A Web-Based System for Personalized Learning Path Tracking of Doctoral Students

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Abstract - High-quality training of doctoral students for valuable and thorough scientific research imposes high academic standards. The new academic generation of young scientists needs to be trained in creativity, critical thinking and autonomous intellectual conclusions. Doctoral students need to find suitable conditions for work, so that they can become independent researchers who at an early stage take responsibility for the scope, direction and progress of their projects. This defines the main purpose of doctoral education, which needs to be led at a high academic and methodical level. The highly acclaimed and well-popularized doctoral information system, developed at the University of Ruse, provides a wide array of possibilities for personalized learning path tracking. This enables the status of each doctoral student to be determined accurately and timely. The software allows for keeping detailed portfolios for each participant, and makes generation of various progress visualization tools, such as reports and graphs, effortless. Generating reports quickly and efficiently is an important benefit, compared to the conventional manual methods widely used in educational institutions. The paper explores the developed software system, and provides some sample analysis based on personal learning paths of doctoral students enrolled in the recent few years.

Keywords - personalized learning path, doctoral, education, software, web

I. INTRODUCTION

The advancements of information and communication technology and of the World Wide Web has led to the digitalization of society in nearly every aspect. Long gone is the time when discussions on the need or benefits of information systems designed to track and augment education in higher education institutions were relevant.

Doctoral students of the digital age expect to be able to use information technology in their everyday research. Some interesting observations have been made in [1] about the use and adoption of information services and web-based environments for research work.

The strive towards improving the quality of service [2] for doctoral students in higher education schools, securing verified and reliable information about their education and activity and the need for evaluation and improvement of the activities related to the planning of educational and administrative work with doctoral students, effective feedback and coordination of the interoperability between administrative structures, scientific supervisors and doctoral students, impose the use of a specialized Web-based software solution to serve all information flow needs related to doctoral degrees [3, 4].

A survey has been conducted on the different approaches and tools employing services and practices that contribute to the doctoral degree process [5, 6] – at the beginning, when a degree position is opened, as well as in tracking and administration of the following stages of the educational process [7]. The available information resources and systems are strictly specific, depending on the particular requirements of each scientific organization and the legislative framework of each country. A complete global study of doctoral education around the world has been conducted in [8], and some useful ideas and suggestions for its improvement have been discussed. A four-quadrant supervisory style management grid based on the Blake and Moulton Managerial Grid Model has been proposed in [9], aiming to improve the style of management of doctoral students; it is currently in use in Australia.

During the development of the Web based System for Doctoral Students at the University of Ruse, the design has mainly been aimed at its biggest potential user groups, namely doctoral students and their scientific supervisors. This has ensured the focus was aimed towards building a high-quality user-centered information system, where the driving forces of the education process itself – doctoral students and their supervisors – are placed.

II. BACKGROUND

The comparison and analysis of different viewpoints [10, 11] about the multidimensional phenomenon that is the individual educational path leads to the summary that in the system of continuous, multi-level education, this term can be described as a process of acquiring a specialized education or degree, with targeted, continuous pedagogical support [12, 13].

Individual learning paths are closely connected with the selection of a future researcher [14, 15], the awareness of personal responsibility for their choice, and the formation of an initiative for their own development [16, 17].

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feedback and coordination of the interoperability between administrative structures, scientific supervisors and doctoral students, impose the use of a specialized Web-based software solution to serve all information flow needs related to doctoral degrees.

An original Web-based software system, which strives to aid the administrative division dedicated to doctoral students, the scientific supervisors and the students themselves, is presented in the paper; the system aims to be useful at all stages – admission, education, monitoring, reporting and automation of all activities related to doctoral degrees at the University of Ruse, while also complying with legislative documents and norms.

The innovative software system for management and reporting of the educational and administrative activities related to doctoral degrees deployed at University of Ruse has contributed to the optimization of the process of tracking, reporting and coordination of all entities involved - research units, the university-wide department for doctoral students, scientific supervisors and doctoral students. The system’s information database is being used for research and analysis of the critical factors, which ensure the standardization and unification of the informational processes and the optimal distribution of the resources of different types of doctoral degrees.

The system for doctoral students has been in active use since 2016, with 312 doctoral students, 189 candidates, and 216 scientific supervisors’ profiles registered to date. A detailed profile is maintained for each doctoral student currently enrolled in one of the degrees offered by the university. The new competitions for doctoral degrees are scheduled and announced via the system, giving candidates the ability to apply for these degrees and track the admission process entirely online; the online admission strictly complies with the time slots and deadlines outlined in the university’s internal regulatory framework.

III. EXPOSITION

A. **User Interface and Profile for Doctoral Students**

As far as documentation is concerned, the education of doctoral students is monitored and regulated using a well-developed and applied system of standard document types (personal learning plan, training curricula, reports, etc.). It is important to note that, taking into account the existence of a wide array of universities and scientific/research organizations, each with its own internal documentation used for the organization of doctoral education, this system is somewhat liberalized. Even so, problems related to the systematization of the information from the development path of the doctoral student.

Summarizing each separate position of the preliminary systematization represents the original idea, and is a true roadmap of the path, which the doctoral student needs to follow in their work on their dissertation. The roadmap details each particular activity and can be thought of as a “passport” of sorts of the future research.

After a study of the main processes related to the admission and education according to the Bulgarian Law for Higher Education was conducted, it was summarized that the information system needs to support entering and maintaining of the following information:

- Data about doctoral students;
- Data about academic staff, serving as scientific supervisors;
- All required documents and their supporting data;
- Data about the currently active admission competitions;
- Reports required by the Ministry of Education and Science;
- An individual work plan for each doctoral student:
  - Type of doctoral degree;
  - Date of enrollment;
  - Term deadline;
  - Date of dissertation finalization;
  - Dissertation topic;
  - Scientific supervisor(s);
  - Basis for admission/acceptance;
  - Mid-degree exam data;
  - Dissertation defense data.

The scientific work of a doctoral student should also be tracked:

- Conference participations;
- Developed projects or project participation;
- Specializations;
- Published articles;
- Participation in the undergraduate learning process – conducted seminar-type/laboratory workshops.

The quality of a research product is a function of a multitude of factors, which are consistently applied and of a synergistic nature. The generated high values of quality up to a point can be “spent” in a subsequent stage and therefore will not multiply into a collecting effect.

The web based system supports and maintains profiles of doctoral students, and thus allows storing, updating and displaying up-to-date information of their current state and the activities that they need to execute in relation to their doctoral degree. The system provides the capability to publish every doctoral student’s individual learning plan, with the option for themselves and their scientific supervisors to view and track deadlines and important stages related to periodical reporting and the overall conformity to the procedure. It also allows students to view the administrative documentation, maintained by the university’s Department for doctoral students in accordance with the legislative requirements. Information about educational credits is also collected and summarized, ensuring that academic mobility is also supported.

A doctoral student’s profile is shown on Fig. 1. It is separated into several different panels. The profile stores data and documentation related to the particular student’s degree. The main panel allows for monitoring the latest activity related to the particular doctoral degree. The progress bar, for example, is a notably useful function through which the time period of the doctoral process can be tracked in a visual manner.
B. User Interface and Profile for Scientific Supervisors

It should not be forgotten that the first mentor, reviewer and the person who should encourage each doctoral student is their scientific supervisor.

Along with doctoral students’ profiles, a profile for each scientific supervisor is also maintained in the system. Supervisors have two main panels available, which they can use to view and manage their assigned doctoral students; they can also manage any degree and competition proposals from their profile page. If such need arises, scientific supervisors also have a limited ability to monitor and edit their doctoral student’s electronic profiles.

A sample profile of a scientific advisor is presented on Fig. 4. They can see and manage the two doctoral students assigned to them.

C. Personal Learning Path and Tracking

During each doctoral student’s enrollment, it is required that an individual learning plan is developed by students and their supervisors, and verified by the corresponding scientific organization. This document is individual to each of the doctoral students, but, to make the process easier, at the University of Ruse there exists a sample plan, which can be used as a guide for doctoral students and scientific supervisors preparing the plan. The document should outline each activity that the doctoral student needs to perform in order to pass the minimum requirements (defined by the legislative norms). An example graph - spiral of development – is presented on Fig. 6. Such a graph can be drawn for each doctoral
student, based on the planned activities and deadlines in the individual plan.

Figure 6. A spiral diagram of a doctoral student’s development

Full-time doctoral students are enrolled for a three-year period, at the end of which they must present and defend their work. The minimum number of activities included in each individual plan are about 30 and are presented on Fig. 6. These can include educational courses, reports, conference participations (with scientific articles or papers), writing of the different chapters of the dissertation (Bulgarian dissertation usually include four chapters), defenses and presentations (a preliminary – internal - and a final one – external). Unfortunately, a small percentage of doctoral students actually manage to defend their dissertation work in the allocated three-year period. The system stores data about every essential activity along with its expected date of completion. On Fig. 7, a model of a trend graphic is proposed; this model can be used to track the doctoral student’s overall progress. A trend diagram can be plotted based on each individual plan; the doctoral student should try to follow the trend curve as closely as possible. If their plot is below the trend curve, this should be a signal to them and their scientific supervisor that they might be behind and should take timely measures in order to defend their dissertation in time.

Figure 7. A trend diagram of a doctoral student

In order for the process to be compliant with the law, each procedure needs to be presented as a logically ordered aggregation of documents (e.g. orders, reports, certificates, etc.), which describe and elaborate the implementation of all activities in the individual plan. This documentation is stored in the doctoral student’s electronic portfolio; every document is signed, stamped, scanned and stored alongside a description, date of issue and various other pieces of metadata, so that the document can be analyzed if needed.

The Web based system maintains a database to help track all stages of the doctoral degree, their sequence and timeline and offers doctoral students and their supervisors the ability to track the up to date schedule using a Gantt chart, which takes into account all important steps of the process – both the ones initiated by the educational institution and the ones initiated by the student or supervisor. A sample chart is presented on Fig. 8.

Figure 8. A visual representation of the Personal Learning Path and progress

The tracking of doctoral students’ learning path is essential for the effective and timely evaluation of their progress. The proposed graphics aim to better visualize doctoral students’ progress, and will help doctoral students better monitor their development process and evaluate the required effort needed to achieve their final target – defending their dissertation. This functionality is also useful to scientific supervisors, who can better control and adjust the process in case it gets behind the planned timeline or pace of development.

D. Administrative staff control panel. Reporting and statistics.

While scientific supervisors are responsible for the education of their assigned doctoral students, the whole process is usually also controlled by a centralized administrative department. At the University of Ruse, this is the Department for doctoral students. The process of management, control and decision making in the preparation of doctoral degree students requires timely access to up to date information for each student. This is achieved using the Web based system’s administrative module. Of particular note is the recently developed reporting package, which allows easy status monitoring by means of different types of graphs, charts and reports, which can be customized by specifying various criteria. On Fig. 9, a view of the module is presented, with a few of the dynamic charts plotting various data points related to data for doctoral students in the past 5 years.
Data about the personal path of each doctoral student at the University of Ruse is stored in the common database, and, when needed, generalized reports can be generated from the learning path data. For the purpose, a module for quick, dynamic reports on doctoral students based on various criteria has been developed; this module makes statistical analysis and processing significantly easier, as users can select only the data points and criteria they need for the particular report. This is especially useful for reporting on a university and national level, which are periodically required by various university entities and the Ministry of Education and Science.

A screen from the dynamic reporting module is presented on Fig. 10.

The reporting section allows generating report tables for every doctoral student in the university by applying different criteria and filtering by: faculty, by scientific specialty, full-time/part-time, etc. Some of the reports are regularly used in the process, so they have been prepared in advance using static database queries; however, to extend the system’s flexibility, dynamic reports can be created by making use of the dynamic report editor.

The report editor allows the administrators to create reports with user-defined columns and filters. This enables an effortless report creation and execution; most of the reports would otherwise require writing additional code or changes to entire modules of the system. As well as the columns, the filters are also user-selectable. Each report is saved as a template in the database and can be executed at any given time. Being saved as a template means that when the report is recalled at a later point of time, it will always be based on the most up to date data.

The report management module is shown on Fig. 11. It is used to manage and run the reports created via the dynamic report editor. Each report can be displayed as a HTML file or exported to Microsoft Excel for further processing or analysis.

IV. CONCLUSION

The web based system for doctoral students is being tested and validated in real conditions and has been deployed for use at the “Angel Kanchev” University of Ruse. Its use helps the university’s administration, the scientific supervisors and the doctoral students in many routine operations and facilitates the work related any procedures accompanying the doctoral degree’s progress tracking. It ensures access to a verified, operative information set related to doctoral students and their educational and academic development. The automated deadline, timeline and stage tracking allows for monitoring of the quality of education of doctoral students.

The training of doctoral students is a complex process, which requires an innovative, contemporary toolset for management and reporting of the different educational activities; inherently, this allows for a higher quality tracking of each stage in accordance with the legislative requirements for doctoral degrees. The creation and refinement of a Web based information system for doctoral students ensures automation of the processes related to tracking and documenting the student’s progress throughout their degree; this assures the credibility of the information of the current status of the training of all doctoral students throughout the university.

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