Developing nursing informatics curriculum

Speaker: Ms Imola Jehoda
Semmelweis University Faculty of Health Sciences Library
Budapest, Hungary

Author: Ms Imola Jehoda

Background: The nursing informatics is an important part of the health science curriculum on many levels of nursing programs across the world. Sweeping changes in health care gives urgency to the call to transform nursing curricula so that new competencies could more closely match practical needs.

Aim: This paper is a report of an integrative review of nursing informatics programs. The purpose is to describe the findings of the review to understand the current state of informatics integration within basic nursing curricula.

Data sources: The Ovid CINAHL, Ovid Nursing Database and MEDLINE, EBSCO CINAHL with Fulltext, EBSCO Health Source: Nursing/Academic Edition and ERIC, PROQUEST Nursing and Allied Health Sources, PUBMED electronic databases were searched for the period 1991 – 2008 for research based papers published in English. Manual searching as scrutiny is an additional method.

Findings: Inclusion criteria of the study were defined. The integrative review was conducted and each paper was explored in relation to: design, purposes, sample, outcome measures and results. Comparisons between study findings are difficult to make because of variation in methodology, settings and sample characteristics. There is limited empirical evidence addressing the use of computer technology, skills and competencies.

Conclusions:
1.) The outcomes of the study are important to guide curriculum development in meeting the changing health care environmental demands for quality, cost effectiveness and safety.
2.) Information literacy and computer literacy are critical to the future of nursing.
3.) Nursing science programs must integrate the contents of complex informatics and competencies into their curricula to prepare nurses for future missions.

Background

After the first attempts to make data processing automatic, there was no doubt that healthcare would be among the important areas of application.

As early as in the second half of the 19th century, Florence Nightingale laid down a fundamental principle of her activity, namely that the preparation and execution of every decision needs accurate data. (1) This data collection and processing, in accordance with the development of technology, first happened using punch cards and later punched tapes. The sudden dynamic development of both the creation of theories regarding this and the related functional data processing was given rise to by the invention and installation of ENIAC (15 February 1946), the predecessor of modern computers. (2) Computers functioning on a large scale, were only usable and economically operatable under conditions of large-scale production, handling large amounts of data. In the 1970s another technological invention, the silicon chip helped the huge cathode ray tube computers become smaller leading to the spread of computers that could be placed on a desk, which were first known and used as desktop- later as personal computers.

The new tool (hardware) speeded up and made possible the development of programs and software needed for the diverse applications and the customizable, service-oriented data management. The first hospital applications are reported to have happened in the 1970s. (3) After the appearance of the software applied in diverse areas of healthcare in the 1980s, the end-user applications were constructed too in almost every field of curing and research. The further development of these - the appearance of the web-based services - was fostered by the faster and faster expansion of the information infrastructure. (4)
The work carried out by using tools of information technology and the increasing number of employees gave rise to the attribute "information society" characterizing society's level of development due to the high amount of research examining the spread of tools and programs in society (culture, recreation, new types of telecommunications channels).

The necessity of treating "Nursing Informatics" (hereinafter NI) as a separate discipline first arose at the session of American Nursing Association in 1960. (5) The technical literature started to publish contributions about the topic of "computer applications in nursing" in the 1970s. (6) Numerous research projects were started, and numerous trade associations and academic associations published their views on the subject, predominantly in the USA. Research regarding the application was started and the International Medical Informatics Association held the first conference on NI in 1982. The steady growth of computer applications made it necessary to train the end-user workforce, i.e. to introduce IT subject at every level of nursing- and medical science education. Numerous theoretical models were created about how to compile their contents and curricula, among which the Conceptual Framework of Nursing Informatics published by Graves J. and Corcoran S. in 1989 was exceptionally prescient. According to it NI is nothing but "a combination of computer science, information science, and nursing science designed to assist in the management and processing of nursing data, information, and knowledge to support the practice of nursing and the delivery of nursing care." (7)

In the same year, Grobe S. was one of the first nurse informaticians to write about the importance of incorporating the competencies into nursing education. (8) The American Nurses Association, in an issue of "Scope of Practice for Nursing Informatics", was the first to define and publish their governing principles, which already included the competencies required at all 3 levels of education. The grouping of these is as follows:

* Minimum Information Competencies for the Profession (general level)
* Nurse Informatics Practice (bachelor level)
* Specialist Practice in Nursing Informatics (12 competencies of master level)

These have since been combined into a single document and have been updated twice. (Last updated in 2008.) (9)

The implementation of the programs belonging to the courses is possible in various forms, for which Zytkowski M. mentions some patterns. (10) The further improved structure of Turley J.'s Nursing Informatics Model (1996) is also based on the organic unity of the three part disciplines, "These circles (three intersecting sciences) overlap to form Informatics at their core.", and the planning of NI curricula is still based on them. (11)

One of the important milestones in determining and developing the elemental course competencies is the study done in Delphi by the three nurse informaticians (Staggers N, Gassert C, Curran C.). Based on that study there are 22 elemental competencies that need to be acquired, as the integration of knowledge, skills and attitudes in the performance of various nursing informatics activities. The four major competencies were ordered beside them: beginning nurse, experienced nurse, informatics specialist and informatics innovator. They identify 300 competencies for the four levels of qualification. (12)

Besides that, academic research continuously tried to explore and clarify the contents of NI, which started to develop dramatically in the '90s. They were trying to do so especially with the contents of Nursing Science, aiming for standardization. Saba VK. (13) published his systematizing work, based on a national sample of home health care patients’ records, titled Home Health Care Classification, in which he identified nursing diagnoses and interventions. (14)

The new definition of NI by the American Nurses Association was published with the results of this work already included. The definition approached the third area, nursing science complementing the other two areas of science (computer science and information science) as follows: "It encompasses a nursing theory such as the nursing process, a nursing model, and a nursing vocabulary such as the Home Health Care Classification (HHCC)". (15)

One of the most detailed progress reports about the NI specialty is contained in the summarizing work „A National Informatics Agenda for Nursing Education and Practice”, (16) which, besides clarifying the academic principles, introduces education models and practical applications and determines the acquisition of educational contents and practical skills, which are based on surveying the needs, as an aim for the future. In the last decade of the last century the usage and support of NI and developed IT began to spread even in the subfields of nursing science, including both the clinical specialties and the patient education. Informatics is
foundational to all areas of nursing practice, and the healthcare environment is particularly demanding on nurse practitioners.

On the recommendation of Staggers N. (17), the academic foundations of NI were expanded, and the standards regarding the curriculum and accreditation were put into the new edition of "Scope and Standards of Nursing Informatics Practice". (18)

The outstanding achievement of the 2000s, supporting the NI specialty, was the development of the TIGER Initiative: Addressing Information Technology Competencies in Curriculum and Workforce (TIGER = Technology Informatics Guiding Educational Reform). The summit was attended by the four largest professional associations:

- the American Nurses Association (later AACN) representing the nurse practitioners
- the National League for Nursing and American Association of Colleges of Nursing representing nurses in education
- The American Organization of Nurse Executives representing administrative nurses
- and in consideration of the importance of the topic, the American Nurses Association Dean's meeting joined too.

The four largest associations represent more than 2 million nurses and at the summit they were joined by 45 smaller specialized professional associations.

The accepted initiatives declare that the informatics is a professional key competency in the 21st century. Because of that, the required informatics competencies have to be built into the Nursing Curriculum at every level of education and the usage of the necessary IT tools have to be taught in order to establish these competencies. (29,53,54)

The other notable NI statement was made by the National League for Nursing (NLN), titled: "Preparing the Next Generation of Nurses for Practice in a Technology-Rich Environment: An Informatics Agenda." It calls on educators to advocate that all nursing graduates have up-to-date skills in computer literacy, information literacy, and informatics. The new position statement requires faculty and curricular initiatives development in information technology. The goal of the federal government was as follows: most Americans should have an electronic healthcare record by 2014. (20)

Even in these days, numerous forecasts are created regarding the future of NI. The topic is dealt with in the fullest detail by the Nursing and Informatics for the 21st Century. (21)

The authors still accept and carry on the concept of NI, but they define the contents of the concept in a wider range. (Not just NI, but Nursing and Informatics) This is also revealed by an interview made with one of the authors, Delaney CW. (22)

"… informatics includes the core that combines information science and computer science; this core is coupled with a discipline [for example nursing]. It is important that all disciplines have their discipline – specific informatics, whether it is pharmacy, medicine, nursing or public health. Taken together, there’s also a common health informatics core that we all share.” … “The (nursing) educational need right now is for every nursing graduate, from curricula from all nursing programs, to graduate with computer and informatics competencies. They are then prepared for practice, teaching and research in this world that is so strongly defined by technology and informatics.”

We conclude that NI plays an essential role in the future directions of healthcare, and in the relationship between nurses and information technology.

**Methods**

**Aim**

This paper is a report of an integrative review of nursing informatics programs. The purpose is to describe the findings of the review to understand the current state of informatics skills – computer literacy and information literacy – integration of nursing science curricula at all levels.

**Design**

An integrative review method was used to identify the literature published to determine the state of knowledge and development of nursing informatics, particularly to imply health- and nursing informatics research, theoretical matters and implementation in nursing science.
Inclusion / exclusion criteria
The papers reviewed
- were published between 1991 and 2008
- evaluated or assessed skills of nursing informatics
- examined nursing informatics educational programs in the context of nurse education
- included nursing informatics curriculum development programs
- had empirical evidence: implementation of the nursing informatics competencies in the practice
- included a sample of nurses from all levels and types of nursing education
- could be implemented in any country
- had full texts accessible

Papers were excluded if they were
- not available in English
- conference or congress matters, published in proceedings
- dissertations
- books, book chapters.

Search methods
Literature searches were conducted November to December 2008 and January to 24 March 2009.
Eight electronic databases were searched:
- OVID MEDLINE
- OVID CINAHL
- OVID Nursing Database
- EBSCO CINAHL with Full Text
- EBSCO ERIC
- EBSCO Health Source: Nursing/Academic Edition
- PROQUEST Nursing and Allied Health Sources
- PUBMED

The search started with the permutation of "Health Sciences Education or Nursing Education" AND "Nursing Informatics". MeSH headings and other specific database headings, relevant keywords, free text terms were combined as appropriate to focus the search on the specific topics. These searches led to a variety of papers focusing on several fields of nursing education.
To avoid excluding relevant articles, the general subject terms were explored without limit, and specific subject terms were added: <curriculum>, <competencies>, <program development>, <program evaluation>, <information literacy>.
Citation tracking and scrutiny of reference lists were also undertaken in the search for additional papers. A manual search was further conducted to locate other relevant works.
The same inclusion criteria were used for searching: papers to be included if they were ones published between 1991 and 2008 in English and links were provided to the full text. The full texts were to be available for electronic retrieval and there were a few full texts with manual search – published more than 10-15 years ago.

Search outcome

<table>
<thead>
<tr>
<th>Databases</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>OVID MEDLINE</td>
<td>46</td>
</tr>
<tr>
<td>OVID CINAHL</td>
<td>76</td>
</tr>
<tr>
<td>OVID Nursing Database</td>
<td>65</td>
</tr>
<tr>
<td>EBSCO CINAHL with Full Text</td>
<td>76</td>
</tr>
<tr>
<td>EBSCO ERIC</td>
<td>7</td>
</tr>
<tr>
<td>EBSCO Health Source: Nursing/Academic Edition</td>
<td>5</td>
</tr>
<tr>
<td>PROQUEST Nursing and Allied Health Sources</td>
<td>14</td>
</tr>
<tr>
<td>PUBMED</td>
<td>616</td>
</tr>
</tbody>
</table>

Titles were cross-checked for duplicates and relevance to the focus of the review.
Results

In the review, I evaluated 116 academic publications published between 1991 and 2008. The primary criterion of the separation and grouping was based on whether the publications were based on research or just described and popularized theories. As a result of this, I found 39 research based publications, out of which 11 elaborate several synthetized topics. 9 out of them are connected to two topics and 2 are connected to three topics. There were 77 publications digesting the theoretical basics. Several topics are touched upon by 12 of them, of which 9 are connected to two, and 3 are connected to three topics, touching on the implementation of the results too. One of the reasons for this is that usually, after reviewing the NI programs, most of the authors immediately reveal the possibility or even the necessity of the development of the curriculum.

The presentation of the results - in accordance with the selection criteria - goes by the synthetized topics, separating the research based and the theory based publications, but featuring them from all perspectives (several times) if their subject or method calls for it.

Synthetized themes

I. Reviewed literature discussing the evaluation fields of Nursing Informatics (NI)
<table>
<thead>
<tr>
<th>Number of references</th>
<th>First Author(s) and Year</th>
<th>Focus</th>
<th>Data collection methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>121</td>
<td>Carty B et al. (1998)</td>
<td>Findings from a national study of nursing education</td>
<td>Research survey</td>
</tr>
<tr>
<td>24</td>
<td>Charters KG (2003)</td>
<td>NI: outcomes, quality improvement</td>
<td>Comparison of sources national datasets</td>
</tr>
<tr>
<td>25</td>
<td>Craig A et al. (2007)</td>
<td>Impact of an information literacy programme</td>
<td>Combined qualitative and quantitative techniques in pre- and post test</td>
</tr>
<tr>
<td>26</td>
<td>Desjardins KS et al. (2005)</td>
<td>Effect on an informatics for Evidence-based Practice Curriculum</td>
<td>Measurement of informatics competencies by three research questions</td>
</tr>
<tr>
<td>27</td>
<td>Eley R et al. (2008)</td>
<td>National Survey of Australian Nurses: information and computer technology education</td>
<td>Self-administered postal survey</td>
</tr>
<tr>
<td>105</td>
<td>Gaumer GL et al. (2007)</td>
<td>Use of information technology by advanced practice nurses</td>
<td>Survey: statistical analysis of nurse practitioner program</td>
</tr>
<tr>
<td>28</td>
<td>Guenther JT. (2006)</td>
<td>NI: mapping the literature</td>
<td>Five core journals references were analyzed for 1996 - 1998</td>
</tr>
<tr>
<td>29</td>
<td>Hart MD. (2008)</td>
<td>Informatics competency and development: within the US nursing population workforce</td>
<td>Systematic literature review: total of 17 citations were selected</td>
</tr>
<tr>
<td>102</td>
<td>Hwang HG et al. (2008)</td>
<td>The measurement of initial nursing NI literacy for clinical nurses</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>30</td>
<td>Jiang WW et al. (2004)</td>
<td>Computer competencies for the nursing profession</td>
<td>Delphi technique</td>
</tr>
<tr>
<td>31</td>
<td>Ku YL et al. (2007)</td>
<td>Efficacy of integrating information literacy education</td>
<td>Comparative study, based on Likert Scale</td>
</tr>
<tr>
<td>32</td>
<td>Lin JS et al. (2007)</td>
<td>An exploration of NI competency and satisfaction related to network education</td>
<td>Cross sectional research study: based online questionnaire</td>
</tr>
<tr>
<td>33</td>
<td>Maag MM. (2006)</td>
<td>A National Study: Nursing Students’ Attitudes Toward Technology</td>
<td>Questionnaires, Technology Attitude Scale</td>
</tr>
<tr>
<td>34</td>
<td>McDowell DE et al. (2007)</td>
<td>Computer literacy in baccalaureate nursing students during the last 8 years</td>
<td>Self-reported questionnaires evaluation study</td>
</tr>
<tr>
<td>35</td>
<td>McNeil BJ et al. (2003)</td>
<td>A US Survey: Nursing information technology knowledge, skills</td>
<td>Based three online research questionnaire 266 of 672 programs completed the survey.</td>
</tr>
<tr>
<td>36</td>
<td>McNeil BJ et al. (2005)</td>
<td>US National Survey: NI knowledge and competencies in nursing education programs</td>
<td>Online survey of deans/directors of 266 baccalaureate and higher nursing programs</td>
</tr>
<tr>
<td>37</td>
<td>McNeil BJ et al. (2006)</td>
<td>Computer literacy study</td>
<td>The survey is based 37 discrete quantitative questions</td>
</tr>
<tr>
<td>38</td>
<td>Ragneskog H et al. (2006)</td>
<td>Competence in NI in Sweden</td>
<td>Competence questionnaires, separated by students vs. nursing educators</td>
</tr>
<tr>
<td></td>
<td>First Author alphabetical (date)</td>
<td>Focus</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Saranto K et al. (1998)</td>
<td>NI in nursing education: a challenge to nurse teachers</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Specially designed questionnaire with three open-ended questions</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>Tarrant M et al. (2008)</td>
<td>Curricular approach to improve the information literacy and academic writing skills</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaluation studies based pre- and post test</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Self – reported questionnaires</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>Wallace MC et al. (2000)</td>
<td>Evaluation: Teaching information literacy skills</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comparison: Pre- and post-programme questionnaires</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Wharrad H et al. (2002)</td>
<td>Health informatics skills in nurse education</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Evaluation based questionnaire</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Wharrad H et al. (2005)</td>
<td>Putting post-registration nursing students on-line</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Questionnaire from use of web site and discussion forum</td>
<td></td>
</tr>
</tbody>
</table>

### I/ B. Theoretical based literature

<table>
<thead>
<tr>
<th>Number of references</th>
<th>First Author alphabetical (date)</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>46</td>
<td>Heimar FM. (2005)</td>
<td>NI: Current issues around the world</td>
</tr>
<tr>
<td>119</td>
<td>Hovenga EJ. (2000)</td>
<td>The article represents the health information education in 20 countries of five continents</td>
</tr>
<tr>
<td>47</td>
<td>Nagelkerk J et al. (1998)</td>
<td>NI: overview of the essential factors for development of educational programs</td>
</tr>
<tr>
<td>106</td>
<td>Orness LL et al. (2007)</td>
<td>BSN curriculum evaluation of NI content</td>
</tr>
<tr>
<td>6</td>
<td>Ozbolt JG et al. (2008)</td>
<td>NI: brief history and advance in the USA</td>
</tr>
<tr>
<td>48</td>
<td>Saba VK. (2001)</td>
<td>NI: overview and discussion of development</td>
</tr>
<tr>
<td>49</td>
<td>Saranto K et al. (2004)</td>
<td>Literature review: information literacy</td>
</tr>
<tr>
<td>50</td>
<td>Simpson RL. (2007)</td>
<td>NI: the economics of education – costs of informatics-trained nurses</td>
</tr>
<tr>
<td>51</td>
<td>Skiba DJ. (2004)</td>
<td>Redesigning nursing curricula for Evidence Based Practice</td>
</tr>
<tr>
<td>52</td>
<td>Skiba DJ. (2004)</td>
<td>Informatics competencies for beginning nurses</td>
</tr>
<tr>
<td>54</td>
<td>Weaver CA et al. (2006)</td>
<td>ANI Connection: TIGER Initiative</td>
</tr>
<tr>
<td>10</td>
<td>Zytkowski M. (2003)</td>
<td>NI: Contemporary Nursing Practice</td>
</tr>
</tbody>
</table>

The number of publications connected to the first synthesized topic is 41, out of which 26 are research based and 15 are theory based.

5 of the 26 research based publications are extensive national surveys (27,33,35,36,41) and their geographic distribution is as follows: 4 are from the USA and 1 is from Australia. One of the studies presents the tasks of NI, and the vision of its accelerated development in the future, based on the evaluation of the foregoing results. (23)

The other publications evaluate the individual fields of NI using the various research and sampling methods listed in the synthesis. The distribution of the publications related to the specialties evaluated is as follows:
- Information Literacy (25,40,42)
- Informatics and Computer Literacy, Computer Competencies (29,30,34,37,43,44)
- Examination of the place and situation of NI in the system of Nursing Education (24,28,32,38,39).
The 15 theory based, descriptive publications provide the synthesis of technical literature regarding to the past, present and future of NI. Most of them trace the course of development of the discipline until now, presenting the opportunities of development in the future and an insight into NI education all over the world.

Several authors (53,54) deal with reviewing and popularizing the TIGER Initiative and the application of competencies recorded in it in both education and practice. The new methods (Evidence-Based Practice) appearing with the development of nursing science suggests the necessity of redesigning the curriculum. (45,51,52) The information literacy, one of the subfields of NI, is reviewed and evaluated in the form of literature review (49). Several studies emphasize that it is important to learn using advanced IT tools in clinical practice within the confines of the NI subject. (45,47,48,55)

### II. Reviewed literature discussing exposition of Nursing Informatics (NI) educational programs in the context of nurse education

#### II/A. Research based literature

<table>
<thead>
<tr>
<th>Number of references</th>
<th>First Author alphabetical (date)</th>
<th>Focus</th>
<th>Data collection methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>128</td>
<td>Arnold JM. (1996)</td>
<td>NI: educational needs</td>
<td>Survey: 497 respondens, 23 content areas, 3 subsamples; nurse educators, nurse managers and informatics nurses</td>
</tr>
<tr>
<td>100</td>
<td>Berkow S et al. (2008)</td>
<td>Nursing competencies in the safe and effective nursing practice</td>
<td>National Survey: from new graduate nurses deemed essential competencies</td>
</tr>
<tr>
<td>56</td>
<td>Bird D et al. (1998)</td>
<td>The role of library and information services in curriculum planning</td>
<td>Discussion and evaluation of an experience for curriculum planning by questionnaire</td>
</tr>
<tr>
<td>57</td>
<td>Chastain AR. (2002)</td>
<td>Information technology integration into the curriculum</td>
<td>Comparison and analysis by Staggers questionnaire</td>
</tr>
<tr>
<td>26</td>
<td>Desjardins KS et al. (2005)</td>
<td>Effect on an informatics for Evidence-based Practice Curriculum</td>
<td>Comparison the types of computer skill competencies by competency scale and scores</td>
</tr>
<tr>
<td>58</td>
<td>Jacobs SK et al. (2003)</td>
<td>A Curriculum integrated approach: Information literacy</td>
<td>Survey and evaluation of information literacy competencies by pre- and post test</td>
</tr>
<tr>
<td>114</td>
<td>Rosenfeld P et al. (2002)</td>
<td>Pilot project: develop the information literacy skills of staff nurses</td>
<td>Comparison and evaluation by pre-and post tests</td>
</tr>
<tr>
<td>59</td>
<td>Saranto K et al. (1997)</td>
<td>Developing the information technology syllabus</td>
<td>Three-round Delphi postal survey</td>
</tr>
<tr>
<td>60</td>
<td>Shorten A et al. (2001)</td>
<td>Developing information literacy</td>
<td>Comparison and evaluation by pre-and post programme questionnaires</td>
</tr>
<tr>
<td>40</td>
<td>Tarrant M et al. (2008)</td>
<td>Curricular approach to improve the information literacy and academic writing skills</td>
<td>Comparison of pre-, post-, and final information literacy scores by demographic indicators</td>
</tr>
<tr>
<td>41</td>
<td>Thompson BW et al. (2008)</td>
<td>National Survey: Informatics in the nursing curriculum</td>
<td>Curriculum integration methods: if the informatics is integrated and if the content is integrated (tables)</td>
</tr>
<tr>
<td>61</td>
<td>Yee CC. (2002)</td>
<td>Identifying information technology competencies needed</td>
<td>Evaluation study: Rossett’s needs analysis model by interview</td>
</tr>
<tr>
<td>44</td>
<td>Wharrad HJ et al. (2005)</td>
<td>Putting post-registration nursing students on-line</td>
<td>Discussion optimal use of on-line resources by Salmon’s 5 stage model</td>
</tr>
</tbody>
</table>
The number of publications examining the place and structure of NI in the system of nursing education is 43. 13 of them are research based, whereas 30 are theory based. In comparison with the previous synthesised topic, we conclude that the number of research based studies is much lower, i.e. the processing method is rather theoretical, and the approach is descriptive. The reason for this is that the NI program reviews, the curriculum descriptions and the presentation of their connection to the system of nursing education rather allows an interpretative, theoretical approach to the topic.
4 of the research based publications are identical to the ones introduced in the first topic, because their authors, with a complex approach to the topic, extend the evaluation to reviewing the NI programs and examining the acceptance of their contents. (26,40,41,44) This complexity especially applies to the study of National Survey: Informatics in the Nursing Curriculum (41). As its early premise, we can mention the study made by Arnold JM. (128) arguing for the need for professional nurses in NI education. From the further studies, 3 engage in the new methods of approaching the education of Information Literacy and the integration of library information services into the curriculum. (56,58,60) The necessity of learning about the competencies related to Information Technology and integrating them into the curriculum is evidenced by the studies of several authors. (44,57,59,61,100) From the theory based publications, the Informatics competencies for nurses at four levels of practice from Staggers N et al.(73) and Curran C.’s extensive analytical works got into the technical literature as widely accepted principles and guidelines. These authors, complementing each other, demonstrated the necessary NI competencies starting from training through the entire professional career. Prior to them, there were already some attempts at mapping separate set of NI competencies and integrating them into the system of Nursing Education. (65,72,74,122,123,130) McGonigle D et al.’s (122) study written in 1991 was a pioneer that defined the new discipline and suggested starting the new courses. In 1993, Noll M et al. (123) already presents the integration of the new subject and in 1994 Simpson presents that of the NI key competencies starting from training through the entire professional career. In 1997, Saba VK et al.’s (130) guidelines set forth and urged the full integration of NI for medical professionals learning, practicing and working at all levels of higher education, and analyzed his experience of the efficiency of the courses integrated into the system of Nursing Education in the development of the students’ IT skills. Their usefulness was also confirmed in the publications of Travis LL.(74,129). The continuous changing of the set of competencies according to the development of informatics as a precondition of the development of the NI curriculum is the subject of the analytical studies of Curran C.(98) and Gassert CA. Pelletier (111), Sherwood (71) and Smedley (110) demonstrate the diverse geographic potentials of further development. Besides the extensive recommendations for competencies and education programs in relation to all areas of education and work, there were numerous other studies that elaborated curricula from a number of areas of education or work. (63,66, 67,69,113,114,115,127,135) These inform us of the development of the general curriculum of Information Literacy (68,75,76), the curriculum related to Evidence Based Practice and the development of the Competency of Information Technology.

III. Reviewed literature discussing NI curriculum development

III /A. Research based literature

<table>
<thead>
<tr>
<th>Number of references</th>
<th>First Author alphabetical (date)</th>
<th>Focus</th>
<th>Data collection methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>Bird DR. (1998)</td>
<td>The role of library and information services (LIS) in curriculum planning</td>
<td>Analysis of the contribution of LIS professionals to the curriculum: modular curriculum development, survey of the needs of educationalists and promote study packages</td>
</tr>
<tr>
<td>57</td>
<td>Chastain AR. (2002)</td>
<td>Information technology integration into the curriculum</td>
<td>Curriculum development by analysis of qualitative findings: comparison of information technology use students, faculty members and employers</td>
</tr>
<tr>
<td>58</td>
<td>Jacobs SK et al. (2003)</td>
<td>A curriculum integrated approach: Information literacy competencies and Evidence-Based Practice</td>
<td>Proposal a new model for integrating information literacy into the master’s nursing program</td>
</tr>
<tr>
<td>59</td>
<td>Saranto K et al. (1997)</td>
<td>Developing the information technology syllabus in nursing education</td>
<td>Recommendations for teaching information technology in nurse education by three-round Delphi survey</td>
</tr>
<tr>
<td>Number of references</td>
<td>First Author alphabetical (date)</td>
<td>Focus</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>125</td>
<td>Axford R et al. (1994)</td>
<td>Knowledge development and dissemination in NI</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>Barnard A et al. (2005)</td>
<td>Integrating information literacy into nursing curricula and nursing education</td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Barton AJ. (2005)</td>
<td>Information competencies in a community practice</td>
<td></td>
</tr>
<tr>
<td>117</td>
<td>Betts H et al. (2000)</td>
<td>The projects demonstrate the increasing in teaching information management and technology</td>
<td></td>
</tr>
<tr>
<td>98</td>
<td>Curran CR. (2008)</td>
<td>Informatics content and competencies</td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>Feeg VD. (2004)</td>
<td>Nursing Curriculum Reform Campaign</td>
<td></td>
</tr>
<tr>
<td>118</td>
<td>Hebert M. (2000)</td>
<td>Summarizes key points – development of NI competencies - of a National (Canadian) NI Projects</td>
<td></td>
</tr>
<tr>
<td>79</td>
<td>Hinegardner PG et al. (1994)</td>
<td>NI programs at the University of Maryland</td>
<td></td>
</tr>
<tr>
<td>126</td>
<td>Kooker BM et al. (1994)</td>
<td>NI educating for tomorrow’s challenge</td>
<td></td>
</tr>
<tr>
<td>134</td>
<td>Nagelkerk J et al. (1998)</td>
<td>NI: New model is presented that identifies six essential factors</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>Sackett K et al. (2005)</td>
<td>Application of healthcare informatics into the strategic planning process in nursing education</td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>Sherwood G et al. (2007)</td>
<td>Quality and safety competency (6 quality and safety competencies are defined) development in nursing education</td>
<td></td>
</tr>
<tr>
<td>104</td>
<td>Sockolow P et al. (2008)</td>
<td>Use of project management skills in NI project</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>Travis LL et al. (1998)</td>
<td>The basic components of the innovative NI curriculum: course descriptions and evaluation</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Verhey MP. (1999)</td>
<td>Development and evaluation of the information literacy curriculum strand</td>
<td></td>
</tr>
<tr>
<td>76</td>
<td>Wallace MC et al.</td>
<td>Models and programmes for information literacy education:</td>
<td></td>
</tr>
</tbody>
</table>
The number of publications regarding this (III.) topic is 29. Their distribution is as follows: 9 research based and 20 theory based publications. The close connection with the previous (II/A.) topic analyzed is shown by the fact that 8 of the 9 research based publications are connected to it, while only 1 is connected to the first (I/A.) topic. The complex approach of the 8 research based publications is shown by the fact that their authors - applying each other's achievements - also make their own suggestions on developing the NI curriculum. The study (43) also having some bearings on the first topic (I/A.), after reviewing and evaluating the health informatics skills in nurse education, also makes a suggestion to develop the curriculum along this line.

From the 20 theory based publications, 9 are also connected to the studies of the previous topic (II/B.), while the other 11 introduce the following main areas of curriculum development:
- NI maturing into a discipline, the description of the first programs and forms of education in 1994 (79),
- the forming and the principles of development of the core curriculum of NI by Axford R et al.(125), and the further levels of curriculum development within the confines of the new models by Turley JP (11) in 1996 and Nagelkerk J et al. (134) in 1998
- the elaboration and review of the NI competency in Canada too, in the extensive study titled National Education Strategy to Develop NI Competencies (118),
- furthermore as the new tool of competency and curriculum development - linked to the individual nursing science subfields - the potential of the project potential is discussed by several authors (77,80,104,117).

### IV. Reviewed literature discussing: Implementation of the NI competencies in the practice

#### IV / A. Research based literature

<table>
<thead>
<tr>
<th>Number of references</th>
<th>First Author alphabetical (date)</th>
<th>Focus</th>
<th>Data collection methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>81</td>
<td>Connors HR et al. (2002)</td>
<td>Academic- business partnership: the SEEDS (Simulated E-hHealth Delivery System) project</td>
<td>Pilot project: IT integrated curriculum evaluation by questionnaire</td>
</tr>
<tr>
<td>82</td>
<td>Honey M et al. (2006)</td>
<td>Improving library services: case study</td>
<td>Quantitative evaluation by questionnaire, qualitative evaluation by interviews</td>
</tr>
<tr>
<td>83</td>
<td>Informa Healthcare (2008)</td>
<td>Nurses computer use</td>
<td>Comparative survey from Internet use for health information</td>
</tr>
<tr>
<td>84</td>
<td>Orness LL et al. (2007)</td>
<td>Implication of computer competencies for nursing education</td>
<td>Research questionnaire for the all courses in a BSN program</td>
</tr>
<tr>
<td>132</td>
<td>Saranto K et al. (1997)</td>
<td>The nursing students want to learn more from information technology</td>
<td>Survey by questionnaire</td>
</tr>
</tbody>
</table>

#### IV / B. Theoretical based literature

<table>
<thead>
<tr>
<th>Number of references</th>
<th>First Author alphabetical (date)</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>63</td>
<td>Booth RG. (2006)</td>
<td>See also II / B. 63.</td>
</tr>
<tr>
<td>124</td>
<td>Cassey MZ et al. (1994)</td>
<td>New trends influencing NI</td>
</tr>
<tr>
<td>86</td>
<td>Cheek J et al. (1998)</td>
<td>Resources for nurses as lifelong learners</td>
</tr>
</tbody>
</table>
In this topic analyzed there are altogether 28 publications. 5 of them are research based and 23 are theory based.

Each of the 5 research based studies - irrespective of the previously discussed topics and independently of one another - engages in the practical implementation of competencies. The earliest (1997) is Saranto K et al.'s (132) opinion poll based study, which confirms that nursing students need a more detailed familiarization with the information technologies within the confines of NI education.

Further research introduces the SEEDS developer project (81), the expansion of library services and the increase of its standards in a case study (82), the nurse computer use (83) and the integration of computer skills into the Nursing Education curricula.

From the 23 theory based publications, 3 discuss their subjects in a complex manner (63,98,99), because all three are devoted to the place and role of the NI curriculum as well as the possibilities of curriculum development in the Nursing Education system. After this they demonstrate the methods of implementing these factors, even directly touching upon the Handheld Devices if needed (98).

The questions and possibilities of practical utilization arose already in the early years of the introduction of NI as an independent discipline. Several studies were devoted to the effects of the new trends brought about by the computerization of NI between 1994 and 2000 (124). Following that the utilization of the tools of NI arose in strategic planning (131), research on the methodology of lifelong learning (86), the development of the mobile learning systems (120) as well as the analysis of the effects of their cognitive functions (133). Later studies on the elaboration of the general theory of implementation grew in numbers. Besides unfolding the new frontiers (87) it is also important to integrate the new information technologies (92). This subject was
handled with high priority by Jenkins ML et al. (90) in 2006, who reviewed and analyzed the National Health Information Infrastructure and the necessity of its integration into nursing practice. In the 2000s, with the appearance of the more and more numerous and advanced applications, the technical literature of implementing and integrating these novelties into NI has also grown. The implementation strategies and the possibilities of their utilization is reviewed by Gassert CA et al. (107) Skiba DJ. (93,94,95) analyzes the utilization of the tools Faculty 2.0 on the model of Web 2.0 extensively and with a great breadth of view, introducing to the practicioning technicians the new pool of tools of communication and the possibilities of application. Eventually he demonstrates the necessity to include them in the nursing curricula and also mentions some methods of that. In the other publications the authors introduce the following special fields and possibilities of application:

- patient safety (85)
- sound data implications (108)
- HIMSS (Healthcare Information Management and Systems Society) Statement (89)
- introduction of new electronic patient records (end of paper based medical record era, 88)
- demonstration of the Infoway Canada project (91)
- and succesfull on-line education programs (97).

The cost-volume-profit analysis of the implementation of the NI projects above (96) summarizes and proves the necessity and importance of their inclusion. The most important is to raise the standards of professional work, which would be beneficial not only for technicians but, besides them, the much larger number of consumers of medical services, making the social benefits invaluable.

Findings

The intent of this review is to draw public attention in the author's country to the importance of the tuition of NI.

The major areas of NI:– computer literacy, information literacy, nursing and health sciences implications – already constitute separate parts of the Nursing Education curriculum, but an integrative minded, competency based education is just emerging within the confines of the curriculum reform of Hungarian higher education. The author wishes to contribute to the successful realization of this by aiming to summarize and analyze the publications of the international technical literature, which had significant effects on and achievements in the evolution and development of the NI curriculum.

The year 1991 was chosen as the starting date of the review. Although Graves and Corcoran (136) had created the complex definition of NI already in 1989, it got internationally accepted as a separate discipline only after its application in databases, which marked the acceptance of the use of the concept. NI as it was entered into the MEDLINE databases as a separate subject-heading at this time. Before that the subject-headings <information management>, <medical information>, <nursing as a profession>, <nursing information systems> were used, which did not cover the inner contents of the entity in its full complexity. The acceptance of the technical terminology and its integration into academic communication is evidenced by the fact that since 2005 using it in MeSH in the forms of <nursing informatics> or <informatics, nursing> has been recommended.

Although the entire review attempts to reveal the process of the development of NI in detail, summarizing its stages we can pinpoint the following significant phases of development:

- 1989 – the creation of the conceptual and operational definition of NI (136)
- 1991 – proposal to start new - NI - courses (122)
- 1993 – proposal to integrate the NI courses into the courses of the Nursing Education faculty (123)
- 1994 – the composition of the first key competencies for the development of NI curricula (72)
  - the description of the first NI program (79), which was given at the faculty of the University of Maryland
  - proposal to install the NI at several levels of education (126, 127)
- 1996 – the surveying of informatic needs of professional nurses, and urging their IT training (128)
- 1997 – proposal to include the entire NI education into the system of Nursing Education at every level of higher education, even postgradually for those who were already in employment Saba VK (130)
- 2001 – Staggers et al. (73) elaborate the entire set of competencies for the 4 levels of Nursing Education in their studies, joined by Curran's studies (98,64) as a supplement
- from the beginning of the 21th century
- national studies, surveys, initiatives and proposals of professional associations have continuously been created and published in the USA to modernize the NI education and make it extensive (27,33,35,36,41,53,54)
- the Information Literacy curriculum and competencies of NI curriculum are being developed continuously (56,58,60,62,68,70,75,76)
- the curriculum and competencies of Computer Literacy subfield are also being developed (57,59,61,66,73,77)
- the contents and competencies of Healthcare Information Literacy are being developed (63,69,80)
- from Web 2.0 to Faculty 2.0, the example of implementing and adapting modern IT tools to the NI curriculum leads to the future (Skiba DJ, 93)

- 2008 – the study of Bakken S et al. (23) delineates the diversity of the prospective changes embedded into the image of the future of NI research. He selects three of them when dealing with the development trends of three areas - Genomic Health Care, Shifting Research Paradigms, Social (Web 2.0) Technologies - in detail. In the part titled Key Components of a Nursing Informatics Research Agenda for 2008-18 – making a comparison with the seven prioritized fields of NI research between 1992 and 1996 - he examines their current and predictable future situations. “These influences are illustrated using the significant issue of healthcare associated infections (HAI).”

From the major conclusions, we should emphasize the extension of the interdisciplinarity of the research, including the utilization of genomical and environmental data. The redesigning of nursing practice, the development of the theory of NI and the development of the patient's and caregiver's knowledge-based cooperation are necessary in the field of Nursing Science. They all have to be complemented by the application of the new technologies and the inclusion of innovative evaluation methods, which also takes the organic connection of human-computer interface factors into consideration.

Conclusions
Reviewing the major stages of the development of NI we can conclude that NI in fact is a:
- continuously developing discipline,
- whose development is closely related to the current state of development of ICT
- and the social impregnation of the ICT tools, i.e. the extensive integration of the social web technologies into the sphere of scientific and technical applications
- for this NI is critical to the future of nursing,
- nursing science programs must integrate the contents of complex informatics and competencies into their curricula to prepare nurses for future missions.

References
34. McDowell DE, Ma X. Computer literacy in baccalaureate nursing students during the last 8 years. CIN: Computers, Informatics, Nursing. 2007; 25(1):30-6.
(Accessed on March 25, 2009)


65. Goossen WTF, Jeuring G, Dassen TWN. Seven years experience in nursing informatics education: changes over the years... third article in a series. ITIN. 1997;9(1):9-11.


84. Ornes LL, Gassert C. Computer competencies in a BSN program. Journal of Nursing Education.


Skiba DJ. Faculty 2.0: Flipping the Novice to Expert Continuum. Nursing Education Perspectives. 2007;28(6):342-44.


Pelletier D, Diers D. Developing data for practice and management: an Australian educational initiative.


123. Noll ML, Murphy MA. Integrating nursing informatics into a graduate research course. Journal of Nursing Education. 1993;32(7):332-4.


