Original paper

MULTIDISCIPLINARY APPROACH IN THE IMPLEMENTATION OF ATL METHODS IN TEACHING OF ANIMAL SCIENCES I. PRESENTATION OF SCENARIOS

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Abstract

One of the problems Serbian HE faces is summing up of knowledge thaught in different courses and its application in real life by professional decision making. In order to give an example of possibilities of interactive teaching methodology and contribute to the transformation of students from knowledge recipients to knowledge co-constructors, a set of scenarios for a multidisciplinary approach in teaching/learning is presented. The set consists of 4 scenarios for knowledge refreshment followed by a final workshop – a debate similar to the real life situation. A multidisciplinary approach to the topic of aquaculture development, water and fish quality in aquaculture is presented in this case. By participating interactive classes and a debate, 4 year students in animal sciences work in groups to exercise solving problems, to make professional decision, and develop other professional and generic skills. This paper presents the result of the process of development o scenarios for such exercise and results of the exercise will be presented in another paper (Part 2).

Key words: *active teaching/learning, case study, knowledge application, teaching/learning scenarios, professional decision making*

Introduction

The primary goal of higher education (HE) is training of professionals able to use acquired knowledge and skills to work efficiently, alone and in a team with other experts, to solve problems and make qualified decisions (Pešikan, 2005; Pešikan et al, 2005; Fry et al., 2008). Real-world professional problems are multidimensional, with more than one solution. Dealing with them needs various competences. Development of procedural and meta-cognitive knowledge (Anderson & Krathwol, 2001) is particularly important when students prepare themselves for real life situation. Unfortunately Serbian HE suffers from a lack of practical work and training of skills, both professional and generic (Pešikan et al, 2006; Ivić, 2008). Moreover, according to the Strategy for education development in Serbian HE there is also a need for wider application of active teaching/learning (ATL) principles, including practical application of the knowledge acquired. Traditional teaching methods predominate in HE in our country. Students are mostly passive subjects that have to understand the knowledge delivered and demonstrate it on exam (Anon., 2012). In order

to prepare students to become competent professionals, independent and responsible, their decision - making capacities have to be developed.

Improvement of the quality of teaching and student activation in classes is possible by introducing new teaching strategy, active learning methodology i.e. learner-centered approach (Lambert & McCombs, 1998; Bransford, Brown and Cocking, 1999; Ivić, Pešikan and Antić, 2001) that contribute to knowledge reinforcement, development of critical thinking and problem analysis from different sides. This includes a shift of student's position from recipient of knowledge to knowledge co-constructor in interaction with the teacher (Moll, 1992; Ivić et al, 2002; Pešikan et al, 2005; Pešikan, 2005; Ivić, 2008; Antić, 2008; Anderson, 2013). Students' capacity for decision-making, problems resolving, argumentation, negotiation, evaluation scientific data and information, critical reasonong etc. could be developed throughout different courses. If they learn in such learning situation, students also have better education outcomes (Johnes, 2006). Student activation obviously demands new approaches for teachers that includes creation of scenarios instead of lessons plans, similar to a theatre scene in which a teacher as a theatre director and students as actors assume completely different roles than in traditional teaching that is primarily delivering of knowledge from teacher to students (Ivić et al, 2002, Antić, 2008). Scenarios are task-directed, interactive, student centered, and usually planned for longer periods than a simple class (Anderson and Pešikan, 2014).The approach in which real-life problems are considered is convenient for student to practice possibilities of different tactics to problem solving and decision - making, but without consequences in real life. In this paper we present a set of teaching scenarios for a multidisciplinary approach to the topics of aquaculture development, water and product (fish) quality in aquaculture.

Materials and methods

In order to place students in a situation of professional decision making, a case was created. To prepare students of the final years of studies for a multidisciplinary approach, four scenarios were prepared to recall classes in which a problem of aquaculture and water and fish quality was tackled from different aspects: ecological, physiological, health and welfare, aquatic animal production and quality. All these aspects have been already studied/learned during classes in Zoology, Physiology of domestic and farmed animals, Aquaculture, and Health protection of domestic and farmed animals. The idea was to organise a workshop during courses thought on bachelor level in final semesters when students would study an immaginary case, approach it from different aspects, and suggest the solution of a problem from the point of view of different stakeholders. A workshop should be organized in the frame of different subjects thought in the 6^{th}, 7^{th} or 8^{th} semester of bachelor study in Animal Sciences (Zootechnics) such as: Professional practice (Internship), Aquaculture, Zoohigiene, Biosafety on farm, and Management of animal production.

The 4 scenarios will be realised during one class each, 45 minutes, in a period of at least 4 weeks. Scenarios are based on 4 assignements students have to accomplish by working in groups and problem solving (by filling a table), as well as reporting results, participating in a discussion and preparation of conclusions.

In addition, students will have about a month to prepare themselves for roles of different stakeholders they have to play in a final workshop (90 minutes). Roles were distributed by drawing roles of stakeholders "from a hat". Students should prepare their roles by

consulting relevant literature. Parts of this preparation are 4 interactive classes held during a semester.

Material prepared for each ATL class: material for random distribution of students in groups, appendices – texts with assignements and tables to be filled in for each class and each group. For each student: a text of the case for the final workshop, descriptions of stakeholders groups and ballots for voting are prepared.

Results and discussion

Table 1 represents a summary of the ATL classes held in this case study.

Table 1. *Summary of scenarios of ATL classes Multidisciplinary approach to aquaculture development, water and fish quality, and a case study*

Professor responsible for the ATL class and scenario author	Topic of the ATL class	Objectives	Assignement and lesson flow	Appendix/inclosure
Zorka Dulić, Environmental aspect	Water quality parameters and needs of aquatic organisms	1. to recall abiotic environmental factors thought in Zoology course in the 1st year and to understand the notion of water quality 2. to link knowledge on abiotic factors in aquatic ecosystems with ecological needs of aquatic organisms (fish and invertebrate) 3. to find out and understand which are the most sensitive and the most tolerant groups according to different parameters, to classify them into eurivalent or stenovalent organisms for different parameters	Students have to read and understand the text in the appendix in order to fill in the table 2 by writing values of different water quality parameters suitable for each fish species and daphnids, as well as to align species from the most to the least sensitive. Work in groups to finish the table (15 min.). Reporting of each group (5 min. each). Discussion lead by the professor about the level of sensitivity, species sensitivity, effect of age etc. to the classification in steno- or eurivalent organisms.	Text about water quality and values of parameters: temperature, DO, pH, electroconductivity, hardness, phosphate for different fish species and Daphnia Table 2 to be filled in

Vesna Davidović, Physiological aspect	Influence of different stressors on physiolo-gical and immunolo-gical parameters of stress reactions in farmed fish	1. To remind students what is homeostasis and neurophysiological mechanisms of stress reaction in vertebrates. 2. To remind students the most common stressors in farmed fish. 3. To connect knowledge about stress with physiological and immunological indices of stress response in fish.	Students have to select terms related to 1. Homeostasis, 2. Stressors and 3. Stress indicators. Work in 3 subgroups to separate terms and then group conclude whether they are properly selected (10 min.). They also have to determine rearing conditions that can affect physiological and immunological stress indicators values in fish. Reporting of group representatives (5 min. each). Discussion lead by the professor about generalized neuroendocrine response and fish adaptive mechanisms in maintaining homeostasis during primary and secondary stress response, as well as systemic changes in the tertiary response due to an inability to adapt to the stressors.	• Table 3 in which different terms given in a separate list have to be distributed into 3 columns (homeostasis, stressors, and stress indicators). Among the terms there are words that refer to one of the 3 given categories, but also words that are not connected with any of the 3 categories can be offered. • Diagrams and drawings showing the course of the fish stress response via hypothalamic-pituitary-interrenal axis.
Renata Relić, Health and welfare aspects	Influence of the environ-ment (water) quality on fish welfare	1. To remind the students on the concept of farm animals' welfare 2. According to the given model, the students should note and set aside fish welfare indicators that point to inadequate water quality	Students have to read and understand the text in the appendix in order to fill in the table by writing fish welfare parameters that refer to poor quality water. Work in groups and finishing the table up to 15 min. Reporting of the each group representative in the next 10 min. After the specific list of welfare parameters is formed, professor and students discuss about chosen parameters.	Table 4 with the task "Comparative review in cattle and fish: the needs and welfare parameters according to the farm animals' welfare concept". Cattle welfare parameters in the table are related to the inadequate environmental conditions. Common welfare parameters in fish are listed below the table.

Marko Stanković, Production aspect	Production systems of fish and effects on water and product quality	1. to remember fish culture systems and understand differences between systems 2. to link knowledge about fish culture systems with abiotic environmental factors for aquatic environment 3. to be able to decide which species can be cultured in each system depending on environmental conditions 4. to conclude about product quality in relation to water quality and production system	Students, distributed in groups, have to read and understand the text in the appendix in order to fill in the table 5 by writing names of fish species (carp, trout, African catfish, pangasius, herbivorous fish) into the corresponding table cell, depending on culture system and range of values of water quality parameters (15 min.). After reporting of each group (5 min. each), a discussion led by a professor about fish meat quality compared to water quality. Formulation of conclusions.	Text about fish culture systems in Serbia and in the world. Water quality parameters to be respected for each system and short characteristics of Serbian aquaculture to remind students what was thought during aquaculture classes with special emphasize on possibilities of further development of Serbian aquaculture. Table 5 to be filled in.
Vesna Poleksić, Final workshop	Workshop – Case study Bilateral cooperation Serbia-Vietnam: gunshot on Serbian aquaculture or chance for Serbian economy	1. to develop ability of case analysis, problem solving, and professional decision making, as well as presenting results and explain professional decisions made 2. to develop skills of intra and intergroup cooperation, effective communication, dialogue, discussion and conclusions formulation	After a month of preparation a Final workshop - parliamentary debate is organized. Students play their respective roles of stakeholders during the final workshop. After a short introduction by a professor (5 min.) each stakeholder group prepares a 10 min. presentation of their group recommendation to the government (40 min.). Follows a "parliamentary" debate: questions asked by members of the parliament and stakeholders, moderated by the president. (30 min.). Voting and final decisions and conclusions of students and professors. (5 min.)	**Case study** Details in the text

The 1st ATL class – Teacher Zorka Dulić: Water quality parameters and needs of aquatic organisms

ATL method: students distributed randomly in groups (4 - 6) have to fill the table (Tab 2).

Table 2. *Assignement for the 1st ATL class: using the text given in the appendix fill in the table by ranges of values for each parameter and aline species according to their sensitivity in relation to each environmental factor*

Water quality parameter	Species of aquatic organism							Order of species from the most to the least
	Carp	Trout	African catfish	Herbivorous fish	Salmon	Pangasius	Daphnia	
Temperature (t^oC)								
Dissolved oxygen (mg/L)								
pH								

Ammonia (mg/L)								
Electroconductivity (μS/cm)								
Phosphate (mg/L)								
Hardness (^{o}dH)								

The 2nd ATL class – Teacher Vesna Davidović: Influence of different stressors on physiological and immunological parameters of stress reactions in farmed fish

Table 3. *Assignement for the 2nd ATL class: Distribute the terms offered in 3 categories: isotonia, food quantity, cortisol concentration, isotonic point, hatch density, glucose level, isohydria, manipulative fishing operations, total protein level, total immunoglobulin level, hypocalcaemia, blood sampling, thyroxin concentration, hypothermia, good quality food, parathormone concentration, hypomagnesaemia, control measuring, satisfying water quality, hematuria, air temperature, progesterone concentration, calciuria, predators presence, adrenaline concentration, acidosis, surrounding noise, insulin concentration, isothermia, androsterone concentration. Note that there are some terms that do not belong to any of the 3 categories*

Homeostasis	Stressors	Stress indicators

The 3rd ATL class – Teacher Renata Relić: Influence of the environment (water) quality on the fish welfare

Assignement for the 3rd ATL class: each group fills in the table and explains group decision

Table 4. *Comparative review in cattle and fish: the needs and welfare parameters according to the farm animals' welfare concept*

N^{o}	CATTLE		FISH	
	Animal needs	Parameters* (examples)	Animal needs	Parameters** (enter into the column)
1	**Adequate living conditions** (i.e. appropriate microclimate and hygiene in the stall, protection from bad weather and predators, comfortable place for resting and movement)	• air temperature too high • poor ventilation • no shelter • easy access of predators • slippery floors • wet bedding	**Adequate environment**	
2	**Proper feeding and watering** (i.e. permanent access to the sufficient quantity of quality food and water, in accordance with the needs)	• insufficient width of the feeding space • insufficient number of the waterers	**Proper feeding**	

3	**Expression of normal behaviour** (i.e. animal housing in facilities that allow sufficient movement and expression of normal behaviour)	•apathy •anxiety •excessive salivation •reluctant movement, rising etc.	**Expression of normal behaviour and possibility to avoid predators**	
4	**Adequate social interactions** (i.e. placement in the appropriate group or separately, in accordance with the type and category)	•aggressive behaviour •submissive behaviour	**Adequate social interactions**	
5	**Protection from disease and injury** (i.e. absence of pain, suffering, illness and injury, the timely provision of professional help)	•body injuries •skin diseases •respiratory diseases •death	**Maintaining good health**	

* Indicators of welfare may be from the environment (environmental characteristics) and from individuals (health, production, biochemical, and behavioural indicators); each indicator consists of measurable properties - parameters (e.g., microclimate in object consists of temperature and humidity, the amount of dust, brightness and other properties whose values can be measured).

** Common welfare parameters of fish are: mortality, body injuries (skin, fins, eyes etc.), presence of diseases and parasites, feed conversion rate, growth, condition factor, swimming behaviour, eating behaviour, fertility, respiration rate, levels of plasma protein, immunoglobulins, glucose, cortisol, enzymes, lysozime and other substances from blood and excretions, phagocyte respiratory burst, values of the water temperature, pH, dissolved oxygen, nitrogen compounds etc.

The 4th ATL class – Teacher Marko Stanković: Production systems of fish and effects on water and product quality

Table 5. *Assignement for the 4 ATL class: Names of following fish species should be put in the table in a corresponding table cell, according to production systems and vales range of environmental factors: Carp, Trout, Salmon, Pangasius, Herbivorous fish, African catfish*

Parameters	Earthen pond	„Riceway“	Cage system
Temperature 20-26^{o}C DO >5 mg/L pH 6.5-8.5 Ammonia <0.5 mg/L			
Temperature 12-16^{o}C DO 7-11 mg/L pH 6.5-8 Ammonia <0.025 mg/L			
Temperature (15-19^{o}C) DO (7-9 mg/L) pH 6.2-7.8 Ammonia (<0.02 mg/L)			
Temperature (22-30^{o}C) DO (2.5-7.5 mg/L) pH 6.5-9.5 Ammonia (0.7-1 mg/L)			

Temperature (20-30^{o}C) DO (>5 mg/L) pH 6.5-8.5 Ammonia (0.2-1 mg/L)			
Temperature (23-28^{o}C) DO (>4 mg/L) pH 6-7 Ammonia (<0.3-2 mg/L)			

Final wrkshop

Approximately 30 students obtain „from a hat", their respective roles of stakeholders that they have to play during the final workshop: Serbian government, importers lobby and producers and weapon traders; Association of Serbian fish producers; Professional public opinion; Consumers' association and media; and Members of Serbian parliament. Depending on the number of students in the generation each stakeholder group is comprised of 4 to 5 students, the 5th stakeholder group of parliament members may be larger. All students receive Appendix 5 – the case, and the list of stakeholders. They have one month to prepare their roles of stakeholders.

Appendix 5 for the Final workshop:

Case study: Bilateral cooperation Serbia-Vietnam: gunshot on Serbian aquaculture or chance for Serbian economy

Serbian government concludes an agreement with the government of Vietnam. Important incomes are expected from export of weapons and possible engagement of Serbian building companies in Vietnam. The government keeps the agreement secret, but part of it are published in media: in the next 5 years together with weapon export and possible building companies engagement, there is import of 10 000 tonnes of pangasius filets per year from Vietnam. Parts of the agreement published are those concerning Serbian export of weapons to Vietnam, and still not precised, building Vietnamese infrastructure that will bring employment to the Serbian industry, and cheap source of protein in Serbian population diet. On the other hand media raise public awareness about the Serbian aquaculture industry that is seriously endangered by pangasius import, which is part of the agreement. The public opinion demands the agreement to be published and a government organizes a public debate in the parliament where all stakeholders will address the assembly. Finally a vote will be organized in order to decide the following: will the parliament ratify the agreement Serbia-Vietnam?

Roles of stakeholders:

1. **Serbian government, importers lobby and producers and weapon traders**. Students have to prepare themselves by studying economic relations between Serbia and Vietnam and/or the rest of the world: types of agreements in the area of agriculture and food production, international regulation, cheap imported fish linked to the large export of weapons and possible engagement of building companies i.e. their workers.

Within this stakeholder group roles can also be divided: prime minister, weapon producers and traders, importers etc…

2. **Association of Serbian fish producers**: Serbian producers are gathered in the Association. Students have to prepare themselves by remembering and studying freshwater aquaculture; carp flesh quality vs. pangasius flesh quality; environmental conditions for carp and pangasius rearing, advantages of carp culture; multifunctional use of carp ponds, part of the Central European tradition. The interactive class held concerning aquaculture will show its importance since its appendix shows the potential of Serbian aquaculture.
3. **Professional public opinion:** Faculty of Agriculture, Faculty of Biology, Faculty of Veterinary Medicine, nutritionists, Chamber of commerce: fish production, water quality, ecology, tourism, quality of water for pangasius culture, effects on meat quality, panga meat vs carp meat quality, fish diseases, traditional carp production in earthen ponds, multifunctional use of carp farms, rural development.
4. **Consumers' association and media**: flesh quality of carp, trout and other species vs. panga meat; levels of protein and lipids, fatty acids composition and quality; healthy diets; management of consumers' perception, marketing, freedom of choice, protection of Serbian fish producers and Serbian economy.
5. **Members of Serbian parliament**: this stakeholder group has to study all aspects mentioned for the other groups in order to prepare for the final debate. This group can be larger than the others, depending on the number of students in the generation; one of them is President of the parliament and moderator of the discussion.

Active teaching/learning will be practiced on 4 introductory ATL classes, in preparation for and during the final workshop. This conception of teaching/learning scenarios gives chance to rise following students' activities: critical reception of information, evaluation of information, argumentation, negotiation, usage of professional language (professional discourse), reasoning about science information in social context, professional decision making, work in a team of professionals, presentation of the decisions taken, answering questions based on their professional knowledge, and solving the problem set in a case. The 4 introductory ATL classes serve to remind the students on topics they had already learnt, together with a 30 days period during which groups of students will prepare themselves for the Final workshop.

Roles of the teachers in such ATL classes and a final workshop will be to: shortly introduce the topics and assignments; follow students' assignment realization; answer the questions; help solving dilemmas; monitor students' inclusion, and stimulate activities in the group; encourage students to ask questions; listen the results presented; ask questions; conclude if the goals are achieved, and lead discussions at the end of each class. At the final workshop when a student plays a role of Parliament president teachers will help drawing final conclusions and formulating the decision.

The final workshop is announced in advance, all the teachers should be present. The case imagined as well as the introductory ATL classes meant to recall what has already been studied during previous courses, should enable students to reflect about and take responsibility for their own learning as suggested by Pešikan (2005), and Fitzmorice (2010). Students are placed in situations similar to real life problems. They practice application of the acquired knowledge. An increase of student motivation for learning and development of their professional and social skills, including transfer of knowledge and its application in new situations is also expected (Pešikan et al, 2006). This exercise is planned for the next school year and results will be presented in another paper (Part 2: Results of the interactive exercise).

Teachers of the Faculty of Agriculture defined following competences required for agricultural professionals: acquire modern knowledge in agricultural sciences; develop agriculture and food technology sector; apply knowledge and professional innovation; knowledge presentation and transfer to non-professionals; food risk-communication; and a number of generic skills (Pešikan, 2005). These competences will be much efficiently attained by creation of a suitable learning environment and the use of active teaching/learning methodology. A multidisciplinary approach in ATL implementation should enable students to develop skills to achieve a wide range of learning objectives. The interactive exercise planned should confirm this consideration.

Conclusions

A multidisciplinary approach proposed in this paper should contribute to better learning by practicing group work, critical reception of information, evaluation of information, argumentation, negotiation, usage of professional language (professional discourse), reasoning about science information in social context, professional decision making, presentation, and defense of the chosen solution as well as training for a democratic debate, respect of opposed opinions and other generic skills that are exercised in a debate foreseen for the final workshop.

We believe that a still dominant teacher-centered classical teaching method cannot fully achieve learning objectives needed for agriculture professionals unlike a musltidisciplinary approach in the implementation of ATL that may enable development of competences required for agricultural sciences.

Acknowledgement

This work was supported by TEMPUS project "Building capacity of Serbian Agricultural Education to link with Society, CaSA" 544072-TEMPUS-1-2013-1-RS-TEMPUS-SMHES and project of Ministry of Education and Science of the Republic of Serbia (project No 179018 "Identification, measuring and development of cognitive and emotional competences important for the society oriented towards European integration/Identifikacija, merenje i razvoj kognitivnih i emocionalnih kompetencija važnih društvu orijentisanom na evropske integracije").

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