Encouraging active learning when teaching geospatial sciences

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In today’s world, higher education, especially in technical sciences, is crucial when speaking about a change in values and attitudes towards sustainability. Engaging students in learning and training process as well as developing their research skills and creative capacity is challenging. This study inquires into the current academic activities and role of used educational technologies and methodologies for encouraging active learning in both undergraduate and postgraduate programs when teaching any engineering course in general, and geospatial sciences in particular. The result of the study suggests the importance of interdisciplinary project and problem-based learning, building partnership with universities, students and industrial companies, monitoring, developing, and implementation of new educational technologies.

Keywords: active learning; geospatial sciences; learning-style preferences; good practice in higher education; creativity

If you tell me I will listen. If you show me I will see. If you let me experience, I will learn. (Lao-Tzu)

1. Introduction

The traditional format of education for many introductory and specialized science courses presents a number of challenges to both teaching and learning (1). If in social studies, traditional methods of teaching and learning may still be considered acceptable, in technical disciplines, they are a prior subject of major changes. Due to many interdisciplinary connections, technical courses in general, and described here course of geomatics (covering a number of geospatial sciences) in particular, need to be focused on student-centered pedagogy (SCP), taking into consideration all possible ways of making both learning and teaching more efficient. Within SCP approach, it is possible to point out the activities, such as lecturing, practicals, lab work, seminars, research, and project- and problem-based learning. Many of the above-mentioned activities have been used in high school for a long time; nevertheless, their efficiency will undoubtedly be less noticeable if they are not modified to the subject, student, and teacher (2, 3).

To come to a better understanding of those modifications to be introduced into educational process, the definition of geomatics needs to be made. According to Arun and Anand, geomatics combines the terms of geodesy and geoinformatics, and includes the tools and techniques that are used in land surveying, remote sensing, cartography, geographic information systems (GIS), global navigation satellite systems, photogrammetry, geography, and related forms of earth mapping. The term has been adopted by the International Organization for Standardization, the Royal Institution of Chartered Surveyors, and many other international authorities, although in some countries, the term geospatial technology is used instead of geomatics (e.g. USA). To sum up, it is possible to say that geomatics is the discipline of gathering, storing, processing, and delivering geographic or spatially referenced information. It means that when teaching geomatics, special attention is paid both to theoretical and practical aspects leading to comprehensive understanding of the subject. The same principles of teaching can be transferred to any other geospatial discipline. One of the advantages of teaching geomatics, as well as many of the geospatial and engineering courses, is the fact that teachers have a lot of supplementary real-life materials and software products which can be incorporated into the educational and training processes. While fulfilling practical and project-based assignments, students are able to get involved both into research activities and solving actual problems of the industry, making it possible to transform creative thoughts into creative actions.

Typically for high school, a large amount of theoretical content is delivered to students through a lecture format, which like any educational technic, may be applied both efficiently and inefficiently. The passivity of students in lectures has long been observed and criticized (4). Respecting the fact that university learners have changed, it is necessary to use active lecturing strategies maximizing student learning of the course content and engaging teachers and learners at higher levels. Making students more engaged in the educational process and delivering its content in variety of settings makes lecture an efficient and successful method of knowledge transfer (5, 6). Nevertheless, even now, some university teachers deliver their material in a traditional passive lecture when

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professor speaks and students take notes without thinking (7). In this case, the lecture fails to motivate and encourage students to attain skills and competences they will need to succeed after graduating and only makes them just remember the material for exams (8).

In many cases, a lecture or practical becomes dull when a teacher fails to deliver the information to the whole group of students. It usually occurs to either a young or, more seldom, senior lecturer who is not well trained (or, as a rule, if speaking about teaching geospatial or technical sciences, not trained at all) in pedagogy. It is not rare that these beginner teachers learn teaching from their teachers remembering what and how they learned and were taught in various classes, and appreciating that learning long after they graduated. That is why junior or beginner faculty members often try to pattern their first teaching experiences based on former professors’ teaching methods, with the goal to be an effective teacher, respected and liked by their students (9), not taking into consideration the fact that learners and their learning-style preferences have changed.

The delivered material may be interesting but if the teacher is not able to explain to his students the importance of the information for their future professional activities and success from the very beginning of the lecture, he takes the first step in the wrong direction – students do and pay more attention only to those things that meet their needs and coincide with their goals. Five introductory minutes in the beginning of the lecture will allow students to understand the importance of the new material and save the teacher from appealing to discipline and attention during the lecture. Due to a number of complex topics in the delivered course, the lecture must be dynamic and inspire students (10) to a more active participation in the educational process. In his studies, reference (11) found out that students are usually capable to accept the delivered information efficiently for 15–20 min (12, 13), whereupon they need either a short rest or change of their activity. While planning a lecture, the teacher has to pay special attention to physiological needs of the students and provide them with different kind of activities every quarter of an hour (e.g. lecture, group or pair work, discussion of the material, writing a test, solving a problem, etc.). Managing in-class cooperation also requires plenty of thought and planning, especially when a large-size class is taught (4). In simple terms, teachers have it in their power to vary stimulation in three domains: what students hear, see, and do (14). During the lecture, the teacher should also plan and deliver his material to students following the classification of educational goals proposed in Ref. (15): understanding; learning; usage; analysis; synthesis; and assessment of the situation. The first three goals are essentially necessary for first-year undergraduate students, while the last three promote and form effective professional skills demanded among senior and graduate students. At the same time, the last three goals require a lot of teachers’ time, work, and ability to apply them.

When speaking about the worst lecture, both students and teachers refer to the “monotone lecturer,” who is unable to vary the transfer of knowledge and presentation of his spoken voice (4). Lowering and increasing the tone of the voice, the use of silences and pauses, introducing in-class debates and conversations or taped recordings, etc. are the ways affecting and varying the student experience. Visual stimulation of students can be done with video and movie clips, PowerPoint slides, diagrams, and graphics, links to the Internet, etc. This kind of student stimulation is essential for teaching technical and engineering subjects, where a lecture without visual aids is mostly inefficient and would be a very rare experience. Incorporating visuals into a lecture can provide a helpful reinforcement to the lecturer’s speech, especially for those students who are visual in their learning-style preferences, the use of visual stimulation is more than a helpful addition and is an important part of the communication itself. Varying what students do in a lecture is the prior task for a teacher to consider – the students will remember what they do in lectures much better than what they are told (16), that is why the teacher should plan at least three things for students to do in any hour each lecture.

When teaching geospatial sciences, special attention must be concentrated on the development of student’s practical skills, deep understanding of theoretical background, and interdisciplinary relationship. This can be reached through the following activities:

- (lecture) by combination of the theoretical course delivery simultaneously with a number of practical problems solved by students individually or in groups (depending on the problem and students’ learning deficiencies), and aiming a better understanding of the theory (15) by means of its practical applications (understanding, interpretation, application);
- (practicals) by development of “real-life” tasks/situations to be solved and requiring a comprehensive understanding of the past theoretical material of the main and associated courses. Within these activities, students are to learn different approaches when solving a problem (understanding, interpretation, application, analysis); and
- (research) by attraction of the students to scientific and R&D works carried out at the university (understanding, interpretation, application, analysis, synthesis, appraisal of the situation).

To better meet the needs and potential of the educational process, it is especially essential to monitor student activities and progress during the semester, determining their learning-style preferences to form teaching strategies both at lectures and practicals (17). For this reason, Chikering and Gamson call for teachers to improve classroom teaching. Being aware of students’ learning-style preferences, teachers can advance
university education themselves, if a focus on improvement is maintained. The late Chikering and Gamson offered seven principles for good practice in high school education (18), which should be adopted and largely applied when teaching geospatial sciences:

(1) encourage contact between students and teachers;
(2) develop interaction and cooperation among students;
(3) encourage active learning;
(4) give prompt feedback;
(5) emphasize time on task;
(6) communicate high expectations; and
(7) respect diverse talents and ways of learning.

Even now, after several decades, these principles are the basis for program and course revision, especially to motivate active and efficient learning in high school.

2. Implementation of active learning strategies for teaching geospatial sciences

2.1. Encouragement of contacts between students and teachers

Speaking out, to answer, or ask a question in a lecture is an incredibly daunting thing to do and it is not surprising that only the bravest students would ever consider doing this. Therefore, if a teacher really wants to hear back from his students in lectures, it is worthwhile thinking about some different ways of stimulating this response. Some of the ways to encourage contacts between students and teachers are incorporating active and problem-based (A&PBL) learning into every lesson (1), adopt several strategies to create a more student-centered learning environment (SCLE), and redesign the course.

The above-mentioned methods have been widely used when teaching humanities and are being successfully adopted for some science and biology courses (1). In addition, a series of influential reports and papers have called attention to the need for changes in approaches to university education in ways that promote active-learning strategies for a diversity of students (19, 20). This need is particularly acute in geospatial sciences, where a steady decreasing number of entrants and graduate students have been noticed for several decades.

Due to a large number of facilities and equipment used at the departments of universities when teaching any geospatial course and carrying out corresponding research activities, the development and implementation of A&PBL and SCLE in the educational and training process should not cause any technical problems. The ones that arise are the problems of teacher’s qualification, awareness, and readiness to learn and apply new educational technologies of active learning in their work. Some of the efficient approaches for a geospatial course replanning and redesign to make it A&PBL and SCLE oriented are described below.

When incorporating A&PBL and SCLE, students are organized into groups of 3–5 working together throughout the whole semester. The choice of the students forming a working group must be based on the previous monitoring of their learning-style preferences, in-class observations, common interests, and educational deficiencies. The monitoring may be done by using student feedback, in-class observations, or interviews.

It is also important to plan the course in such a way that every lesson, the groups are given a quantitative, qualitative, or conceptual problem. When planning the time period for any particular problem, the compulsory condition is that it must be always time limited. Usually, the time frame is calculated as time necessary to the teacher to find the solution of the problem multiplied by 1.3 or 1.5 depending on the teacher’s experience (21). The variety of active-learning exercises that can be used in A&PBL and SCLE educational process is well described in Ref. (20).

The in-class discussion of the found solution should be always started from the group of students having insignificant educational deficiencies. As a rule, such approach allows other groups of students to get better prepared for the discussion and shows them what aspects of the solution need to be emphasized when presented. As a result, all of the following groups of students feel themselves more confident while making their presentation.

As for the course redesign, its organization has to meet the main pedagogical tasks of the teacher and student class-time activities. While delivering the in-class material, when the teacher supposes to use a number of front, group, and pair activities, it is necessary to plan and organize the educational process, thus to provide all in-class time employment of each student. It can be reached by the combination of active-learning exercises, assuming various activities offered to particular students or groups at the same time (e.g. reading, problem-solving, making a test, concept maps, etc.). By organizing the educational process in such a way the teacher creates more opportunities for in-class communication and encourages students to address him much oftener; at the same time, students working in groups are able to develop their in-group communicational skills.

2.2. Development of interaction and cooperation among students

Taking into consideration the results of in-class monitoring and focusing on differences in students’ preparation level and their learning-style preferences, teachers are able to apply SCP and project-based (PBE) methods in educational process. The results of the monitoring allow the teacher to select groups of students in such a way that their joint team-learning activities will compensate every particular student educational deficiencies. Such approach solves several problems simultaneously. First, the students understand that their project-based work will
be successful only if all of them are active while fulfilling their part of work. Second, the results achieved by the end of the project work inspire and motivate students to a deeper self-training in the subject as well as improve their performance in communicational, professional, and critical thinking skills and competences. Third, by working on a project, each student can experience many new and important activities helping and encouraging him to overcome some of his educational and communicational deficiencies, leading to improved learning outcomes. If speaking about geospatial sciences, students’ project activities can be concentrated and organized for solving of a part of a larger project supervised by the teacher and carried out by several groups of students during in- and out-of-class activities. This approach motivates students to interact with their group mates and students working in other ones; it induces them to address to additional sources of information. The effect of the described approach is more noticeable when students are working on the solution of a real problem (e.g. creating or updating a data layer for GIS; laying of a route for geodetic or aerial survey; etc.).

The described here method is efficient when solving the task of interaction and cooperation development among students during educational process. The studies (22) carried out at the Siberian State Academy of Geodesy from 1998 to 2006 indicate that the presented SCP & PBE methods are effective for all students of the class (courses of cartography, GIS, photogrammetry, remote sensing, geomatics, and applied geodesy) if compared with traditional methods of training, especially after a two-year period (Tables 1 and 2), but they proved to be much more effective for students having low (A) and high (C) levels of educational deficiencies (Table 3).

2.3. Encouragement of active learning

Students do not learn much just sitting in classes listening to teachers, memorizing the earlier prepared assignments, and giving out answers. They must discuss what they are learning, write about it, relate it to past experiences, and apply it to what they think is important. Starting from the early 90s, a series of articles have paid attention to the need for changes in approaches to engineering education in ways that promote meaningful learning, problem-solving, and critical thinking for students (19, 20). Taking into account that most of geospatial sciences belong to engineering, it is possible to draw a parallel and come to conclusion that active-learning methods should be largely introduced and implemented in educational and training processes when teaching geospatial disciplines. This need is most seen at the introductory level, where a major leakage of students toward engineer and science careers has been noted (23). That is why universities had to pay their special attention to redesigning of existing curriculums and courses implementing above-mentioned approaches into educational process. Later, the combination of these approaches was adopted under the name of “active learning.” Reference (24) defines active learning as “seeking new information, organizing it in a way that is meaningful, and having the chance to explain it to others.” Active learning emphasizes student responsibility for their own and their peers’ learning, and promotes a higher level of training when students go beyond the content trying to understand the connections within and how they were formed. Reference (1) asserts that active learning improves not only student outcome but attitudes as well.

Majority of students see learning as the accumulation of unambiguous information and resist active-learning techniques when they believe these techniques are not sufficient to provide them with needed information (2). One of the ways to accomplish a more positive student reception of active-learning courses would be to organize classes so as to achieve a judicious balance of student-centered activities and presentation-style instruction (2). Such form of learning emphasizes interactions both among students, and between students and a teacher involving a cycle of activity and feedback, where students are given real opportunities to apply their learning in the classroom, which allows the latter to become independent and critical thinkers (25).

The task of a teacher is to structure classroom activities in such a way that they would not compete

Table 1. Students’ educational outcomes before (beginning of the academic year) and after (end of the academic year) implementation of SCP & PBE methods.

| Year    | First year | Second year | Average growth |
|---------|------------|-------------|----------------|
|         | Beginning  | End         | Growth         | Beginning  | End         | Growth         | Average growth |
| 1998–2000 | 0.72       | 0.82        | +0.10          | 0.80       | 0.87        | +0.07          | +0.15          |
| 1999–2001 | 0.71       | 0.79        | +0.08          | 0.81       | 0.85        | +0.04          | +0.14          |
| 2000–2002 | 0.74       | 0.81        | +0.07          | 0.79       | 0.87        | +0.08          | +0.13          |
| 2001–2003 | 0.76       | 0.87        | +0.11          | 0.85       | 0.96        | +0.11          | +0.20          |
| 2002–2004 | 0.72       | 0.79        | +0.07          | 0.80       | 0.88        | +0.08          | +0.16          |
| 2003–2005 | 0.72       | 0.81        | +0.09          | 0.81       | 0.90        | +0.09          | +0.18          |
| 2004–2006 | 0.75       | 0.85        | +0.10          | 0.84       | 0.93        | +0.09          | +0.16          |
| Average  | 0.73       | 0.82        | +0.09          | 0.81       | 0.89        | +0.08          | +0.16          |
with students’ needs; to explain students that class time will be spent on activities designed to a better understanding of the most difficult concepts; customized mini-lectures will help create a better perception; that classroom activities are focused on students’ needs. References (26, 27) proved that first-year students are more receptive to active-learning techniques. That is why a proper introduction of active-learning value allows teachers to capture the enthusiasm of all students.

Reference (3) adduces four basic elements of any active-learning strategy, they are: talking and listening, writing, reading, and reflecting. These elements and student-centered approach can be used in many different combinations to create specific active-learning strategies that are able to satisfy any student’s learning-style preferences.

Researches, carried out at the Siberian State Academy of Geodesy (22), showed that when developing active-learning strategies to provide a higher efficiency of their implementation into educational process, student learning-style preferences should be taken into account (Table 4).

One thousand and eighty-two participants completed the survey on their learning-style preferences from 1998 to 2007 (approximately 100 students a year). The participants ranged from 17 to 20 years old, with an average age of 18.2 years.

Each year, after analyzing the results of the survey and autumn semester monitoring, active-learning strategies were modified correlating the changes in student learning-style preferences, which allowed the educators to reduce the resistance to active-learning techniques from students considerably.

The impact of the autumn semester monitoring on active-learning strategies modification proved to be very important. The in-class observations showed that within their first semester at the university, a significant number of students changed their previous attitude to learning-style preferences (Table 5).

Reference (28) pointed out two types of motivation when learning: extrinsic and intrinsic, considering the latter one far more essential for creativity. Having the results of the survey and monitoring a set of individual and group projects, paying attention to intrinsic type of

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Table 2. Students’ educational outcomes shown within traditional methods of training.

| Year       | First year |       |       |       | Second year |       |       |       |
|------------|------------|-------|-------|-------|-------------|-------|-------|-------|
|            | Beginning  | End   | Growth|       | Beginning   | End   | Growth|       |
| 1998–2000  | 0.70       | 0.79  | +0.09 |       | 0.73       | 0.79  | +0.06 |       |
| 1999–2001  | 0.73       | 0.81  | +0.08 |       | 0.75       | 0.82  | +0.07 |       |
| 2000–2002  | 0.68       | 0.77  | +0.09 |       | 0.72       | 0.78  | +0.06 |       |
| 2001–2003  | 0.75       | 0.81  | +0.06 |       | 0.77       | 0.80  | +0.03 |       |
| 2002–2004  | 0.71       | 0.79  | +0.09 |       | 0.74       | 0.79  | +0.05 |       |
| 2003–2005  | 0.73       | 0.81  | +0.08 |       | 0.78       | 0.83  | +0.05 |       |
| 2004–2006  | 0.70       | 0.79  | +0.09 |       | 0.73       | 0.81  | +0.08 |       |
| Average    | 0.71       | 0.80  | +0.08 |       | 0.75       | 0.80  | +0.06 |       |

Table 3. Average growth of students’ educational outcomes before (beginning of the academic year) and after (end of the academic year) implementation of SCP & PBE methods.

|       | A |       | B |       |       | C |
|-------|---|-------|---|-------|-------|---|
|       | Beginning | End  |   | Beginning | End  |   |
| Average | 0.860 | 0.996 | +0.136 | 0.830 | 0.858 | +0.028 |
| Growth |       |       |       |       |       |       |

Table 4. Student learning-style preferences in the beginning of their first semester at university (response percent).

| Learning style         | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|------------------------|------|------|------|------|------|------|------|------|------|------|
| Reading                | 23.4 | 25.7 | 22.2 | 19.4 | 17.3 | 16.5 | 15.3 | 8.6  | 9.9  | 12.0 |
| Subject-specific software | 37.5 | 41.4 | 40.8 | 38.4 | 35.2 | 35.2 | 31.5 | 31.1 | 30.2 | 28.0 |
| Web (blogs, wikis), Podcasts | 0.0  | 0.0  | 2.4  | 7.3  | 21.2 | 28.5 | 46.5 | 59.8 | 53.7 | 56.0 |
| Internet research      | 0.0  | 0.0  | 0.0  | 1.3  | 4.5  | 14.1 | 17.3 | 24.9 | 43.4 | 56.0 |
| Other learning-style activities | 35.0 | 27.3 | 27.3 | 30.4 | 18.9 | 13.0 | 20.1 | 21.4 | 24.1 | 28.5 |
| Individual learning style | 23.1 | 20.9 | 22.3 | 19.7 | 21.6 | 18.8 | 19.1 | 16.8 | 16.3 | 14.0 |
| Group learning style   | 76.9 | 79.1 | 77.7 | 80.3 | 78.4 | 81.2 | 80.9 | 83.2 | 83.7 | 86.0 |
motivation, was specially developed and offered to students. The offered projects were of a different level and corresponded to determined student learning-style preferences, so any student or a group of students was able to choose the most-suitable circumstances and familiar environment while working on a project. Every developed project provided students with eight core processes generating new understanding derived from existing knowledge: problem finding; information gathering; concept search and selection; conceptual combination; idea generation; idea evaluation; implementation; action monitoring (28, 29). Active application of SCP and PBE approaches into educational process provides students with a complex four-dimensional interactive relationship: creative persons, cognitive process of creativity, products of creative performance, social and cultural contexts (28, 30). Thus, introduction of SCP and PBE approaches focused on student's personality, knowledge and motivation, thinking and learning styles into educational and training processes allows educators to promote creativity and research skills to learners, transforming their novel ideas into useful products. While working on a project, teachers as facilitators should provide opportunities for active engagement by students and encourage creativity in the latter ones by supporting, student-centered environment, not-hierarchical teaching styles and applied methods. Further research showed that students considered teaching style (friendly, encouraging, enthusiastic) and methods (A&PBL, SCLE, assessment system) a key factor for their success results.

During the research, it was noted that application of the PBE approach focused on real industrial problems provided among students a higher interest in searching for solutions, experimenting, and achievement of the result. The level of student PBE involvement and efficiency of SCLE also increased when teachers and university administration had provided in-course and inter-course collaboration within educational net organized among partner universities. In this case, working groups were formed of students from different universities or faculties and had several supervisors.

2.4. Prompt feedback

Knowing what one knows and doesn’t know focuses his learning. In this way, feedback is an integral part of learning. Having prompt feedback helps the teacher tailor the content and his explanations to the needs and backgrounds of the students. The difficulty in presentation of the course material at the right level, to meet the needs of diverse student groups, can be significantly reduced or eliminated if the teacher gives his students an immediate chance to check out their understanding and perspective (4). Although it seems a rather simple idea, the practice shows that it usually is, a little more difficult to achieve. Thus, even having insight into students’ needs, interests, experiences, abilities, and general level of education, it is actually difficult to deliver the material knowing that for some, it will be too simple, for others, too complex, and hopefully, for majority, it will be just right.

Similar to any story, each part of a lecture has a distinct purpose. In the beginning of a lecture, it is essential to capture students’ interest, engage, and motivate them to learn. During the first minutes, the teacher can use a number of activities that connect to the students and make them relate prior knowledge to the lesson ahead, then the teacher may ask them to write or give an oral prediction of what they think will be next with an explanation. The act of anticipating what is coming next is an active process and builds retention of content.

The middle of the lecture, where most of the content delivery happens, is another opportunity to use brief active lecture strategies. Pausing every 15–20 min, the teacher permits students to process the new information actively, which help keep students focused. One activity that is useful in the middle of a lecture is a question-generating technique when students or pairs of students are required to create a question that they feel is very difficult. Through the level of questions posed and the way they are answered, it is possible to indirectly assess student understanding. This process also helps the teacher to create a bank of questions that can be used in other class activities, guided reading, quizzes, tests, and exams.

The closure of the lecture ties up loose ends, summarizes main points, and opens opportunities for connections beyond the content. An effective closure activity encourages students to make connections to the presented material, and extends the learning beyond the university setting to the student’s world. Questioning strategies can be replaced by any active strategy that engages students in synthesizing, applying, or summarizing. Prompt feedback gives teachers a clear understanding of what students find or found unclear, and what they feel were the most important points, or how this topic would be seen under different conditions.
A general time-activity scheme of a typical 90-min active-learning lecture of any of the geospatial disciplines is shown in Figure 1.

Some other feedback strategies can also be implemented into educational process: audience response systems, a.k.a. clickers; student summaries; pair/share; free write/one minute paper; focused listening; question and answer pairs; 3–2–1 protocol; 10–2 protocol; note check (3), etc.

2.5. Emphasizing time-on-task

As it was mentioned above, one of principles in Ref. (18) for good practice in high school education emphasizes time-on-task, which means that teachers should create opportunities for students to practice good time management. This includes setting realistic time frames for students to complete out- and in-class assignments. It also means that teachers need to explain students the strategies for managing their time while completing tasks of the course.

It was noted that many students do not realize how much time they should be spending on each course they take. Relying on our experience, we are able to say that students should regularly spend at least 2 h preparing for every 1 h spent in class. In other words, a 2-h class requires about 4 h of preparation (reading, completing assignments, studying) every single week. Depending on the skills of studying effectively some students might spend more or less time, but they need to know, this is the average.

While delivering the content and giving students in-class assignments, teachers need to show effective time management strategies (e.g. how to break down larger tasks into smaller pieces); illustrate to students approaches used to solve problems and complete projects.

One more aspect of emphasizing time on task is to guide students to where they should be devoting their time on projects and assignments. By providing students with rubrics, or checklists, for projects with point values given for each portion of the project will allow students to focus their time on task, making them understand that the content of the project, supporting arguments, and evidence are worth more points than the presentation itself or its unusual visual design they may spend countless hours on.

During our research on efficiency of traditional and IT ways of supervising and student project-based activities consultation, it was found out that current informational technologies play a very important role in the student learning-style preferences (Figure 2).

Below is the list of some of the existing techniques allowing the teacher to increase efficiency of student time-on-task (18, 31):

- class notes are posted on the class website for student review saving some time each day;
- e-consulting allows teachers more opportunities to support students as individual learners as well as better identify student’s individual needs;

| Time (min) | Activity | Notes |
|-----------|----------|-------|
| 5         | Speaking and Listening | Revision and introduction |
| 10        | Listening and taking notes | Theoretical part of the topic |
| 15        | Speaking, analyzing, understanding | Discussion of the new topic |
| 20        | Active learning (problem solving), interacting | Work in groups |
| 25        | Speaking, upholding one’s point of view | Presenting the results of a group activities |
| 30        | Analyzing, speaking | Discussion |
| 35        | Listening and taking notes | Theoretical part of the topic |
| 40        | Analyzing, speaking | Speaking of practical applications and interdisciplinary connections |
| 45        | Active learning, (problem solving), interacting | Work in teams |
| 50        | Speaking, upholding one’s point of view | Presenting the results of a group activities |
| 55        | Analyzing, speaking | Discussion |
| 60        | Listening and speaking | Test work |
| 65        | Active learning, (problem solving), interacting | Team 1 |
| 70        | Analyzing, speaking | Team 2 |
| 75        | Speaking, upholding one’s point of view | Discussion |
| 80        | Analyzing, learning, writing | Summarizing |
| 85        | Listening and speaking | Summarizing |

Figure 1. General time-activity scheme of a typical 90-min lecture (from left to right: lecture time, duration, lecture activity, student activity).
e-mail messages replace live visits to teachers saving commuting time;
interactive programs allow students to manipulate the variables and see what happens visually helping them to learn better;
online lab exercises allow students to access learning activities at a time and place convenient for them offering considerable flexibility;
posting assignments on the web eliminates the time spent by students to retype the assignment;
providing availability of many research materials online and through electronic databases and the Internet enable students to access what they need, changes students’ research possibilities, and saves their time and resources; and
sending e-reminders about the expected completion dates for projects allows students to better plan their time.

2.6. Communicating high expectations

Those teachers who expect more from their students always get more. High expectations are important for everyone – for the poorly prepared, for those unwilling to show themselves, and for the bright and well-motivated students (18). Expecting students to perform well becomes a coming true prophecy when teachers and university administration hold high expectations for them and make extra efforts.

To make this principle work for different kinds of students (rich, poor, older, younger, male, female, well and under-prepared), special attention must be paid to both methods of teaching used in the training process and student learning deficiencies.

When speaking about methods of teaching, motivating students for efficient study, it is always necessary to keep in mind that the subject taught, after all, is at least as important as how it is taught. Within this concern, some universities implement good training practices depending very much on their students and their circumstances. For this purpose, many institutions of higher education establish special centers to support teachers in their teaching endeavors. Broadening the methods of content delivery and methodology of teaching allows transforming teacher’s knowledge of a subject in ways that promote student understanding and learning (32).

Interviews, monitoring, and in-class student learning-style preferences observations allow teachers to develop special SCL strategies, using PBE methods and group work activities. Students, forming the working groups, are selected thus to compensate their learning deficiencies. Compensation of the learning deficiencies makes the student group able to develop and carry out complex assessments, too difficult for each student taken separately, obtaining much better results due to the joint learning activities. As a rule, the success of group work promotes further self-development of every student in the group, reducing or eliminating the existing learning deficiencies, and improving other educational skills and self-assessment.

2.7. Respecting diverse talents and ways of learning

Students we meet in our class rooms are different from one another and have their own learning-style preferences. There are many roads leading to learning. Some students show progress in the lecture room, but may be all thumbs when working in the laboratory, others rich in hands-on experience may not be so good with theory. Reference (33) emphasized that “Faculty who show regard for their students’ unique interests and talents are likely to facilitate student growth and development in every sphere – academic, social, personal, and vocational.” When teachers respect diversity and take particular learning needs and learning-style preferences into account, they provide positive learning experiences and have a better chance of reaching and developing these students. While designing a course, it should be taken into consideration that students need to have an

Figure 2. Student in-class and IT learning-style preferences while working on a semester project (24 project groups).
opportunity to demonstrate their talents, learn, think, and express themselves in a range of ways that work for them. Such approach makes all students feel as though they belong and that their points of view are important (34). Later, over some time, the teacher will be able to induce them to learning in new more efficient ways that do not come so easily.

The main thing that must be done is to understand the range of learning-style preferences and approaches students typically bring to the course and then help students understand how to apply them to improve their learning. To do so the teacher should: (a) design more than one method of learning for students – develop the assignments that give students a choice to fulfill them in their own way; (b) recognize, respect, and reward creativity; (c) allow students to choose from different modes of project presentation; (d) understand and allow for different pacing; (e) offer chances for students to take leadership roles in groups; (f) design course materials, activities, and assignments to encourage analysis, synthesis, application and evaluation.

Different talents, learning-style preferences, and pace of work can be advantageous when educational process includes technology.

3. Conclusions

From the discussion presented above, it is clear that contemporary active-learning approaches and methods used for teaching geospatial sciences have many advantages. For instance, students are induced to vigorous cogitative activity and maximum development of creative thinking; active learning accustoms students to analyze essence of the phenomena, find out interrelations, and formulate conclusions.

However, active learning has its demands – students should have certain intellectual abilities and be prepared to overcome difficulties. Not all students are ready to active learning that is why it is necessary to accustom them to modern training from the first days of study.

When employing A&PBL and SCP in any teaching course, at least three things should be kept in mind.

First, A&PBL and SCP methods require longer time and efforts compared with traditional teaching methods and in some instances, traditional methods are more effective in transmitting knowledge to the learner in a limited time.

Second, although those undergraduate and graduate students who were taught with use of active methods of A&PBL and SCP training showed better results than the traditional teaching methods, it does not mean that traditional methods are useless and should be completely discarded. By itself, A&PBL is inadequate for the demands of higher education; students must additionally master some fundamental knowledge appropriate to their chosen discipline.

Third, though students are the center in SCP, teachers are still very important and their role should be changed from disseminator to facilitator. Most teachers are familiar with traditional teaching methods, and they prefer to employ these methods opposing the new ones because in this case, they need to spend more time and energy on preparation and translation. To make introduction described in the article teaching methods and approaches into educational process easier, teachers should be trained or retrained in special university centers to get better prepared for A&PBL and SCP application.

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References

(1) Armbruster, P.; Patel, M.; Johnson, E.; Weiss, M. Active Learning and Student-centered Pedagogy Improve Student Attitudes and Performance in Introductory Biology. CBE Life Sci. Edu. 2009, 8 (3), 203–213.
(2) Walker, J.D.; Cotner, S.H.; Baepler, P.M.; Decker, M.D. A Delicate Balance: Integrating Active Learning into a Large Lecture Course. CBE Life Sci. Edu. 2008, 7 (4), 361–367,
(3) Gregory, J.L. Lecture is Not a Dirty Word, How to Use Active Lecture to Increase Student Engagement. Int. J. High. Educ. 2013, 2 (4), 116–122.
(4) Exley, K. Encouraging Active Learning in Lectures. ASHE-J. 2010, 2 (1), 10.1–10.8. http://ojls.ashe.org/index.php/aishe-j/article/view/10.
(5) Barnett, J. Implementation of Personal Response Units in Very Large Lecture Classes: Student Perceptions. Aust. J. Educ. Technol. 2006, 22 (6), 474–494.
(6) Silver, H.F.; Perini, M.J. The Interactive Lecture: How to Engage Students, Build Memory, and Deepen Comprehension; ASCD: Alexandria, VA, 2010.
(7) Clark, J. Powerpoint and Pedagogy: Maintaining Student Interest in University Lectures. Coll. Teach. 2008, 56 (1), 39–44.
(8) Gauci, S.A.; Dantas, A.M.; Williams, D.A.; Kemm, R.E. Promoting Student-centered Active Learning in Lectures with a Personal Response System. Adv. Physiol. Edu. 2009, 33, 60–71.
(9) Scudder, R.R. The Pedagogy of University Teaching: Issues in Higher Education, 2003–2005. http://www.ashe. org/academic/teach-tools/scudder.htm#sthash.iM1UYbCw.dpuf (accessed April 12, 2014).
