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Original paper

Determinants of students' approach to learning biology at the university level

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Summary. This research examined students' approaches to learning biology and tested differences in learning approaches between students of different study programs, different genders and years of study. The sample included 141 students (120 female and 21 male) from the Department of Biology and Ecology of the Faculty of Science, University of Novi Sad (Serbia). The results showed that about half of the examined students have a deep approach to learning, followed by a surface and a strategic one. The differences in approaches to learning in relation to the study program, gender and year of study did not prove to be significant.

Keywords: age, biology education, gender, learning approaches, university students.

INTRODUCTION

The task of higher education is developing students' skills that will enable them to become versatile experts in their fields, as well as lifelong learners. To achieve these goals, successful learning is expected, which implies the development of a deep approach to learning, and meaningful and critical learning instead of just repetitive knowledge (Asikainen and Gijbels 2017).

Biggs (1994, cited in Azer et al. 2013) defined learning approaches as "ways in which students go about their academic tasks, thereby affecting the nature of their learning outcomes." Extensive research from the end of the 20th century established that students apply dominantly one of three different approaches to learning: surface, deep or strategic approach (Entwistle and McCune 1997). Students who predominantly use a surface approach to learning tend to focus on factual knowledge and memorization of information (Azer et al. 2013) without a true understanding of the studied content (Abraham et al. 2006). They are extrinsically motivated, view tasks as imposed from outside, and are motivated by the fear of failure (Gadelrab 2017). On the other hand, students with a deep learning approach tend to go deeper and examine a wide range of aspects related to the learning content (Azer et al. 2013). They are focused on understanding and connecting ideas and are oriented toward acquiring knowledge that fulfills their curiosity, interests and satisfaction. Their characteristic is a highly expressed internal motivation. Students who dominantly apply a strategic approach to learning are oriented towards achievement, i.e., towards reaching the goal and getting a good (desired) grade. When learning, these students find optimal learning conditions and invest the exact

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amount of effort they consider necessary to achieve the set goal (Gadelrab 2017).

Six phases of learning that students experience during their study were formulated by Marton and Säljö. The lower three conceptions characterize the surface approach to learning: quantitative knowledge accumulation, memorization and storing, and fact acquisition for future utilization. The higher three phases are typical of the deep learning approach: sense-making through abstraction, reconceptualizing reality interpretation, and holistic personal growth (Marton and Säljö 1997, cited in Mystakidis 2021).

Research on the college student population has confirmed that students with a deep learning approach have better academic scores and greater satisfaction. Therefore, the deep approach to learning is associated with a higher level of personal and intellectual development of students, as well as satisfaction with the faculty. This trend is relatively consistent across disciplines (Nelson Laird et al. 2008).

The teacher plays a very important role in developing the learning approach in their students (Gordon and Debus 2002; Baeten et al. 2010). Depending on students' skills and competencies, approaches to learning can change in response to the learning environment (Zeegers 2001; Azer et al. 2013). Therefore, extensive research has focused on finding ways to encourage a deeper approach to learning that would lead to a higher quality of education (Olić Ninković et al. 2019). It is a fact that the modification of the learning approach is most effective in students with high cognitive abilities. Modification of the learning approach must also include a change in motivation for learning because the affective domain is very important. The nature of the subject, the teacher's demands and the students' perception of the teacher's demands influence the choice of learning strategy (Zeegers 2001).

In a longitudinal study, Cope and Staehr (2005) determined that the perception of workload is key to encouraging a deep approach. By gradually reducing the course load each year, they reached a point where enough educational content was covered to meet the course objectives, but significantly more students felt they had enough time to apply a deep approach to learning.

A deep approach is associated with effective discussions that include seeking explanations, considering different perspectives, active interest and engagement in the subject, and integrating and applying knowledge (Visschers-Pleijers et al. 2006). Deep learning comprises understanding, elaboration, critical appraisal, and analysis (Heijne-Penninga et al. 2010).

Azer et al. (2013) have advised teachers on how to promote deep learning in students: a decomposition of information using questions, analogies, mind maps, group learning, and critical and reflective thinking; application of active learning strategies; providing feedback and debriefing; and application of learning to new problems outside of the classroom environment.

There is a hypothesis that students' deep approach develops during higher education (Baeten et al. 2010; Asikainen and Gijbels 2017). During a three-year study, it was established that older students have approaches to learning that differ from the approaches of their younger colleagues (Zeegers 2001). Older students use a deep approach to learning, and in addition, it has been shown that they are more satisfied with their experience at the university. This is in accordance with the idea that the deep approach is more driven by internal motivation than the surface approach (Tagg 2003, cited in Nelson Laird et al. 2008).

Empirical studies of gender-related preferences in approaches to learning science and mathematics are limited and contradictory. Gunderson et al. (2012) have shown that girls tend to have more negative attitudes towards learning mathematics, which could be the result of parents' and teachers' expectancies for children's mathematics competence. In the study of gender differences during online learning, differences were observed in learning behaviour patterns. Female students were more active in achievement-oriented learning activities, indicating that their learning approach was strategic (Wang et al. 2022). However, Zeegers found no statistically significant differences between chemistry students of different genders related to their learning approaches (Zeegers 2001).

METHODS

This research aimed to examine the distribution of the approaches to learning biology in the sample of students of the Department of Biology and Ecology of the Faculty of Science and Mathematics of the University of Novi Sad (Serbia). In addition, the goal was to examine whether there are differences in approaches to learning among students of different study programs, genders and years of study.

This research included 141 students (120 female and 21 male) from the Department of Biology and Ecology, Faculty of Science, University of Novi Sad (Serbia). The sample comprised students of the undergraduate academic studies of biology (60) and ecology (66), as well as the integrated academic studies of biology education (15). The students who participated in the research were 20-22 years old. They attended a different year of study: there were 45 second-year students, 47 third-year students and 49 students in the fourth year of study. Students voluntarily participated in the research. They were informed about the nature of the research and the applied instrument and were allowed to withdraw at any time.

Students' approach to learning biology was assessed using a modified and translated Approaches and Study Skills

Inventory for Students (ASSIST; Entwistle and McCune 1997). A version of the 52-item questionnaire was used, which was previously confirmed on a national sample to have high internal consistency, in which research Cronbach α was 0.82 (Olić Ninković et al. 2019). Items were adapted to reflect approaches to learning biological disciplines included in the curriculum. Items in the questionnaire describe the characteristics and behaviors of students who have a surface, deep or strategic approach to learning. Participants were asked to rank their agreement with each item on a scale, within the range from 1 (strongly disagree) to 5 (strongly agree). Cronbach's α in this research for the entire questionnaire was 0.84, and the consistences for individual subscales were as follows: a surface approach to learning 0.67, deep approach 0.82 and strategic approach 0.85.

In statistical data processing, basic descriptive and psychometric indicators were calculated. Differences in approaches to learning between students of different fields of study and different genders were examined by applying a t-test for independent samples, while differences between students of different years of study were tested by applying a one-factor analysis of variance. The collected data were analyzed using the IBM SPSS software package (version 21).

RESULTS

The questionnaire consisted of three subscales that determine the surface, deep and strategic approach to learning biology. Basic descriptive indicators were calculated, as shown in Table 1. Skewness and kurtosis for all variables were in the optimal range (skewness between -2 to + 2 and kurtosis between -7 to + 7, according to Hair et al. 2010), which fulfilled the assumption of normality of data distribution.

Each of the three approaches to learning was assessed through several components. Arithmetic means and standard deviations of learning approach components are given in Table 2.

In the next step, the dominant learning approach was determined for each student by comparing the arithmetic means for the three approaches. The results showed that the largest number of students had a deep approach (70 students, 49.6%), followed by a surface approach (41 students, 29.1%) and a strategic approach (30 students, 21.3%).

Due to the small number of students of integrated academic studies, where prospective biology teachers are educated, and due to the similarity of this study program with the program of the undergraduate academic studies of biology, students of these two study programs were joined in the single cohort. In this way, the students were divided into two groups: (1) 75 biology students, and (2) 66 ecology students. Applying the t-test for independent samples on these two groups, no significant differences in learning approaches between biology and ecology students were registered (Table 3).

Using the t-test for independent samples, differences in the approach to learning biology between students of different genders were examined. The obtained results are shown in Table 4 and indicate that these differences are not statistically significant.

Based on the enrolled year of study, students were divided into three groups: second (45), third (47) and fourth-year students (49). Differences in approaches to learning biology among students of different years were examined using one-factor analysis of variance. The obtained results did not show statistically significant differences (Table 5).

DISCUSSION

The research aimed to examine the approaches to learning the biological disciplines in tertiary students of biology and ecology. Knowing the students' learning approach is very important because such information can enable teachers to help students get the maximum benefit from their studies (Zeegers 2001).

This research determined that the majority of biology and ecology students dominantly have a deep approach to learning biological disciplines. Fewer apply a surface approach and, to the least extent, a strategic one. Half of the students included in this research stated that their goal is to search for the meaning of the concepts studied, use data, acquire skills and understand the material by connecting it with previous knowledge, which are the characteristics of students with a deep learning approach. A deep approach to learning occurs through the active engagement of students, it is associated with problem-solving skills, creativity, and the ability to think critically (Mystakidis 2021).

A third of students have a surface approach to learning biological disciplines, which means that they memorize concepts without meaningful learning and essential understanding of the content. They use only the learning materi-

Table 1. Descriptive statistics for the entire sample.

Learning approach	Min	Max	M	SD	Skewness	Kurtosis
Surface	33	72	54.69	7.78	-0.07	-0.08
Deep	33	79	57.38	8.98	-0.25	0.23
Strategic	39	91	68.83	10.25	-0.14	-0.34

als closely related to the curriculum and suggested by their teachers, without seeking further reference. Approximately 20% of the surveyed students approach learning strategically to find optimal conditions for achieving the set goals. In other words, students who have a dominant strategic approach tend to organize their studies well, spend their time rationally, and tend to meet teachers' preferences. These students have a developed motivational orientation towards achievement, i.e., reaching the goal and getting a desired grade (Gadelrab 2017).

Based on the approach that students use in learning, conclusions can be drawn about the quality of teaching (Mirkov 2009) because students' approaches can be seen as a response to the learning environment (Azer et al. 2013). Therefore, the finding that the deep approach is the most represented approach among biology and ecology students reflects a positive image of the use of teaching methods and the demands placed on students. Namely, students who are satisfied with the subject, cognitive load, teaching methods and the clarity of the set goals strive for a deep approach. Also, for students who approach learning in depth, it is proven that they feel confident and self-aware and prefer teaching methods that support learning and understanding (Baeten et al. 2010).

Table 2. Components of learning approach.

Learning approach	Component	M	SD
Surface	Lack of purpose	12.26	3.51
	Unrelated memorizing	12.64	2.43
	Syllabus-boundness	14.98	2.83
	Fear of failure	14.80	3.21
Deep	Seeking meaning	15.42	2.57
	Relating ideas	14.39	2.72
	Use of evidence	14.53	2.49
	Interest in ideas	13.02	3.17
Strategic	Organised studying	13.30	2.70
	Time management	11.81	3.00
	Alertness to assessment demands	13.89	2.76
	Achieving	14.24	2.61
	Monitoring effectiveness	15.59	2.53

Table 3. Differences in learning approaches of biology and ecology students.

Learning approach	Study programme	M	SD	t	df	p
Surface	Biology	54.81	7.42	0.19	139	0.85
	Ecology	54.56	8.24			
Deep	Biology	56.73	8.71	-0.91	139	0.36
	Ecology	58.12	9.29			
Strategic	Biology	68.21	9.81	-0.76	139	0.45
	Ecology	69.50	10.77			

Table 4. Differences in learning approaches of students of different genders.

Learning approach	Gender	M	SD	t	df	p
Surface	Male	53.24	7.88	-0.929	139	0.35
	Female	54.95	7.77			
Deep	Male	55.00	10.55	-1.321	139	0.19
	Female	57.80	8.66			
Strategic	Male	67.86	11.06	-0.470	139	0.64
	Female	69.00	10.14			

Table 5. Differences in learning approaches of students of different years of study.

Learning approach	Study year	M	SD	t	df	p
Surface	Second	56.20	7.46	1.25	2 (138)	0.29
	Third	53.85	7.24			
	Fourth	54.12	8.51			
Deep	Second	56.13	8.15	2.52	2 (138)	0.08
	Third	59.57	9.56			
	Fourth	56.43	8.93			
Strategic	Second	69.49	8.70	2.14	2 (138)	0.12
	Third	70.83	10.69			
	Fourth	66.31	10.82			

Because there is evidence of the adaptability of the learning approach and that it is possible to change it (Zeegers 2001; Gordon and Debus 2002; Azer et al. 2013) it is necessary to further apply such teaching methods that would contribute to increasing the number of students with a deep approach. There are numerous tips based on empirical findings and related to a deep approach such as the use of discussions (Visschers-Pleijers et al. 2006), elaboration (Heijne-Penninga et al. 2010), group learning, using analogies, and other (Azer et al. 2013).

Differences in approaches to learning between biology students and ecology students did not prove to be statistically significant. Based on this result, it can be concluded that teachers have similar requirements and apply similar strategies, methods and ways of working within different study programs at the Department of Biology and Ecology.

Recent studies state that the presence of men and women is balanced in biology (Cheryan et al. 2017). However, in the conducted research, there were more female than male participants. Although Chiuo et al. (2012) established that male students have deeper motivation and apply deep learning strategies more than female students, differences in learning approaches among students of different genders did not prove to be significant in this study, which is also in line with the results of earlier research (Zeegers 2001).

There are indications that older students are more inclined to take a deep approach to learning and show a greater willingness and ability to commit to learning strategies that require more effort (Zeegers 2001). However, in the conducted research, the differences in learning approach between second, third and fourth-year students did not prove to be significant.

The importance of this study is reflected not only in finding out which is the dominant approach to learning biology within the university level students, but also in the way their teachers work. The finding that half of the examined students dominantly apply a deep approach to learning reflects a positive image of the Department of Biology and Ecology. However, it also leaves significant room for improvement, and it is desirable to apply strategies, methods and forms of work that will further encourage the development of a deep approach among other students, i.e. the development of cognitive and non-cognitive skills that will aim to have graduated students who can respond to the demands of future employers.

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