic at the field centre included observation of plants in nature (mainly leaf colour-natural green or red, autumn yellow and red) and taking a sample of the plants to the laboratory for further observation and exploration. Pupils try to isolate chlorophyll in a red-coloured leaf and understand its importance for photosynthesis. Under a microscope, they observe respiratory pores on both sides of the leaf; and they test for the presence of water and carbon oxide in the respired gases. They also do the test at night on living plants and with specific parts of the plants. They can find out that the respiratory process of leaves is more intensive at night and flowers respire more intensively during the day. It is also possible to test for the presence of amyloid in the leaf where it is synthesized, or in other plant parts (like seeds and roots) to establish where the amyloid is stored. They experiment with the plants, suggesting their own investigative approach, and change experimental variables according to their own interests and way of thinking. The course instructor is in the position of an adviser or consultant about experimental procedures or safety issues and also a source of needed information. Pupils are required to make sense out of the experimental results and established scientific ideas, while the instructor facilitates this knowledge construction. It is assumed that the pupils will remember more about photosynthesis from this approach. They feel more self-confident about their knowledge, and they use it without restraint. Practically, it means that new knowledge is not just connected with photosynthesis, but it is likely that these ideas are stored in a rich conceptual network about plants.

Pupils Samples

The courses at the science education field centre were prepared for elementary school pupils in grades 5 to 9 (10–14 years). Advertising brochures about the project were sent to several primary schools throughout Slovakia to recruit participants for this study. (More information about the project and its initial research can be found at: http://pdf.truni.sk/fak/katedry/katbiol/Teren/Teren.htm.) Recruitment was aimed at typical primary classes without any specialization (foreign languages, mathematics, religions). Limitations were placed on participation from classes of students who were highly interested in science for this research study.

Pupils in this study came from seven elementary schools located in various communities. Every school selected was required to provide two or more similar classes. One class was randomly selected and asked to take part in the course at the science education field centre, and the other class or classes in the school served as a control group taking part in the traditional science program. There were no apparent reasons to assume that the experimental and control classes were not similar. For convenience, two samples of 10–14 year-old pupils were identified with 363 pupils (165 boys, 198 girls) serving as a control group and 151 pupils (70 boys, 81 girls) serving as an experimental group. Pupils in the experimental group, who completed the course at the science education field centre, were instructed by the authors. Pupils in the control group received only the traditional science instruction about a variety of topics at their elementary school. Both the experimental and the control groups consisted of classes from the same participating schools, but no attempt was made to control the science topics studied.

Assessment of Motivation Orientation

Four motivational orientations emerged from the factor analysis of the original survey (Adar, 1969). Su (1991) provided various types of motivational tests; however, the most successful version involved 16 statements, four statements for each category of motivational style. Each statement represented one of the four motivational orientations (effort, conscious, curious, social) in four different learning situations. Johnstone & Al-Naeme (1995) presented four sets of four statements about different aspects of school activities associated with one of four pupil prototypes (pupil's attitude toward school work, laboratory work, projects, relationships with schoolmates and friends). Every row of the motivational test consisted of four statements with an associated pupil's name. There were several different statements, and the respondent selected one that was most similar to her or his personal stance-"Most like you" (Johnstone & Al-Naeme, 1995, p. 226). This simplified version required less time than Adar's original version. Statements 1–4 related to the class work, statements 5-8 related to laboratory work, statements 9-12 related to projects, and statements 13-16 related to social life. Each four items were placed in a separate row of a 4 × 4 matrix from which the pupil selected only one name of a person most like themselves (David, Ian, Lee, Marie, or Tina) in the blank space in the last column (Johnstone & Al-Naeme, 1995, p. 227):

Class work

1. The support of my friends is very important to me during exam times. (David)
2. In class, I enjoy hearing about the implication of science for everyday life. (Ian)
3. I don't like to offer suggestions in class discussions unless I am sure I am right. (Maria)
4. It is very important to me to be in the top few of the class. (Tina)

Laboratory work

5. Practicals with very rigid instructions bore me. I prefer to follow my own ideas. (Tina)
6. I like practical work when the instructions are clear and you know just where you are and what is expected. (Lee)
7. I hate doing practical work with others since they can keep you back. (David)
8. I enjoy discussing and working on practical problems with my friends. (Maria)

Projects

9. In school, I would rather study science facts and laws than waste my time in practical investigations. (Lee)
10. I don't like to work alone when I am learning new ideas in science. (Tina)
11. I don't like doing new science projects in the laboratory unless I can follow clear instructions. (Ian)
12. I am keen to learn about the latest discoveries and inventions. (Maria)

Social life

13. When exam times come round, I cut out other activities to concentrate on study. (Ian)
14. I am so busy enjoying myself that I tend to put off my study till the last minute. (Maria)

15. I like to be involved in new and unusual hobbies and games rather than stick to the normal ones. (Tina)
16. I like activities in which I can compete with others and win. (David)

Statements called “Maria” refer to curiosity, “David” to achiever (effort oriented), “Tina” to social, and “Lee” and “Ian” to conscious motivational types. Following the respondents’ choices from the four sets of four items, pupils were categorised into one of the defined motivational orientations. Dominant orientations were identified by having the same pupil’s name in a majority, for example, 4 Davids, 3 Davids and 1 other name, or 2 Davids and 2 different pupils’ names (4:0, 3:1, 2:1:1). If no dominant category of the motivational orientation was found (2:2, 1:1:1:1, i.e., equal proportions of names selected), the pupil was assigned to the unclassified category.

Pupils in the experimental groups were tested using the modified version of the motivational test on the last day of their stay in the science education field centre. The same test was administered to the pupils in the control group at the same time in their home school.

Data Analysis and Results

The data analyses involved verification of the construct validity and reliability of the MODT and a series of non-parametric tests (Chi-square test) to compare the distribution of motivational orientations in the original sample used for norming the instrument and the control sample and to compare the orientations expressed in the control sample and experimental sample. Although completion of the MODT was easy and quick for pupils and the classification procedures were very simple, most of these pupils could not be classified as one of the four motivational types. This instrument appears to have some value, but its general application and sensitivity in situations where only delicate changes in orientation after short-term effects of experimental education would be expected is questionable. The two research questions regarding the application of the MODT in a new population and the comparison of pupils’ expressed motivational orientation in a traditional classroom science program(s) and the field centre program were considered sequentially.

Validity and Reliability of the MODT

Each response of a pupil was numerically coded as 1 = Curiosity, 2 = Effort, 3 = Consciousness, and 4 = Social style. Then, the distribution of

TABLE I

Inter-item correlations from the experimental group calculated by Spearman's correlation coefficients

	Achiever	Conscious	Curious	Social
Achiever	–	0.29**	−0.33**	−0.14
Conscious		–	−0.54**	−0.40**
Curious			–	−0.03
Social				–

**Denotes significant correlation at $p \leq 0.01$.

classified and unclassified respondents and the inter-item correlation (experimental and control groups) and distribution of all pupils' responses were conducted to explore the construct validity and reliability of the MODT. A majority of the control group students (65.6%) and experimental group students (72.2%) did not demonstrate a dominant motivational orientation using the MODT and scoring procedures provided. In general, inter-item correlations (non-parametric Spearman's correlation coefficients) showed similar patterns of negative association between different motivational orientations in both experimental and control groups as expected (Tables I and II). Curiosity, which was predicted to be the most important motivational style in this study, was negatively associated with the other three motivational styles (consciousness, effort, and social). Significant ($p = 0.01$) correlations were found in five of the six cases examined. This suggests that with the increasing level of curiosity the level of other motivational orientations decreases, where the negative correlation coefficients were highest in

TABLE II

Inter-item correlations from the control group calculated by Spearman's correlation coefficients

	Achiever	Conscious	Curious	Social
Achiever	–	−0.07	−0.19**	−0.09
Conscious		–	−0.53**	−0.32**
Curious			–	−0.18**
Social				–

**Denotes significant correlation at $p \leq 0.01$.

TABLE III

Description of motivational orientation distribution: original study, control and experimental groups

Motivational orientation	Original study (Johnstone & Al-Naeme 1995), $N = 217$ (adjusted $N = 182$)	Control group from the present study, $N = 363$ (adjusted $N = 125$)	Experimental group from the present study, $N = 151$ (adjusted $N = 42$)
Achiever	$N = 11$, 5%, (6%)	$N = 3$, 0.8%, (2.4%)	$N = 1$, 0.7%, (2.4%)
Conscious	$N = 80$, 37%, (44%)	$N = 61$, 16.8%, (48.8%)	$N = 14$, 9.27%, (33.3%)
Curious	$N = 32$, 15%, (18%)	$N = 46$, 12.7%, (36.8%)	$N = 20$, 13.2%, (47.6%)
Social	$N = 59$, 27%, (32%)	$N = 15$, 4.1%, (12.0%)	$N = 7$, 4.6%, (16.7%)
Uncategorised	$N = 35$,16%	$N = 238$,65.6%	$N = 109$,72.2%

this case in both groups. Interestingly, no significant associations between achiever and social orientation were found for the experimental and control groups. These investigations suggest that the MODT has questionable validity and reliability when used with Slovakian students.

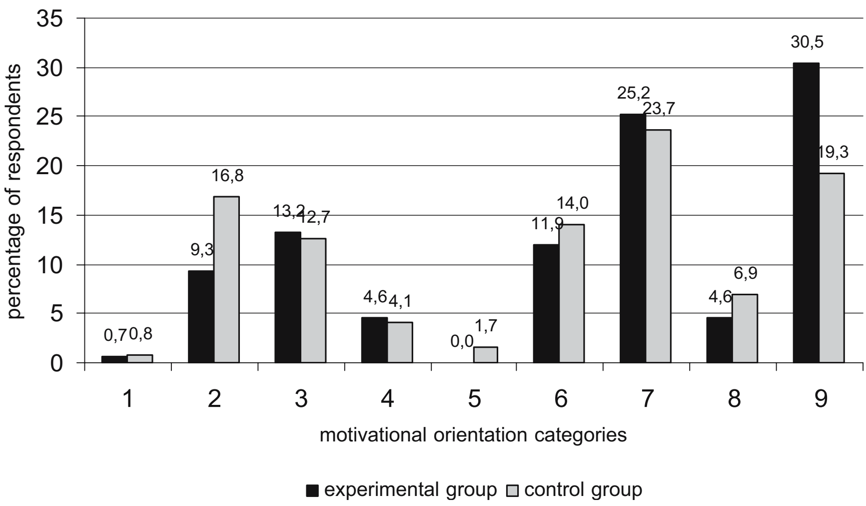

Figure 1. Distribution of respondents into motivational orientation categories. Motivational orientation categories: 1–effort, 2–consciousness, 3–curiosity, 4–social, 5–with tendency to effort, 6–with tendency to consciousness, 7–with tendency to curiosity, 8–with tendency to social, 9–non-categorised.

Comparison of the Distributions of Motivational Orientations: Slovakia and United Kingdom

Descriptive statistics (number of pupils, percent of sample, adjusted percent of classified sample) were calculated for the control group (traditional classroom sample) from Slovakia to parallel the percent distribution reported for the original United Kingdom sample (Table III). Conspicuous difference was detected in the high proportion of uncategorized pupils from the Slovak sample (66%) compared to the reported value for the original United Kingdom sample (16%). The classification procedures provided by the instrument authors and operations used in the current study were checked, but no scoring errors or inconsistencies were detected. Therefore, the comparison of the Slovak and United Kingdom samples was limited to those pupils who were clearly classified into one of the four motivational orientations. After excluding uncategorized pupils, adjusted sample sizes and percentage distributions were calculated. These adjusted values were compared using a non-parametric Chi-square test. The adjusted percent distribution of motivational orientations of Slovak pupils differed significantly (χ^2 = 26.124, df = 3, $p \leq 0.001$) from the distribution reported for the United Kingdom pupils in the original study (Johnstone & Al-Naeme, 1995). Pair-wise comparisons of the adjusted values of individual orientation revealed a significantly higher proportion of curiosity-oriented pupils (χ^2 = 14.44, df = 1, $p < 0.001$), and a significantly lower proportion of social oriented pupils (χ^2 = 16.89, df = 1, $p < 0.001$) in the Slovak population as compared to the original United Kingdom sample.

Comparison of the Control and Experimental Groups

The differences in motivational orientations expressed between the two groups of Slovakian pupils receiving the traditional classroom instruction (control) and the science education field centre experience (experimental) and reported in Table III were compared using the non-parametric χ^2-test. The adjusted percent distribution of motivational orientations of Slovak pupils from the experimental group did not significantly differ from the control group (χ^2 = 3.13, df = 3, p = 0.37). Small sample sizes originating from the high proportion of uncategorized pupils did not allow comparison of the motivational orientation differences between girls and boys.

Importantly, the distribution of pupils' responses on each of the four statements were spread across the four and related to the four motivational styles leading to??? and showed strong bias toward unclassified motivational styles. Either none or a minority of pupils consistently preferred one of the four orientations (which is the maximum, i.e. 4:0, see Sect. Methods) or three (i.e., 3:1) statements related to the same motivational style. The same pattern was observed for all motivational orientations.

To improve the sensitivity of the analysis of these data, we increased the number of motivational orientation categories and distributed the respondents by their selection of the statements into the following categories that captured a tendency toward an orientation: 1 – effort, 2 – consciousness, 3 – curiosity, 4 – social, 5 – with tendency to effort, 6 – with tendency to consciousness, 7 – with tendency to curiosity, 8 – with tendency to social, 9 – non-categorized. Categories 1–4 represent respondents that showed clear motivational orientation (3 or 4 out of four chosen statements selected represent a single motivational orientation). Categories 5–8 represent respondents with tendency toward any of the four motivational orientations (two out of four chosen statements represent a specific motivational orientation, and the other two chosen statements selected were distributed across the other orientations). Figure 1 demonstrates similar distribution patterns of the orientations for the control and experimental groups. A correlation of these nine pairs of values for the two groups reveals a high association (r =0.892). Closer inspection of Figure 1 illustrates a tendency toward consciousness orientation in the control group and a tendency toward curiosity in the experimental group.

Discussion

Numerous studies have focused on pupils' motivation through science education (Hanrahan, 1998; Nolen, 1988; Nolen & Haladyna, 1990; Tatar & Robinson, 2003), but experimental evidence related to the changes in motivational orientation is rare. Recently, Salmi (1993, 2003), using a different method to determine motivation, found a significant increase in the intrinsic motivation of pupils who visited a science education centre in Finland. Gibson & Chase (2002), Knox, Moynihan & Markowitz, (2003), and Markowitz (2004) also showed increased pupil interest toward science after their participation in extracurricular science programs. We found that a large percentage of Slovakian pupils' motivational preferences could not be classified by the MODT, that Slovakian pupils were generally more curious but less social in comparison to the UK sample reported (Johnstone & Al-Naeme, 1995), and that the pupils' experiences acquired by learning in the field do not influence pupils' expressed motivational orientations. We found the final results surprising and disappointing. Several explanations might be applied to these results.

First, the method used for evaluation of motivational orientation (MODT, Johnstone & Al-Naeme, 1995) cannot be considered as valid and reliable, as is desirable for such research, nor is it applicable to different socio-cultural contexts. The test reliability was not provided in the original study; therefore, the value of the MODT is questionable. Perhaps this method can be used for a quick categorization of pupils into motivational groups, but the MODT does not appear to be valid, reliable, and sensitive enough for use in this type of research. It might be more defensible to convert the MODT into 16 Likert-type items clustered into four instructional foci (school work, laboratory work, project work, and social context). The scenarios for each orientation may need to be revised to reflect the socio-cultural context of the target population.

Second, it was unreasonable to anticipate that short-term effects of experiential learning in the science education field centre would result in changes of motivational orientation. In fact, the original study reported only descriptive but no experimental data that would support an idea as to the potential changes in motivational styles. Other studies cited showing effects of extracurricular programs lasted longer than the five-day courses at the science education field centre.

Third, changes of short-term effects may be reflected mainly in the situational interest that refers to the appealing effect of characteristics in an activity or objects that triggers responses from an individual at the exact moment of person-activity interaction (Hidi, 2000). However, these changes were not detected by items in the design of, and scoring procedure itself, for the MODT. Thus, potential effect on pupils' interest can still not be ruled out; additional research is needed to evaluate effects on interest.

Significant differences between motivational types of Slovak and UK samples reported in this study remain unclear. There are numerous factors responsible for this finding, for example, individual pupils' interest or learning specializations. However, information related to pupils' individual background and school environment in the original study were not provided to allow comparison with those of the Slovakian pupils.

Practical work has a key role in science teaching (Gott & Duggan, 1996). The concrete experiences resulting from this practical work are the basic foundation for knowledge. If pupils are offered an opportunity to acquire information by their preferred learning orientations, they feel their own ability to learn and understand are not a matter of the school's domain but rather a matter of their own responsibility, effort, need, and interest. Constructing knowledge allows pupils to understand the use of that knowledge better, which is why the knowledge is more relevant to them. Although we did not obtain the expected evidence about the effect of informal learning to increasing a curious orientation in pupils' motivational styles, we believe that the science learning environment should offer as many varied incentives for motivation to learn as is possible. The non-written rule-the more incentives that come from the environment, the more we can learn about the environment-could be applied in this case.

ACKNOWLEDGEMENTS

We are indebted to Shari and Larry Yore for their helpful comments, language corrections, and extreme patience during the improving of previous versions of the manuscript.

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