

Towards a Framework for Usability Evaluation of Educational Artifacts created with Web 2.0 Applications: A Pilot Study

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Abstract - Web 2.0 refers to the second generation of web applications which encourage different kinds of interaction among users and enable them to create various artifacts. Although Web 2.0 applications are widely used in educational settings, researches on usability of artifacts created by their means are fairly modest. This paper explores attributes which contribute to the usability of educational artifacts. With an aim to develop a comprehensive framework, we conducted a pilot study during which data was collected with the use of an online questionnaire. Participants in the study were students of Information and Communication Sciences. Empirical findings are presented and discussed.

I. INTRODUCTION

Almost a decade ago, Tim O'Reilly and Dale Dougherty [1] coined a term "Web 2.0" which is nowadays commonly used as a synonym for the second generation of web applications. Web 2.0 is considered to be a significant shift from static web sites where users could only browse, view, read, and download published content to dynamic web services which support different types of interaction among users and enable them to share created artifacts. Influenced by Web 2.0 paradigm, the traditional e-learning process where students were passive recipients of educational content solely produced by teacher was transformed into e-learning 2.0 [2] where students are able to interact and actively contribute to the development of educational artifacts. Standalone learning platforms aimed for publishing learning content are replaced with decentralized and interoperable learning communities where students can remix and use educational artifacts in accordance with their own preferences. One of the core elements underlying the concept of e-learning 2.0 is connectivism [3] according to which learning is no longer an individualistic but collaborative activity.

Usability assessment plays a fundamental role in the user-centred design of web applications. According to the recent standard on software quality evaluation [4], usability is defined as "degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". Current research on evaluation in the e-learning context deals with usability assessment of

learning environments [5] or measuring technical and pedagogical criteria of static learning material [6]. Latest research effort on assessment of Web 2.0 applications is focused on measuring quality of mashups [7], and development of a methodology for evaluating the quality in use of Web 2.0 applications [8][9] whose adequacy has been empirically validated in the context of services for collaborative writing [10] and mind mapping [11]. However, the existing research on evaluation of artifacts created with Web 2.0 applications is rather rare. The objective of this paper is to present results of the pilot study where usability of educational artifacts created by means of various Web 2.0 applications was investigated by means of an online questionnaire.

The remainder of the paper is structured as follows. Section 2 describes Web 2.0 applications that were used in our research for completing educational activities. Details on employed research methodology are contained in the fourth section. Discussion on empirical results of conducted pilot study is provided in the fourth section. Concluding remarks and future work directions are offered in the last section.

II. WEB 2.0 APPLICATIONS

There are a number of web applications that demonstrate the foundations of the Web 2.0 phenomena and are widely applied in educational context. More recently, taxonomy of Web 2.0 applications whose features can be used in educational settings has been proposed [12]. This section offers a brief overview of the most prominent representatives of the set forth taxonomy that are tailored to the context of our study and supplemented with practical examples of their implementation in educational environment.

Wiki refers to a web service such as *MediaWiki* that enables users to create a knowledge repository in a form of interlinked web pages. It can be effectively used for gaining pedagogical benefits by both students and teachers. Students can employ a wiki for writing, editing, and sharing their own thoughts during classes, creating content that supplements and extends delivered course materials, and asynchronously collaborate with other peers on joint projects. On the other hand, teachers can apply a wiki for publishing lectures, providing feedback to

students, etc. In that respect, wiki can serve as a central place for the implementation of educational activities as well as for the integration of educational artifacts created by means of other Web 2.0 applications [13].

Cloud Suite Services such as *Google Drive* represent a free alternative to commercial office applications. They can be used instead of the paper and pencil for taking notes during lectures as well as for generating different types of educational artifacts thereby creating collection of course study materials. Being collaborative in nature, cloud suite services enable students to work synchronously on the same document, participate in brainwriting sessions, share and organize created documents, etc.

Social Bookmarking Sites such as *StumbleUpon* are aimed for discovering, saving, sharing, managing, and referencing various artifacts. They allow users to associate flat, unstructured, and individually selected keywords known as tags with a particular artifact. The emergent collection of all the users' tags and artifacts is commonly referred to as folksonomy. Given that annotation of web artifacts has proven to have effect on problem solving ability [14], social bookmarking sites represent a valuable source of artifact needed for completing educational activities (e.g. writing a seminar paper).

Web applications for knowledge organization such as mind mapping and diagramming services are meant for visual representation of information. *Mindomo* as a representative of mind mapping services helps students to decompose and understand complex problems thus enabling them to arrange, memorize, and learn information in highly sophisticated way. *Gliffy* as a member of the diagramming family allows students to generate a graphical illustration of an algorithm or process thereby assisting them in the analysis of given assignment and design of its solution. Both mind maps and diagrams can be created collaboratively, shared publicly or privately, and embedded into other Web 2.0 applications.

Screencasting services such as *Screencast-O-Matic* enable users to record screen output together with audio narration. Teachers can use them for recording lectures or tutorials and accordingly make screencasts available to all students for future reference. Attendees who were absent from a particular lecture can use screencasts to catch up on the content they missed. In addition, screencasts are adaptable to students' learning style and pace. Namely, students can view screencasts whenever they want and as often as they need. Finally, students can record a screencast to demonstrate a procedure of solving a given assignment in specific environment.

Social Networks are structure of personalized web pages that represent individuals and relationships among them within a particular domain. They allow individuals to create public or semi-public profile in order to establish a connection, interact, and share artifacts with others who have similar interests. Depending on their primary purpose, Orehovački et al. [12] distinguish three types of social networks: general, professional, and specialized. Social networks meant for general use such as *Facebook* can be utilized by students for acquiring new knowledge through discussion with their peers, getting feedback from

teacher, creating a repository of diverse artifacts, etc. Professional social networks like *LinkedIn* enable students to create portfolios of their achievements over a certain period of time. Moreover, they allow students to connect with experts in a certain field and through interaction with them widen theoretical knowledge gained during the course. Specialized social networks such as *Snipplr* enable students to obtain feedback from teacher, professionals, and other peers on correctness of published snippets of the source code. In that manner, social networks encourage collaborative learning while their features motivate students to become more skillful in solving programming assignments.

Web 2.0 applications that merge data from multiple sources into one integrated interface are referred to as mashups. Popular representatives of mashup applications are personalized portals like *Netvibes* which provide their users with a feature of subscribing to the Rich Site Summary (RSS) or Atom Syndication Format (Atom) feeds of interest. Feeds are XML formats that provide users with concise and frequently updated content. Individuals are able to use mashups for following updates from multitude web resources. By employing services such as *Dapper*, both students and teachers can create feeds thus enabling all interested to track changes on artifacts generated by means of other Web 2.0 applications. Finally, students have the ability to subscribe to different educational feeds and thereby design Personal Learning Environment (PLE).

III. RESEARCH DESIGN

With an aim to evaluate educational artifacts created by means of Web 2.0 applications, a questionnaire with 46 items related to various facets of usability was designed. These items were supplemented with demographic questions regarding participants' age and gender, as well as with questions on frequency of using most popular representatives of different types of Web 2.0 applications. Responses were modulated on a five point Likert scale (1-strongly disagree, 5-strongly agree). In addition, overall usability of educational artifacts was assessed by means of five point semantic differential item (1-low, 5-high). The pilot study lasted for four months (one semester) and was comprised of several parts. As an integral part of each of four different assignments, students had to create educational artifacts by means of Web 2.0 applications described in previous section. For each assignment they were asked to use different representative of particular type of Web 2.0 applications. All created artifacts were integrated with wiki by means of links or embedded images. Thereafter, students were asked to use integrated artifacts when learning for midterms. At the end of the semester, an online questionnaire was employed for collecting data on perceived usability of educational artifacts. A total of 92 subjects (63% male, 37% female) aged from 19 to 22 ($M = 20.26$, $SD = 0.800$) took part in the pilot study. The subjects in the pilot study were students of Information and Communication Sciences. At the time when the pilot study was conducted, subjects were in the second year of study. The pilot study was conducted within the Data Structures course.

IV. PILOT STUDY RESULTS

The data on use frequencies of most popular representatives of Web 2.0 applications with educational potential (blogs, social bookmarking sites, social networks, image sharing services, cloud suite services, mashups, instant messengers, virtual worlds, microblogs, wikis, and video podcasting services) is presented in Figure 1.

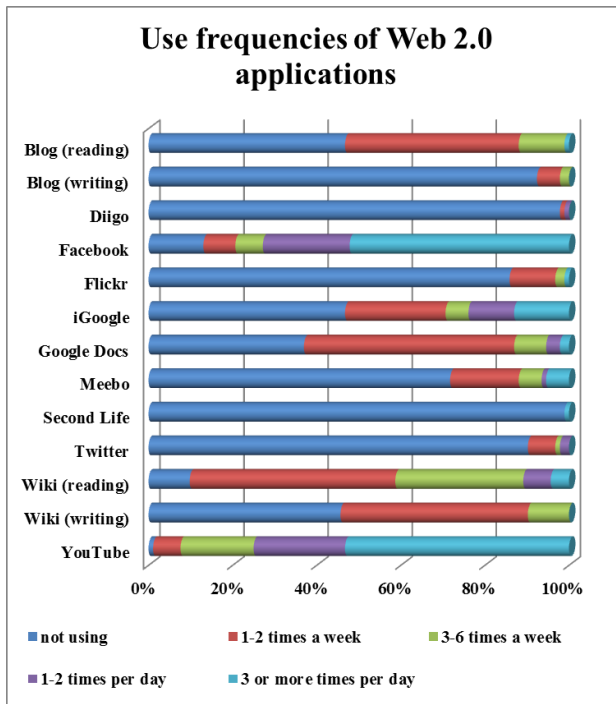


Figure 1. Use frequencies of Web 2.0 applications

Among eleven different types of Web 2.0 applications, participants in the pilot study most commonly use video podcasting services and social networking sites. Namely, the data in Figure 1 indicate that YouTube and Facebook are used at least once a day by 75% and 72.82% of pilot study participants, respectively. On the other hand, both virtual worlds and social bookmarking sites are used quite rare. More specifically, 98.91% and 97.83% of pilot study participants reported that they do not use Second Life and Diigo, respectively. When contrasting active and passive use of wikis, majority of pilot study participants more often read wiki entries (90.22% at least once a week) than contribute to its body of knowledge (54.35% at least once a week). Pattern of using blogs is very similar. As many as 53.26% of pilot study subjects read blogs at least once a week while only 7.61% of them writes their own blog posts. Use frequencies of remaining five Web 2.0 applications are as follows: Google Docs, iGoogle, Meebo, Flickr, and Twitter are used at least once a week by 63.04%, 53.26%, 28.26%, 14.13%, and 9.78% of study subjects, respectively. The aforementioned findings indicate that students of Information and Communication Sciences do not use frequently enough various types of Web 2.0 applications which are in accordance with findings discussed in [15] and [16].

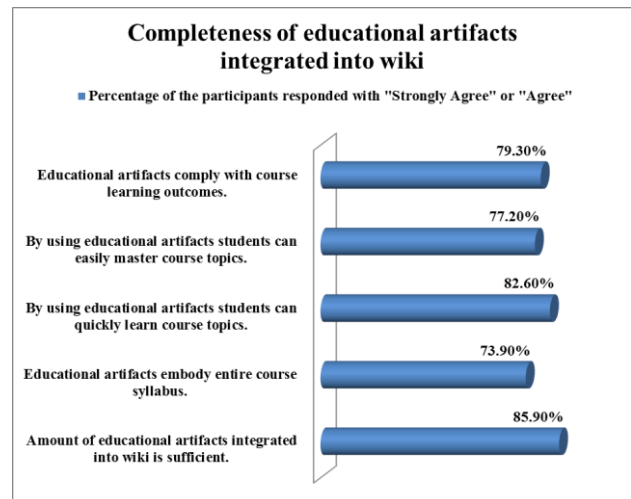


Figure 2. Completeness of educational artifacts integrated into wiki

As can be observed from the responses to questionnaire items which are presented in Figure 2, pilot study participants believe that educational artifacts integrated into wiki cover all course topics. In particular, majority of participants assume that educational artifacts comply with course learning outcome ($M = 3.61$, $SD = 0.877$) and embody entire course syllabus ($M = 3.53$, $SD = 1.133$). Moreover, most of pilot study subjects agree that use of educational artifacts leads to increased learning efficiency ($M = 3.72$, $SD = 0.869$) and facilitates knowledge acquisition ($M = 3.52$, $SD = 1.032$). Finally, 85.9% of students support the statement that the amount of educational artifacts integrated into wiki is sufficient ($M = 3.79$, $SD = 0.819$).

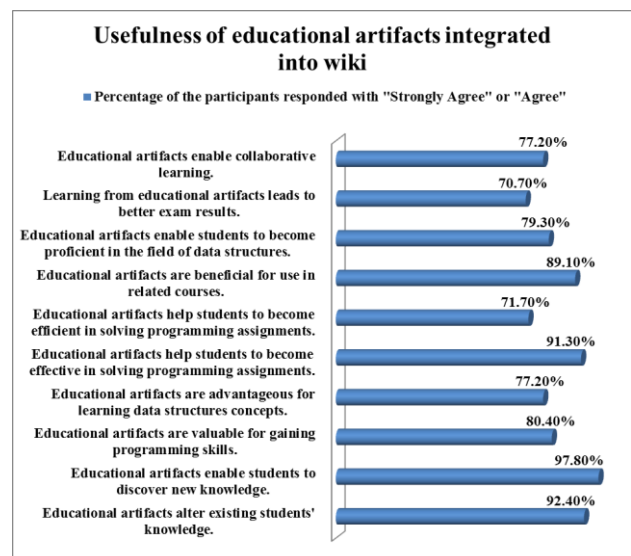


Figure 3. Usefulness of educational artifacts integrated into wiki

According to the data presented in Figure 3, pilot study subjects perceive educational artifacts integrated into wiki as useful. For instance, predominant number of respondents strongly agree or agree that educational artifacts alters existing students' knowledge ($M = 4.00$,

SD = 0.679) and enables them to discover new knowledge (M = 4.22, SD = 0.551). Furthermore, most of the pilot study participants strongly agree or agree that educational artifacts help students to become effective (M = 4.01, SD = 0.734) and efficient (M = 3.49, SD = 1.094) in solving programming assignment as well as proficient in the field of data structures (M = 3.68, SD = 0.983). Also, majority of students responded that they strongly agree or agree that educational artifacts integrated into wiki are valuable for learning data structures concepts (M = 3.55, SD = 1.152), and gaining programming skills (M = 3.72, SD = 0.941) which leads to better exam results (M = 3.41, SD = 1.111). Majority (89.1%) of pilot study subjects used the same responses to express their agreement with the statement that educational artifacts are advantageous for use in data structures related courses (M = 4.04, SD = 0.876). Finally, as many as 77.20% of students strongly agree or agree that educational artifacts enable collaborative learning (M = 3.60, SD = 1.070).

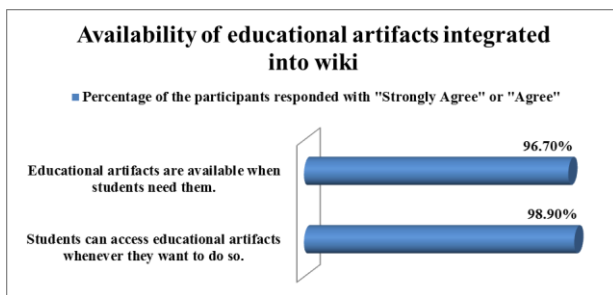


Figure 4. Availability of educational artifacts integrated into wiki

The data presented in Figure 4 illustrate that students perceive educational artifacts integrated into wiki as available. As many as 96.70% responded with "Strongly Agree" or "Agree" to the questionnaire item "Educational artifacts are available when students need them." (M = 4.55, SD = 0.618). Also, 98.90% of them gave the same responses to the statement "Students can access educational artifacts whenever they want to do so." (M = 4.51, SD = 0.671).

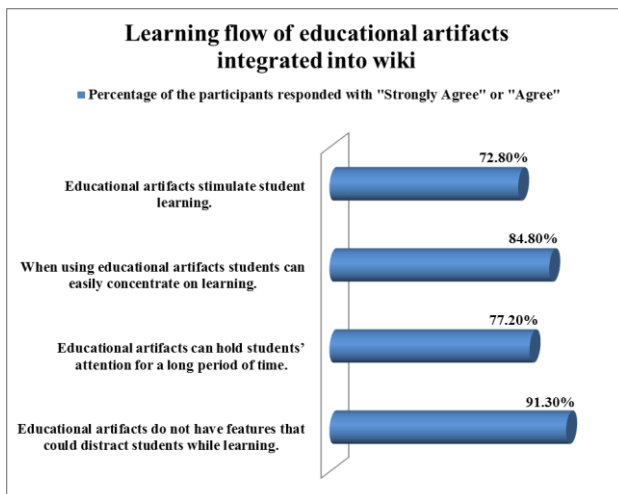


Figure 5. Learning flow of educational artifacts integrated into wiki

According to the results presented in Figure 5, educational artifacts integrated into wiki positively affect students' learning flow. Namely, most of pilot study participants strongly agree or agree that educational artifacts do not have features that could distract students while learning (M = 4.04, SD = 0.797) and accordingly can hold their attention for a long period of time (M = 3.64, SD = 0.979) and stimulate their learning (M = 3.48, SD = 0.955). Also, predominant number of them (84.80%) responded affirmatively to the item "When using educational artifacts students can easily concentrate on learning." (M = 3.78, SD = 0.849).

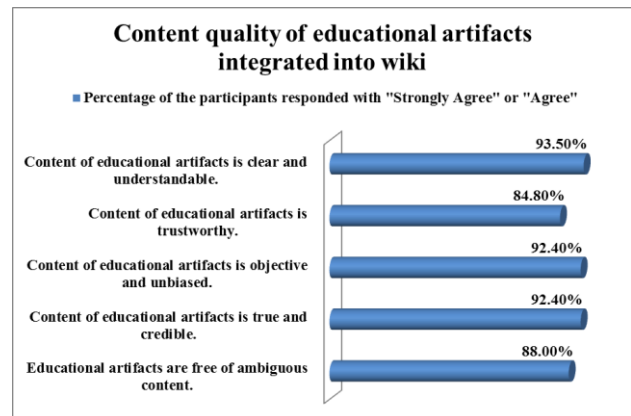


Figure 6. Content quality of educational artifacts integrated into wiki

The data in Figure 6 indicate that content quality of educational artifacts integrated into wiki is acceptable. More specifically, most of the pilot study subjects strongly agree or agree that content of educational artifacts is clear and understandable (M = 3.97, SD = 0.601), trustworthy (M = 3.79, SD = 0.896), objective and unbiased (M = 4.20, SD = 0.905), as well as true and credible (M = 4.02, SD = 0.695). In addition, majority of them (88%) support the statement that educational artifacts are free of ambiguous content (M = 3.87, SD = 0.801).

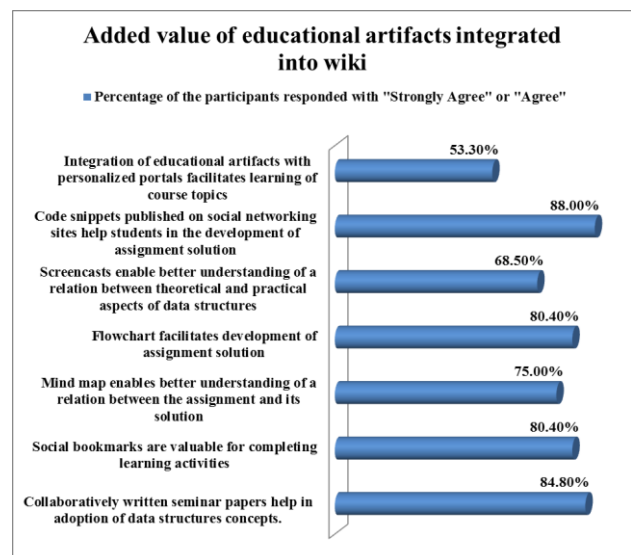


Figure 7. Added value of educational artifacts integrated into wiki

According to the data presented in Figure 7, pilot study subjects believe that educational artifacts integrated into wiki add value to the learning process. More specifically, the predominant number of respondents stated that they strongly agree or agree that a) collaboratively written seminar papers help in adoption of data structures concepts ($M = 3.85$, $SD = 1.005$), b) social bookmarks are advantageous for completing learning activities ($M = 3.59$, $SD = 1.060$), c) mind map enables better understanding of a relation between the assignment and its solution ($M = 3.51$, $SD = 1.254$), d) flowchart facilitates development of assignment solution ($M = 3.77$, $SD = 1.196$), e) screencasts enable better understanding of a relation between theoretical and practical aspects of data structures ($M = 3.47$, $SD = 1.321$), f) code snippets published on social networking sites help students in the development of assignment solution ($M = 4.08$, $SD = 1.030$), and g) integration of educational artifacts with personalized portals facilitates learning of course topics ($M = 3.58$, $SD = 1.170$).

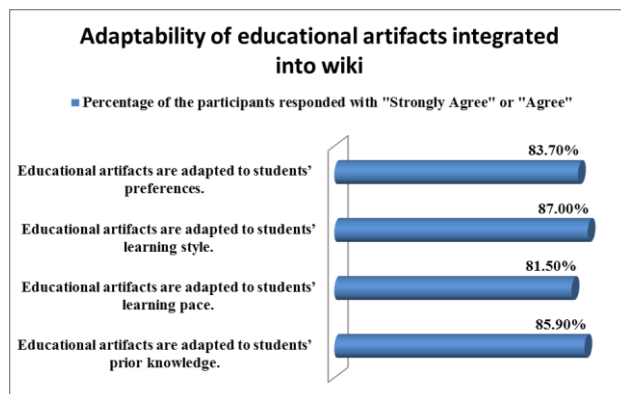


Figure 8. Adaptability of educational artifacts integrated into wiki

The data illustrated in Figure 8 indicate that educational artifacts integrated into wiki are adapted to students' needs. Namely, most of pilot study participants strongly agree or agree that educational artifacts are adapted to students' prior knowledge ($M = 3.84$, $SD = 0.893$), learning pace ($M = 3.68$, $SD = 0.983$), learning style ($M = 3.82$, $SD = 0.838$), and preferences ($M = 3.70$, $SD = 0.848$).

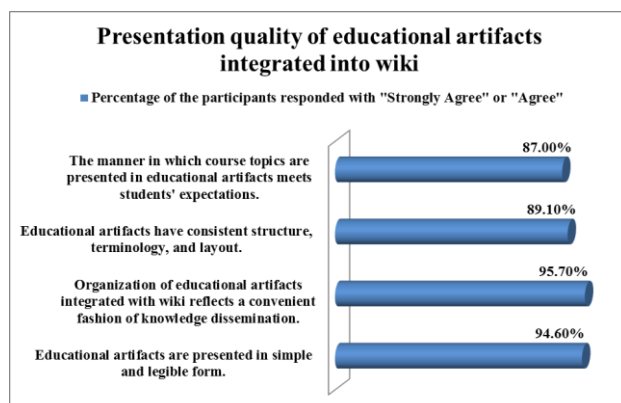


Figure 9. Presentation quality of educational artifacts integrated with wiki

According to the data shown in Figure 9, presentation quality of educational artifacts integrated with wiki is satisfactory. For instance, majority of students strongly agree or agree that educational artifacts are presented in simple and legible form ($M = 4.08$, $SD = 0.633$), and have consistent structure, terminology, and layout ($M = 3.84$, $SD = 0.774$). In addition, most of students (95.70%) believe that organization of educational artifacts integrated with wiki reflects a convenient fashion of knowledge dissemination ($M = 4.07$, $SD = 0.570$). Finally, 87% of them strongly agree or agree that the manner in which course topics are presented in educational artifacts meets students' expectations ($M = 3.75$, $SD = 0.689$).

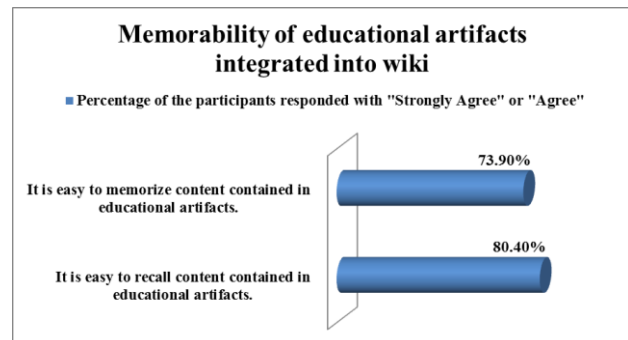


Figure 10. Memorability of educational artifacts on the wiki

The findings shown in Figure 10 illustrate the high level of educational artifacts' memorability. In particular, majority of pilot study participants strongly agree or agree that it is easy to both memorize ($M = 3.49$, $SD = 1.094$) and recall ($M = 3.66$, $SD = 0.855$) content contained in educational artifacts.

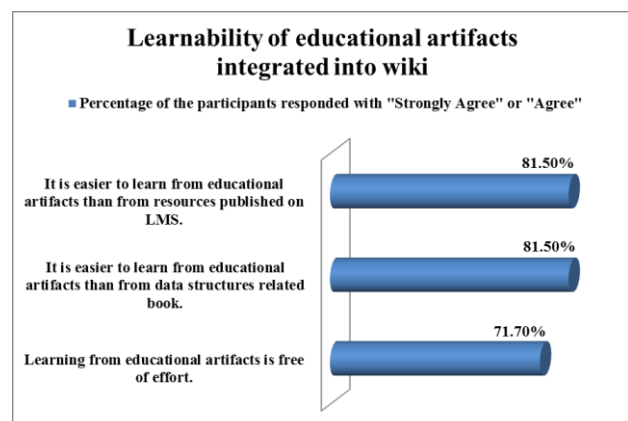


Figure 11. Learnability of educational artifacts integrated into wiki

The data presented in Figure 11 indicate that it is easy for students to learn course topics from educational artifacts integrated into wiki. Namely, most of students (71.70%) strongly agree or agree that learning from educational artifacts is free of effort ($M = 3.42$, $SD = 0.997$). Moreover, majority of them believe that it is easier to learn from educational artifacts than from resources

published on LMS ($M = 3.70$, $SD = 0.958$) or from data structures related books ($M = 3.85$, $SD = 1.157$).

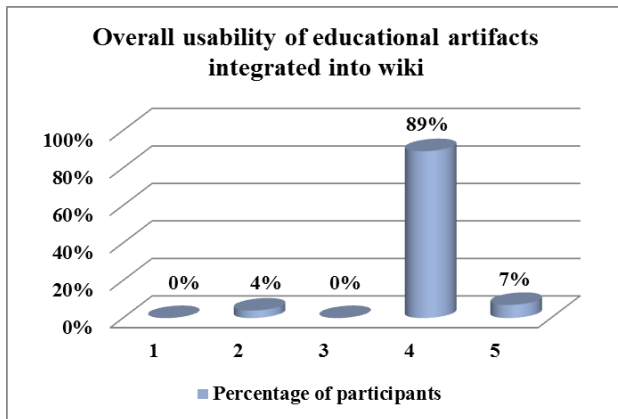


Figure 12. Overall usability of educational artifacts integrated into wiki

According to the results presented in Figure 12, the overall usability of educational artifacts integrated into wiki is perceived as fairly high ($M = 3.98$, $SD = 0.491$). The set forth indicate that students support the use of artifacts created by means of Web 2.0 applications for educational purposes.

V. CONCLUSION

Implementation of Web 2.0 applications in e-learning environment brings numerous benefits to students. The concept of e-learning 2.0 enables students to solely or collaboratively create, remix, and use educational artifacts according to their own needs. Pilot study results indicate that completeness, usefulness, availability, learning flow, content quality, added value, adaptability, presentation quality, memorability, and learnability are distinguishable facets that determine perceived usability of educational artifacts. In order to examine the robustness of findings presented in this paper, more studies should be conducted. Therefore, our future work will be focused on revision and validation of proposed attributes as well as development of a comprehensive framework meant for usability evaluation of educational artifacts created with Web 2.0 applications.

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