The Necessity of Teaching Material and Its Development in Technology Education in Estonia

Aron Lips[1] MA; **Andry Kikkull**[2] PhD
Tallinn University, Estonia[1,2]
aronlips@tlu.ee[1]; andryk@tlu.ee[2]

Abstract: In the year 2011 the last curriculum for basic schools in Estonia was accepted. The implementation of the curriculum challenges teaching materials in use. Estonian lifelong learning strategy 2020 foresees the modernization and renewal of teaching materials through increasing their digitalization. To find out the current status of study ware in general education schools, a mapping was carried out in Estonia from February to April 2016. The mapping covered all the subjects including technology education. This study made it possible to get a nationwide overview of the existing teaching materials and its quality that support the curriculum. For the authors of this article, the mapping created interest to find out whether and how the Estonian technology education teaching materials have changed and developed in recent decades to meet the various existing syllabus goals. What type of teaching materials are used by the technology teachers now and what kind of teaching materials they need for technology lessons and meeting the goals in the curriculum? To answer the questions in the research results of the mapping of teaching materials and content analysis of technology education textbooks and syllabuses are used in this article. To find out the needs of teachers the results of a survey from autumn 2016 and its analysis were taken as a base. To analyze the data in the survey a programme SPSS 22 was used. As an overall result there can be said that the change in the theoretical content of teaching materials corresponds the changes in the curriculum. At the same time instructional materials of practical tasks have not changed enough. These are, however, the most required and used by the teachers in the teaching process. Instructional materials for practical tasks created using today's digital possibilities are most needed by teachers.

Keywords: craft and technology education, school education, teaching materials.

Introduction

Just as education policy changes over time and in accordance therewith new school curriculums are adopted, different study materials used for covering the curriculum must also comply with the changes. As teachers we all have a common goal to develop students in such a way that they would become independent learners who are able to identify, understand and analyze ideas and use their knowledge for solving problems (Dobler, 2015). In order to accomplish this goal, learning must be active, attentive, important and self-directed process. In classroom the primary learning tools are study materials which contain plenty of meaningful information, yet some students are challenged by reading study materials because of their hard readability, complex wording and overcrowded content (Allington, 2001). These situations may present cognitive challenges reflected by decline in reading motivation or inexperience of understanding dense text and creating on this basis new meanings (Sheridan-Thomas, 2008). However, digital study materials which can promote active and self-directed learning, offering learners different ways and forms for receiving information, are gaining popularity and offering an alternative (Schunk, Zimmerman, 1998). E-study materials can comprise different opportunities for supporting learners; it may be reflected in font size options, using interactive links, changing text to speech or presenting information through video clips. In this way, learning can be promoted in ways which were not possible before with study materials containing printed texts (Dobler, 2015).

As a changing approach to learning, digitalization of study materials in compulsory schools by year 2020 is also provided for in Estonia as one important education reform (Eesti elukestva…, 2014). The subject of technology education taught in compulsory schools must also go along with the above developments. Digital study materials have several advantages over printed study materials, primarily their interactivity, yet their lower production costs are also not of little importance (Hawkins, 2000). However, the publishers producing study materials are yet hesitant, fearing piracy and trying to develop study materials to be impossible to copy or to print out (Minkel, 2000).

Although modern technology changes our forms of educational information transmission, their content still remains most important. Therefore, also while creating study materials in modern form, we must turn toward curriculum for producing their contents. During Estonian re-independence period the subject

of technology education has had a total of three different curriculums which have evolved from traditional crafts increasingly toward technology education (Kikkull, 2016; Soobik, 2015). The curriculum of technology education has become in time less specific and more general, allowing to achieve the curriculum objectives while addressing learning topics differently and doing practical works (Kikkull, 2012; Soobik, 2011). Therefore, while creating new study materials, it is important to know which study materials technology education teachers use in schools for covering the curriculum. While producing new study materials, in addition to fulfillment of curriculum requirements, didactic questions also arise, namely what types of study materials teachers need today. Should only modern form be considered in the case of new study materials, or should their contents also be renewed? Answers to these questions are searched in this article which objective is to provide an overview of study materials used in Estonian technology education, frequency of their usage and need for new study materials.

Methodology

Analysis of this article is based on two studies: firstly, a comparative study of Estonian technology education textbooks development trends and current curriculums, and secondly, identification of user habits and needs of technology teachers with respect to study materials were being used. Therefore, the following research questions were formed for addressing this topic:

- what are the development trends of textbooks being used in technology education?
- what are the Estonian technology teachers' user habits and preferences with respect to study materials and what are the needs for new study materials?

Document analysis (Flick, 2014) was used to find the answer to the first research question. In the case of document analysis, context must always be considered while interpreting data. Official documents allow generally less room for different interpretations and their context is more limited; it makes their analysis easier and less ambiguous, making therefore the creation of meanings also easier (Greenwood, Levin, 2000). In current study different textbooks and curriculums were addressed as documents, in which case the developments of structure and content of textbook were compared to the requirements of curriculum content. Technology education textbooks that were published regularly in Estonia since the 1970s were used in the analysis. 5 textbooks or series of textbooks published in different years and corresponding curriculums were selected for analysis.

A web-based questionnaire was used for finding the answer to the second research question. The e- Formular environment was used for conducting the survey and it was conducted in the autumn of 2016. The questionnaire was forwarded to all Estonian schools providing basic education where technology education was taught. In 2016 there were 454 such schools in Estonia (Koolid, 2016). However, at the same time many technology education teachers work in several schools and therefore assessing their overall number is difficult (Tööõpetuse õpetajate…, 2010). The questionnaire included nine free and multiple-choice questions, answering to which took approximately 10 min. The questions were divided into three blocks: background information of the respondent, study materials being used and frequency of their use, and need for new study materials. 66 questionnaires arrived back with answers. Of the teachers who responded, 90 % were men and 10 % women, corresponding to the overall gender breakdown of Estonian technology teachers (Tööõpetuse õpetajate…, 2010). The average age of the teachers was 49 years, expressing the general average age of Estonian teachers which was 47,9 years in 2013 (Eisenschmidt, Ruus, 2015). The survey provided data belonging to different feature types that were analyzed with the program SPSS 22 which enabled to present different necessary statistics.

Results and discussion

In the first study focusing on identification of study materials development trends, the structure and content of textbooks was analyzed and compared to the curriculums that were in force in that period of time. As stated above, five main textbooks published in different times were used in the analysis. The results of the analysis are summarized in Table 1. The results indicate that first textbooks published (I) were in compliance with the study programs that were in force in the years of publishing the textbooks; these study programs were very detailed and the textbooks were suitable for being instruments of their implementation. The contents of these textbooks were very technical and their text was complex. The part of material processing included different processing technology instructional material. For supporting the study programs, textbooks of electro-technical and bookbinding work were also

published separately; but these textbooks are not included in current analysis. The woodwork and metalworking textbooks (I) that were used in the analysis were several times reprinted during 16 years. Since 1991 after regaining Estonian independence, class-based textbooks (II) began to appear one by one. The curriculum of 1996 reduced considerably the number of topics being taught and simplified and generalized learning content. The published class-based textbooks (II) distributed the topics of previous technology-based textbooks by classes and significantly simplified learning content. The part of woodwork and metalworking integrated different material processing technologies with work instructions for the manufacture of articles (Table 1).

Table 1

Comparison of textbooks and curriculums

Textbook	Content distribution	Comments on the textbook	Beginning of validity and name of the curriculum	Topics
(I) 1974-1990 - woodwork and metalworking textbooks based on processing technology, a 160 pg.	30 %- materials science, 35 %- manual processing, 35 %- machine processing	The part of material science – specific hard text. The part of processing – material processing techniques.	Estonian Soviet Socialist Republic (ENSV) and first Republic of Estonia (EV) study programs	General technical preparation, woodwork, metalworking, electro-technical work, housework, gardening and agricultural work, bookbinding work.
(II) 1991-2000 – class-based series of crafts textbooks, a 80 pg.	30 %- general technical preparation, 35 %- woodwork, 35 %- metalworking	Simplification of previous textbooks and distribution of topics by classes.	1996- Crafts	General technical preparation, woodwork, metalworking and works by choice.
(III) 2005 ja 2007 - woodwork and metalworking textbook based on processing technology, 80 pg.	50 %- technical knowledge, 50 %- work instructions	Technical knowledge- manual and machine processing of material and materials science, electric hand tools.	2002- Craft- and technology education	Technological history and literacy, contemplation and technical creation, processing of materials, coat finish and electric hand tools
(IV) 2011 – technology and creativity textbook, 150 pg.	70 %- engineering and technology, 30 %- work instructions	Engineering and technology, design and materials science.	2011- Technology education	Technology in everyday life, design and drafting, processing of materials, homemaking, project work.
(V) 2011-2015 – class-based techno-logy education text-books, a 100 pg.	100 %- technology theory	Literature translated from French language, theory of technology.		

In 2002 the curriculum „Craft- and technology education" was established which name already indicated the developments toward technology education. The level of detail increased in the curriculum again and new topics were added to traditional ones: electric hand tools, technical literacy. In 2005 a technology-based woodwork and metalworking textbook was published (III) again. The new curriculum's learning content was generally reflected in the textbook. However, half of the textbook volume was devoted to work instructions for manufacturing different articles and therefore the textbook could not entirely communicate the curriculum's learning content any more.

In 2011 the last curriculum „Technology education" took effect. Previous general technical and engineering learning content was changed into technology studies. The textbook „Technology and Creativity" (IV) no more included woodwork and metalworking instruction, but focused on general introduction of different technologies and alternative materials such as glass, plastics and leather. One third of the textbook consists of a collection of work instructions for different articles. Therefore, this textbook does not enable teaching of basic skills for material processing and is useful for covering theoretical part of technology education and as an additional study material beside older textbooks.

The last series of textbooks (V) „Technology education" is the only translated literature and includes theoretical material of technology education. The textbook is appropriate only for covering the curriculum's topic „Technology in everyday life".It may be concluded that textbooks have generally followed curriculum developments and strived to cover the learning content nationally prescribed for the subject. Strong tendencies toward deepening technology education appear in these developments. However, it can be seen that for covering the whole curriculum the production of different textbooks is required, be they based on classes, material processing technologies or different curriculums. Although in the 21th century new technology themed textbooks have been produced for Estonian technology education subject, the textbooks dealing with different materials processing have remained in content and in form into the previous century.

In case of second survey it was important to get an overview of the importance of study materials in technology education. In the context of this article, study materials are defined as different digital and printed materials enabling to communicate learning content that have been used in technology education so far, like textbooks, work instructions, handbooks and learning objects, that were identified in the course of Estonian study ware mapping (Lips, 2016). In the case of multiple-choice answers in the questionnaire, a list of different types of study materials was specified for teachers.

Teachers were initially questioned about how often on average they use study materials in technology education lesson. Figure 1 gives an overview of the results. The answers indicate that 42 % of the teachers use different study materials in technology education lesson 2-3 times a month (Figure 1). Taking into account that one study group has technology education lesson four times a month, then 60 % of teachers use at least every second lesson or more often some study material for conducting a lesson. This result suggests that study materials are for teachers relatively important tools in teaching.

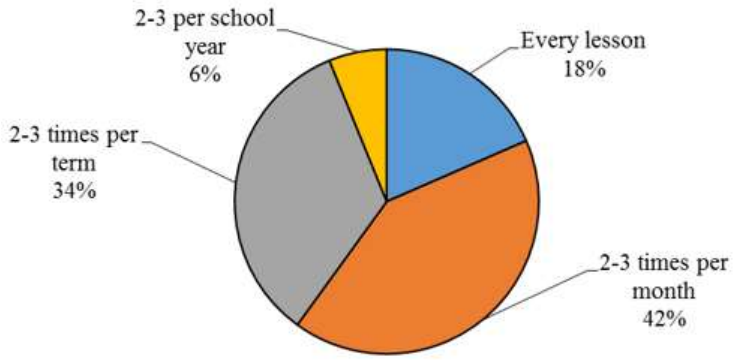

Figure 1. Frequency of study materials usage by technology education teachers.

The main form for achieving technology education learning objectives has been through times practical independent work with materials and tools (Rihvk, Malmstein, 2008). The technology education curriculum that was in force in 2002 also pointed out that practical activity should comprise in technology education lesson approximately two thirds of study time. Such proportion had not to be followed in every lesson. While covering new type of work or topic, most of a lesson was spent on covering theory questions and working practices. Yet in lessons where laborious items were manufactured, the majority of time was dedicated to practical work (Põhikooli ja gümnaasiumi…, 2002). The new technology education curriculum adopted in 2011 did not, however, specify similar volume of practical learning activity, and emphasized the importance of different technological knowledge learning topics instead, pointing out that in technology education the studies are divided into five theme blocks: technology in everyday life; design and drafting; material processing; homemaking; project work. First three parts comprise approximately 65 % of teaching, homemaking 10 % and project work 25 % (Ainevaldkond „Tehnoloogia", 2011). Therefore, in relation to these developments, it is important to know which type of study materials are most used by technology education teachers and whether it is related to the increase in theory volume of studies or to teaching of practical working practices.

Next it was examined which type of study materials the teachers have used in teaching and what are their user preferences. An overview of the responses is given in Figure 2 which indicates that most of the teachers have used printed textbooks (77 %) and instructional materials written by themselves, followed by videos found on the web (65 %) (Figure 2). It can be understood, because in Estonia

technology education textbooks have been issued mostly compared to different study materials, and a textbook may seem to be the best study material precisely for a newer teacher.

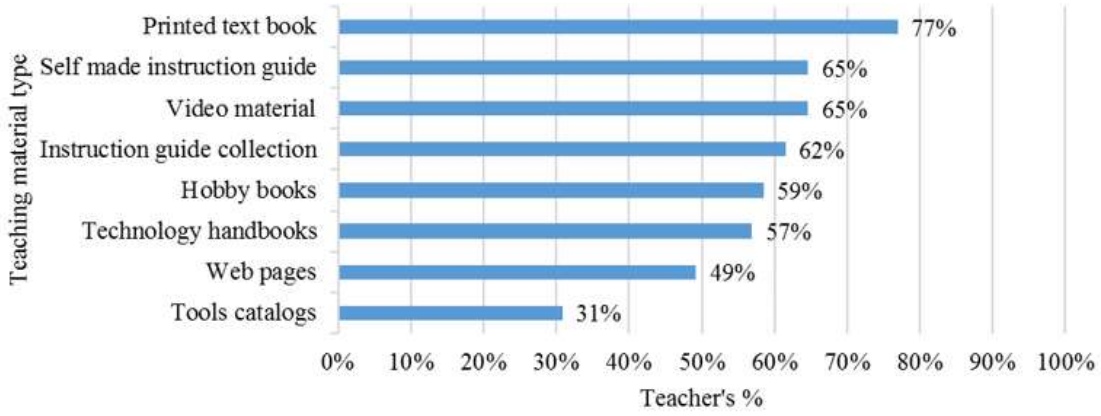

Figure 2. Study materials used by teachers.

Textbooks in the field of technology have been published regularly in Estonia since 1970s. Since then, in Estonia several technology education textbooks, a collection of work instructions and series of textbooks have been published which were offered to the teachers for ranking according to the frequency of their usage. This sample included:

- 1974-1990 – woodwork and metalworking textbook based on processing technology;
- 1992 ja 1990 – work instructions collection;
- 1991-2000 – class-based series of craft textbooks;
- 2005 ja 2007 – woodwork and metalworking textbook based on processing technology;
- 2011 – technology and creativity textbook;
- 2011-2015 – class-based technology education textbooks translated from French language.

The analysis of sequencing results indicated that teachers use mostly the class-based craft textbook that was published during years 1991-2000. This can perhaps be justified by teachers' common understanding of learning process where they trust the division of study themes and their contents provided by the study material's author which must meet the curricular requirements. In Estonia, the newest technology education textbooks published in 2011-2015 that are translated from French language have also been issued as class-based. Teachers, however, have not adopted these and they are least used of textbooks. This situation can be justified with the fact that technology education is strongly linked to local culture and traditions and would not so easily be subject to general educational trends (Schleicher, 1991), and that Estonian technology education has traditionally focused on practical work which is not supported by this textbook. The teachers ranked on second place the collection of work instructions that was issued already in 1992 and includes 93 work instructions for doing practical works. While looking at usage of textbooks based on processing technology, it can be observed that here the newest textbooks are used, namely the study material issued in 2005 which includes also 50 % work instructions collection. However, the teachers prefer woodwork textbook over other technologies, indicating again the material processing traditions that are common in Estonia.

At the same time a question raised whether a textbook is also the most used study material in technology education lesson? For answering this question, the teachers were asked to rank different study materials according to frequency of their usage. Although previous question indicated that teachers had used in teaching mostly textbook, however, it was not any more the case according to the sequence on the basis of frequency of usage. The teachers ranked study materials as follows:

1. self-written work instruction;
2. collection of worksheets or work instructions;
3. textbook;
4. web environments and webpages;
5. web video material;
6. technology handbook;
7. workbooks;
8. web-based learning objects;

9. hobby activities book;
10. tools catalogue.

Thus, according to frequency of usage, teachers use textbook only as third study material, preferring by far both self-written and printed work instructions. Consequently, it can be argued that in Estonian technology education lesson learning through practical work during which different artifacts are manufactured remains central. This result will once again highlight the peculiarity of technology education where teachers while setting study goals follow more their own interests and the school's material technical base than what is provided in the curriculum (Kikkull, 2012; Kikkull, 2016).

The above does not, however, throw light on the question what should be further development of study materials in technology education and whether teachers prefer to use in teaching digital or traditional study materials specially developed for technology education. Therefore, it is important to determine what study materials technology education teachers need. Although study materials on paper were most used by teachers, different digital study materials cannot be excluded either. In spring 2016 in Estonia nationally conducted compulsory school's study materials mapping demonstrated that in technology education the essential study materials for covering the curriculum exist on paper. There is also a small amount of digital study ware which covers all topics in the subject area episodically or partially. Thus correct digital study ware is missing in technology education (Lips, 2016). Usage of digital study materials was clarified with the teacher survey which indicated that teachers rank by far as the most popular the YouTube video environment that was pointed out 28 times. Different types of DIY and 'How to do' video materials being used for educational purposes are probably meant here. There are special technology education learning objects and study subjects' associations websites where study materials can also be found were marked only 1-2 times. The survey demonstrated that although 91 % of teachers have themselves prepared for their students different, mainly printed study materials in the form of manufacturing drawing or work instruction, many (71 %) teachers lack courage or skills for preparing web-based instructional or study materials which would also be available and usable for other teachers. This trend may stem from both teachers' low self-esteem and lack of didactic materials preparing skills.

For determining further development trends of study materials the teachers were finally asked what type and content of study materials technology teachers need more. For determining the study material types, teachers had to assess the need for specified paper and digital study materials on 9-stepped Likert scale where 1 was the most needed and 9 the least needed study material. The study materials sequence based on averages is presented in Figure 3.

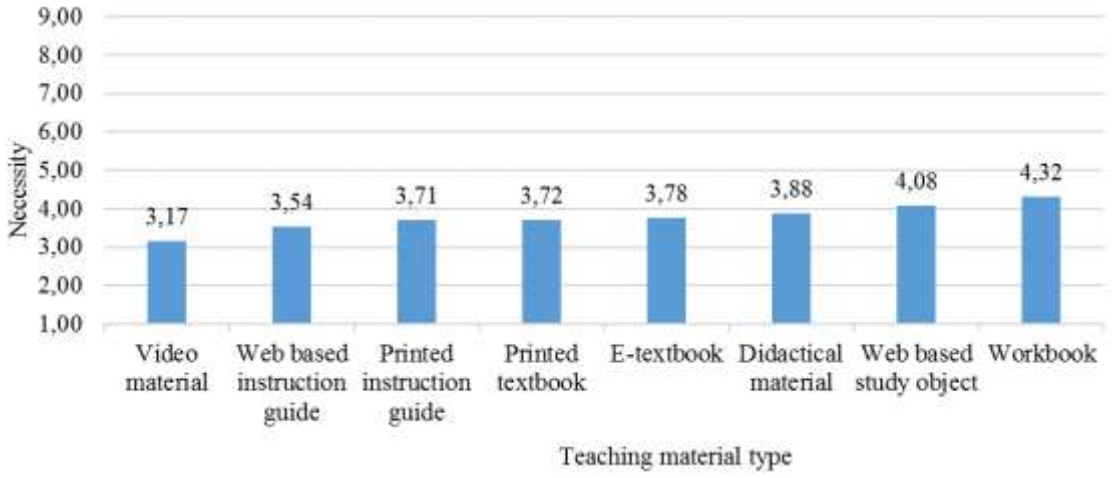

Figure 3. Averages of needs for study material types.

The analysis of study materials sequence and averages indicates that most teachers need different types of study materials (all study materials have mode 1), but video materials are wanted the most (M=3,17; SD=2,78), which is in accordance with the use of digital materials mentioned above. It is followed by web-based and printed work instructions. Comparative analysis of age groups and study material needs of respondent teachers did not provide significant differences of opinions (Figure 3).

Finally, it was examined what content of study materials teachers need. The question was presented as an open question and the teachers' answers were categorized. It is worth noting of the results that learning content related to *material processing* was brought out at most, namely 11 times. 9 times the teachers wanted *electronics and electrical engineering study materials* and 4 times *robotics* materials. Thus teachers are still interested in study materials related to different materials processing which could be prepared as video material or digital and printed work instructions. However, modern technology fields like electronics and robotics are also gaining popularity.

Conclusions

In conclusion, it can be brought out that technology education study materials have developed unevenly through different curriculums in Estonia and different theory themes materials have been developed more than has been invested in preparing materials with practical orientation. In the same time, different study materials together cover the curricular topics.

Although textbook is the most widely used study material among teachers, different work instructions that are directly related to manufacturing different artifacts are still a favorite of technology teachers. In the same time students need different basic knowledge and skills before starting practical work. Teachers think that this basic knowledge and skills would be most reliably taught using a class-based textbook in which the learning content has been already divided into topics following the inner logic of the subject. Although teachers can use several printed textbooks with different level and structure, they see great potential also in modern digital solutions which can be implemented in study materials. This is testified by frequency of usage of YouTube video environment by teachers and the need for video materials created especially for technology education that has been pointed out.

The fact that technology education in Estonia is still a subject with practical orientation and teachers miss namely modern material processing study materials may be pointed out as an important one.

Bibliography

1. *Ainevaldkond „Tehnoloogia" (Subject field "Technology").* (2011). Põhikooli riiklik õppekava lisa 7. Eesti: Vabariigi Valitsuse 06.01.2011. a määruse nr 1. Tallinn: EV Riigi Teataja. [online] [06.12.2016]. Available at https://www.riigiteataja.ee/aktilisa/1290/8201/4018/141m%20lisa7.pdf (in Estonian)
2. Allington R. L. (2001). *What really matters for struggling readers: Designing research-based programs.* Boston, MA: Allyn & Bacon.
3. Dobler E. (2015). e-Textbooks. *Journal of Adolescent & Adult Literacy*, Vol. 58(6), pp.482 – 491. [online] [06.11.2016]. Available at http://doi.org/10.1002/jaal.391
4. *Eesti elukestva õppe strateegia 2020 (Estonian Lifelong Learning Strategy 2020).* (2014). [online] [06.11.2016]. Available at https://www.hm.ee/sites/default/files/strateegia2020.pdf (in Estonian)
5. Eisenschmidt E., Ruus V.-R., Poom-Valickis K. (2015). Õpetajahariduse perspektiivid – olukord ja väljakutsed (Teacher Education Perspectives - situation and challenges). *Riigikogu Toimetised* Vol. 31. (in Estonian)
6. Flick U. (2014). *An Introduction to Qualitative Research* (5th ed.). London: SAGE Publications.
7. Greenwood D. J., Levin M. (2000). Reconstructing the relationships between universities and society through action research. In Denzin N.K., Lincoln Y.S. (Eds.). *Handbook of qualitative research*. Thousand Oaks, CA: SAGE Publications, Inc., pp. 85 – 106.
8. Hawkins D. T. (2000). Electronic Books. *Online*, Vol. 24(5), pp.18 – 36.
9. Kikkull A. (2012). Comparing the Nordic countries' and the Estonian Craft syllabuses. Similarities and differences. In Dišlere V. (Ed.). Proceedings of the 5th International Scientific Conference *Rural Environment. Education. Personality* (REEP). Jelgava: Latvia University of Agriculture, pp. 154 – 160.
10. Kikkull A. (2016). *Didaktilised ja organisatoorsed tingimused õpilaste teadmiste praktikasse rakendamise tõhustamiseks tööõpetuse ja reaalainete lõimingu kaudu põhikoolis (Didactic and organizational conditions for forming students' applicability of knowledge through integrating craft and sciences in compulsory school*). Doktoritöö. Tallinn: Tallinna Ülikool. (in Estonian)
11. *Koolid (Schools).* (2016). EHIS - Eesti Hariduse Infosüsteem. [online] [06.11.2016]. Available at https://enda.ehis.ee/avalik/avalik/oppeasutus/OppeasutusOtsi.faces (in Estonian)

12. Lips A. (2016). Tehnoloogia (Technology). In Kõiva M, Müil E., Varend L., Raudsepp I., Mjalitsina N.(Eds.). *Ülevaade üldhariduse õppevara kaardistusest 2016. a.* Tallinn: SA Innove. (in Estonian)
13. Minkel W. (2000). The E-Textbooks are Coming. *School Library Journal*, Vol. 46(9), p. 18.
14. *Põhikooli ja gümnaasiumi riiklik õppekava (The national curriculum for basic schools and upper secondary schools).* (2002). Eesti: Vabariigi Valitsus. [online] [06.11.2016]. Available at https://www.riigiteataja.ee/akt/162998 (in Estonian)
15. Rihvk E., Malmstein K. (2008). Motivatsioon tööõpetuses (Motivation in craft education). *Haridus*, Vol. 11-12, pp. 30 – 33. (in Estonian)
16. Schleicher K. (1991). Handicrafts. In A. Lewy (Eds.). *The International Encyclopedia of Curriculum*. Israel: Pergamon Press, pp. 694 – 698.
17. Schunk D. H., Zimmerman B. J. (1998). *Self-regulated learning: From teaching to self-regulated practice.* New York, NY: Guilford.
18. Sheridan-Thomas H. K. (2008). Assisting struggling readers with textbook comprehension. In Hinchman K. A., Sheridan-Thomas H. K. (Eds.). *Best practices in adolescent literacy instruction*. New York: Guilford Press, pp. 164 – 184.
19. Soobik M. (2011). Innovative Approaches to Technology Education in Estonian General Education Schools. *Procedia - Social and Behavioural Sciences* Vol. 29, pp. 57 – 66. [online] [16.11.2016]. Available at http://www.sciencedirect.com/science/article/pii/S187704281102667X
20. Soobik M. (2015). *Innovative trends in technology education. Teachers' and students' assessments of technology education in Estonian basic schools*. Doctoral Thesis. Tallinn: Tallinna Ülikool.
21. *Tööõpetuse õpetajate andmed 2010-11. (Craft teachers' data in the 2010-11).* (2010). Tallinn: Eesti Hariduse Infosüsteem. (in Estonian)