Experiences of Classroom Techniques and Learning Outcomes

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Abstract

This article is a part of a research project that is aimed to explore how the background variables of learning are related to learning outcomes in a Sloyd subject, internationally referred to as Craft, Design and Technology. The research question of this article is: "How are ninth grade pupils' experiences of classroom techniques related to their learning outcomes?"

The empirical data is based on an evaluation by the Finnish National Board of Education (FNBE). The data (n = 4,792) was collected by stratified sampling from 152 schools. The data of pupils' experiences of classroom techniques was gathered in a specified questionnaire using a narrowed sample (n = 1,548). Three main orientations for learning were found: Learner-Centred Learning, Teacher-Directed Learning and Collaborative Learning. Furthermore, two orientations were formed of technical and textile technology areas of the subject.

Analysis revealed that participating in either classes of technical technology area or textile-technology area predicted success in the other area as well. Thus, learning outcomes in one area correlate with the learning outcomes in the other. Due to this result, the effects of learning orientations were analyzed separately for both technology areas. Experiences of Learner-Centred Learning predicted success in technical technology area while experiences of Teacher-Directed Learning predicted success in textile technology area. Collaborative Learning didn't predict success in either of the areas. The results can be applied in developing the subject more towards the learners' point of view.

Key words

Sloyd education, craft, design & technology education, learning outcomes, classroom techniques, self-regulated learning

Introduction

Finland was the first country in the world to establish Sloyd as a compulsory subject in 1866. Due to Nordic heritage, Finnish Craft, Design & Technology Education is still referred to as Sloyd Education (see Borg, 2008). The official name is only Craft in the Finnish National Core Curriculum for Basic Education (2004). In Finland, the most fundamental content of technology education is taught especially in technical technology area within the subject Sloyd (Kananoja, 2009). Internationally, technology education is involved in subjects such as Science, Technology, Engineering and Mathematics (STEM). In Finland, the Sloyd subject (comprises technical and textile technology areas) is categorized within the group of practical subjects, with subjects such as Art and Physical Education (Kauppinen, 2009: 5). As in Sweden, school subjects are commonly divided practical or theoretical, but this is not unproblematic (Norström, 2013). Both theoretical and practical knowledge is applied in Sloyd. Sloyd characterizes the subject in Finland, because both Design & Technology are traditionally related to Craft, while in many countries technology is taught apart from Craft (comp. Norström, 2013; Rasinen, Ikonen & Rissanen, 2011).

Pupils' readiness for Self-Regulated Learning and the relation of leisure-time interests and learning outcomes has been studied earlier in this research project

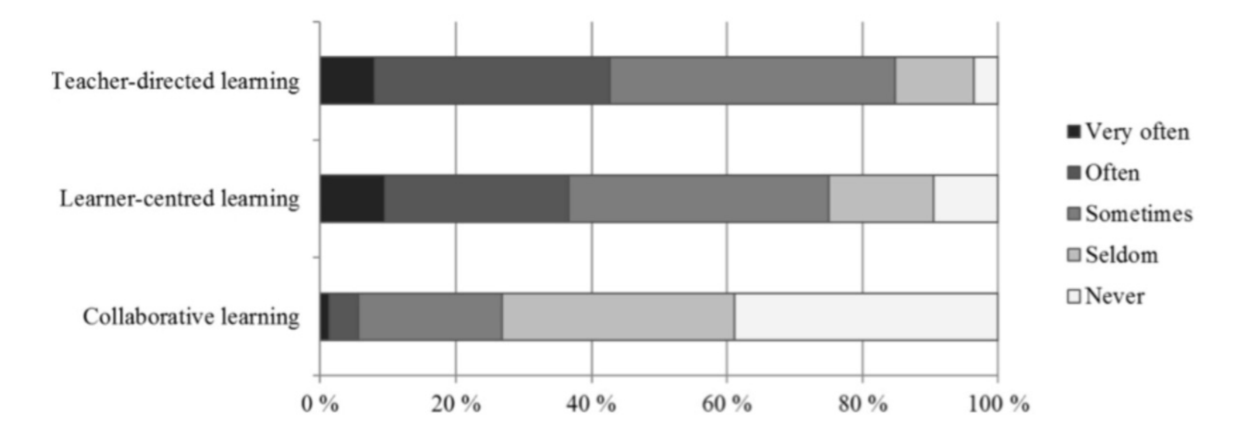

Figure 1. Students' (n = 1,548) experiences of the learning orientations.

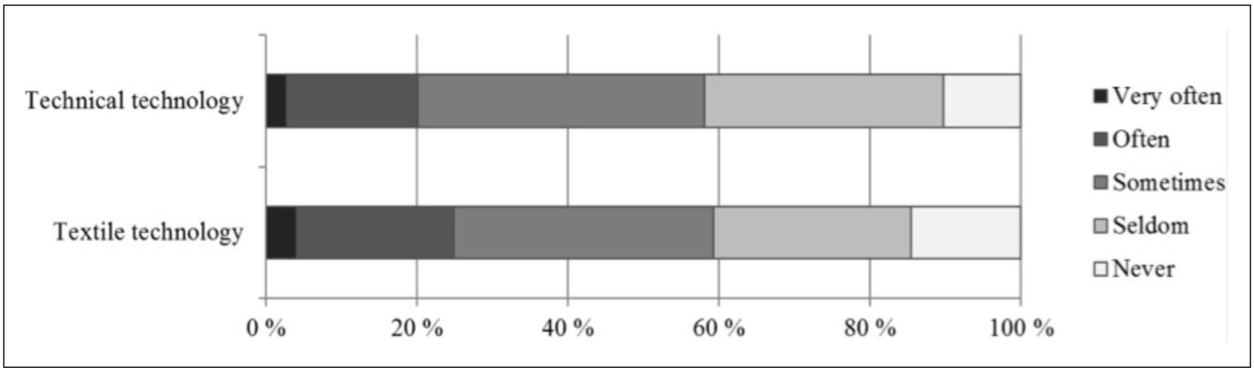

Figure 2. Students' (n = 1,548) experiences of learning technical technology area and textile technology area.

(Metsärinne, Kallio & Virta, 2014; Metsärinne & Kallio, 2014). According to that study, pupils' maintenance and repair-related craft interests and activities during leisure time affect their learning outcomes, but production-related interests and activities do not. The analysis is based on evaluation data of the Finnish National Board of Education (FNBE). To study Self-Regulated Learning, three factors of learning orientations were formulated from the data. They were placed between Teacher-Directed (receptive) Learning and Learner-Centred (independent) Learning experience. Collaborative Learning by working with pairs or working in groups are closer to Learner-Centred Learning than to Teacher-Directed Learning (Lahdes, 1977; Hilmola, 2012). By working collaboratively pupils take part in planning of teaching and making decisions, for example in problem solving process. (Hilmola, 2012; Metsärinne, 2004). These concepts are discussed further in the next chapter. Hilmola (2012) has studied Sloyd teachers' working methods in practice. In that study, the Sloyd teachers' (n= 257) answers in FNBE data revealed that Finnish Sloyd teachers generally use Learner-Centred working methods. Teacher-Centred and Collaborative Learning methods are unusual in Sloyd. Applying versatile working methods are aiming towards students' Self-Regulated Learning.

There were four statements in the factor of Teacher-Directed Learning. They revealed low level of Self-Regulation. For Learner-Centred Learning, there were five statements revealing a high level of Self-Regulation. For Collaborative Learning, there were five statements.

Experiences of both Teacher-Directed and Learner-Centered Learning were common. 74.6 % of pupils had experienced Learner-Centered Learning and 84.3 % had experienced Teacher-Directed Learning at least sometimes. 26.6 % of students had experienced Collaborative Learning. Technical technology area and textile technology area formed another two factors with seven statements for both technology areas. (Metsärinne, Kallio & Virta, 2014; see table 1).

In Finland, most often pupils study both technology areas in grades 3–5 and after that they choose one of the areas. In the 8th and 9th grade, the subject is optional. The Sloyd subject is optional in the eighth and ninth grades, but compulsory in the seventh grade. The evaluation was carried out with ninth graders, from which 33 % had studied technical technology and 19 % textile technology. In the seventh grade, 72% of pupils had studied technical technology and 65% textile technology. 38 % of pupils had studied both technology areas. This explains how over 50 % of pupils had experienced learning in both technology areas at least sometimes. (Hilmola, 2011: 172).

According to the FNBE evaluation, the pupils' learning outcomes were good overall (Hilmola, 2011: 158–237). The relation between pupils' experiences of classroom techniques and learning outcomes was not analysed by the FNBE. The research question of this article is: "How are ninth grade pupils' experiences of classroom techniques related to their learning outcomes?"

Theoretical Background

In Finland, the last national Core Curriculums for Basic Education have not been written in normative but descriptive way. It isn't mentioned in the curriculum which technologies should be taught and learned within the Sloyd subject. Teaching and learning is carried out through Exploratory Production based on actual cases relevant to student's environment of life. (National Core Curriculum for Basic Education, 1994; 2004; Peltonen, 2003; Lindfors, 1991; 1999). The technologies are finally defined in the local learning environments and school contexts. The modern and actual knowledge of technology is achieved continuously in the cases of Exploratory Production by the teacher and the learner or by collaborative ways. Teacher-Directed Learning is mainly used when pupils have difficulties with their Self-Regulation or technological competence. Learner-Centred Learning is used when students have readiness for Self-Regulation and enough technological competence. For Collaborative Learning, there are two viewpoints. From Vygotskian perspective, learners are part of cultural actions and they learn to share knowledge and thinking gradually. From Piagetian perspective, learners' social interactions can be a motivator for production activities, although new ideas come from a learner's constructive mind. According to Hong, Yu & Chen (2011: 336–337): "the Vygotskian perspective suggests that only the less-capable person benefits from the interaction…and on the other hand, the Piagetian perspective suggests that peer collaborative settings provide opportunities for all students to learn." "Students become active participants in their own learning processes and also learn to solve problems and work collaboratively" (Neo & Neo, 2013: 49). Therefore both perspectives are useful and used when educating pupils towards Learner-Centred Collaborative Learning (for example Hamilton, 2007; Kangas, Seitamaa-Hakkarainen & Hakkarainen, 2013a).

Each learning task with a unique production case renews a learner's knowledge base which has an effect on the next task and case. Progress in the continuum of learning makes it possible to apply more complicated technology and quality of production. Self-Regulated Learning is required in Exploratory Production. "Self-Regulated Learning is an active constructive process in which learners set goals for their learning and monitor, regulate, and control their cognition, motivation, and behaviour, guided and constrained by their goals and the contextual features of the environment" (Pintrick & Zusho, 2002: 64). From this basis, Nicol and Macfarlane-Dick (2006: 5) has introduced a model in which the teacher first sets tasks from which the pupils then set their own goals. Moreover, the model of Exploratory Production established in Sloyd Education has a philosophical basis that includes an existential viewpoint (Peltonen, 2003; Metsärinne & Kallio, 2011; Metsärinne, Kallio & Virta, 2014). Adapting Dewey (2011: 108–112), learners are encouraged to set production goals from their own life-world to achieve meaningful learning. In this way, learning is internally valued, regulated and motivated behaviour and it is performed out of interest and enjoyment of the activity for its own sake and there is no external control (Stefanou, Perencevich, DiCintio & Turner, 2004: 98–99).
A learner is expected to answer all three questions related to Self-Regulated Learning with support of the teacher. 1. Regulative knowledge: Why do I learn to produce technological activities? 2. Declarative knowledge: What do I learn and produce? 3. Procedural knowledge: How do I learn and produce? The second and the third questions are based on the goals for learning and production set as the answer of the first question. From Self-Regulated viewpoint, regulative knowledge is related to thinking of responsibilities such as values and risks, declarative knowledge is related to thinking of resources such as subject areas and information and procedural knowledge is related to thinking of concepts such as skills and practice (comp. Gradwell, 1999: 251).

To explore a learner's readiness for Self-Regulated Learning in Technology Education, the model of Exploratory Production and Zimmerman's (1998: 4; 2011: 56) model of Self-Regulated Learning were combined (Metsärinne, Kallio & Virta, 2014). Both models have three phases. The Definition Phase of Exploratory Production is related to the Forethought Phase of Self-Regulated Learning, the Implementation Phase is related to the Performance Phase and the Reliability & Quality Control Phase is related to the Self-Reflection Phase. In the Definition Phase of Exploratory Production, learners are envisioning and regulating their technological production activities. Next, in the Implementation Phase, the envisioned goals are tried and implemented through ideating, planning and manufacturing. Finally, in the Reliability & Quality Control Phase, the goals are tested with new products in their usage targets. In the earlier article of this project (Metsärinne, Kallio & Virta, 2014), learners' readiness for Self-Regulated Learning was studied in the Definition Phase of the model. The focus of this article is on the classroom experiences in the Implementation Phase and on the learning outcomes measured in the Reliability & Quality Control Phase.

In this article, the relation between experiences of classroom techniques (in the Implementation Phase) and learning outcomes (in the Reliability & Quality Control Phase) is analyzed. The Implementation Phase is regulated by goals set in the Definition Phase: the preconditions for the implementation (consists of envisioning the product idea, planning and manufacturing with technological knowledge) are defined in the earlier phase. Exploratory Production involves Ryle's (1949) original questions 'why', 'what' and 'how' of the Self-Regulation sub-processes in the contextual questions of 'where', 'with whom' and 'when' (Zimmerman, 1998: 3–4; 2000; Pintrich & Schunk, 2002). These categories are linked to regulatory knowledge (for why), declarative knowledge (for what) and procedural knowledge (for how) (comp. Chester, 2007: 26; Schraw, 2006: 245–

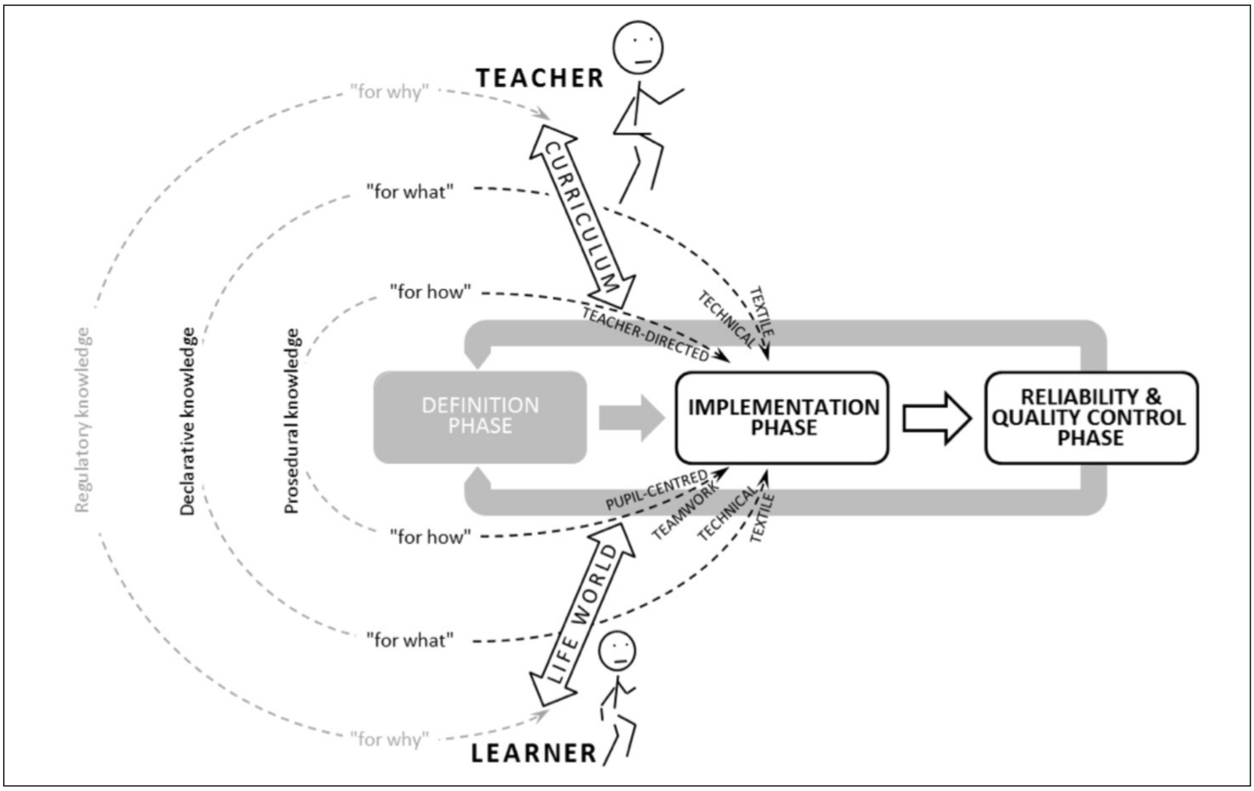

Figure 3. The learning orientation factors and the technology area factors in the theoretical framework of the Exploratory Production Model.

246). The question "for why" is already considered at this phase while the questions "for what" and "for how" are processed further. According to Hope (2009: 50): "Factual knowledge will not impact on a child's (or adult's) approach to a practical design task unless they see it's relevance to the task." Therefore, in Exploratory Production, the task is involved primarily in the learner's life-world. The approach to the task is regulated primarily by the learner in the Definition Phase of the production. On this basis, the technological content knowledge and procedural knowledge are taught and learned in the Implementation Phase. Technological and design knowledge is emphasized while practical knowledge of using tools and machines has a supplementary role.

Adapting Koehler & Mishra (2008: 15), the combined meaning of technological knowledge and pedagogical knowledge is that: "there are certain ways of thinking about and working with technology that can apply to all technology tools for different ways of accomplishing a given task". To describe technological literacy as a central part of learning of technology, de Vries (2011) has categorized technological knowledge as conceptual knowledge and contextual knowledge. This viewpoint emphasizes that learning technology is not only learning how to implement but also what to implement. Conceptual knowledge comprises designing ('design as a verb'), modelling, systems, resources and values of technology. In this viewpoint, contextual knowledge comprises construction, artefacts for practical purpose ('manufacturing'), communication and other contextual areas of technology. Design is related to conceptual knowledge and manufacturing is related to contextual knowledge. According to de Vries (2011: 78): "designing is the type of problem solving in which a design problem is solved". So: "design is obviously about making, but more importantly it is about generating knowledge on how to make, how to solve a problem, how to improve ways to solve it, and how to transform the problem solving procedures themselves into general intellectual tools" (Mioduser, 2009: 393). In Finland, these goals are the general goals of Sloyd even though in practice the subject is still divided into technical technology area and textile technology area (National Core Curriculum for Basic Education, 2004).

Methods

The Finnish National Board of Education (FNBE) evaluation was constructed of the most common and most important content areas of technology by a group of experts and compulsory education teachers. The data was collected by stratified sampling from 152 compulsory education schools representing a comprehensive cross-section of counties and groups of districts (Laitinen, Hilmola & Juntunen, 2011). The more general questionnaire that all sample pupils (n = 4,792) from 152 schools answered, had ten questions – five on the Technical sub-area and five on the Textile sub-area. The more specialized part for a narrowed sample (n = 1,548) from 49 schools out of the 152, had twelve questions on the Technical sub-area and twelve on the Textile sub-area. (Hilmola, 2011a: 161.) In addition to the 34 questions above, some pupils from the narrowed sample were asked to complete a production exercise (n = 661). The more specified questionnaire included questions on pupils' comprehensions, leisure time interests and classroom techniques as background variables (Hilmola, 2011a: 175-181). The learning outcomes questionnaire consists of items about working methods and materials (such as wood, metal, electronics and textile planning and manufacturing technologies). Students need this knowledge in the implementation phase of their Exploratory Production.

CLASSROOM TECHNIQUES QUESTIONNAIRE

	Descriptives				Factor Structure Matrix				
	M	SD	Skewness	Kurtosis	Collaborative Learning	Textile technology	Learner-Centred Learning	Technical technology	Teacher-Directed Learning
Teamwork product planning	2.03	1.05	.74	-.23	**.934**	.181	.393	.337	.219
Ideating of new products in teams	2.13	1.08	.66	-.33	**.895**	.191	.399	.314	.237
Teamwork manufacture	1.91	1.05	.94	.06	**.823**	.129	.322	.340	.206
Presenting own planning to other students	1.69	0.99	1.32	.90	**.758**	.194	.309	.321	.131
Evaluating other students products	2.04	1.10	.82	-.12	**.623**	.107	.309	.316	.206
Knitting	2.74	1.25	.07	-1.05	.088	**.885**	.202	-.293	.187
Sewing clothes	2.96	1.24	-.10	-1.01	.050	**.873**	.232	-.293	.177
Crocheting	2.85	1.20	-.02	-.97	.099	**.857**	.194	-.247	.189
Reading of textile diagrams	2.70	1.22	.08	-1.02	.180	**.813**	.289	-.196	.207
Clothe-care and repairs	2.66	1.18	.15	-.86	.149	**.789**	.209	-.190	.188
Safety of textile technology	2.80	1.22	.05	-.93	.115	**.789**	.215	-.173	.210
Composing textile diagrams	2.48	1.21	.30	-.92	.264	**.756**	.304	-.116	.157
Own product planning	3.09	1.17	-.19	-.71	.316	.259	**.919**	.224	.335
Manufacturing based on own planning	3.18	1.17	-.31	-.63	.334	.213	**.867**	.238	.347
Presenting own planning to teacher	3.13	1.26	-.24	-.90	.316	.192	**.860**	.242	.324
Own ideating of new product	3.23	1.17	-.30	-.61	.290	.288	**.858**	.179	.367
Evaluating own manufacture process	2.86	1.19	-.05	-.85	.390	.315	**.696**	.205	.384
Metal techniques	2.76	1.27	.05	-1.09	.322	-.347	.151	**.898**	.145
Wood techniques	3.24	1.07	-.26	-.47	.216	-.243	.196	**.805**	.252
Electronics	2.56	1.27	.22	-1.10	.381	-.258	.187	**.798**	.136
Composing technical drawings	2.45	1.20	.27	-.96	.486	-.111	.358	**.697**	.188
Reading of technical drawings	2.54	1.16	.20	-.88	.474	-.071	.355	**.676**	.221
Safety of technical technology	3.56	1.12	-.58	-.26	.116	-.136	.176	**.663**	.267
Machinery	1.80	1.13	1.31	.73	.458	-.106	.140	**.565**	.069
Manufacturing products planned by teacher	3.18	1.13	-.27	-.55	.176	.096	.281	.245	**.760**
Manufacturing products by following teachers guidance	3.51	1.03	-.53	-.08	.041	.244	.320	.115	**.750**
Copying products	3.08	1.10	-.23	-.51	.258	.195	.296	.220	**.739**
Teacher has given product-ideas	3.09	1.09	-.30	-.51	.313	.208	.516	.265	**.662**

Extraction Method: Maximum Likelihood.
Rotation Method: Oblimin with Kaiser Normalization.

Table 1. Descriptives & Factor Structure Matrix of the Classroom Techniques Questionnaire.

	χ^2(df)	CFI	TLI	RMSEA	SRMR
Learner-Centred Learning	11.53(6)	.99	.99	.02	.01
Collaborative Learning	22.23(4)	.99	.98	.05	.01
Teacher-Directed Learning	15.15(4)	.99	.98	.04	.02
Technical technology	34.01(7)	.99	.98	.05	.02
Textile technology	38.68(12)	.99	.99	.04	.01

Table 2. Fit of the factor structures.

The division of the questionnaires between the technology areas affected the analysis of the data. Generally, the division is not considered important, but the data showed differences in the results between the two technology areas. Originally, there were 29 statements related to classroom techniques that were divided into two groups in the FNBE report. In the first group, there were statements related to pupils' experiences of learning of the technology areas (technical and textile). The other group was related to pupils' experiences of the learning orientations. In this group, there was a statement: "I have received a grade for my product from the teacher." According to the FNBE evaluation report (Hilmola, 2011: 175), the score for this statement differed from others in the same factor (9 % of students stated that they have never or only seldom received a grade). Due to the preliminary examination of the data, this statement did not fit into the categorization. Because it is a routine for teachers to grade products, this statement had no information value in the categorization and it was left out. 28 statements were used in the analysis (appendix).

The statements of the questionnaire were categorized using Exploratory Factor Analysis. The factor structure was clear as all factors were formed without difficulties and all statements were rated meaningfully (see Little, Lindenberger & Nesselroade, 1999). There were three factors for learning orientations: 'Teacher-Directed Learning', 'Learner-Centred Learning' and 'Collaborative Learning' and two factors for the technology areas of the subject. The internal consistency was evaluated by calculating Cronbach's (1951) alphas for the entire questionnaire (alpha = .90) and for the factors (alpha = .94 for factor 1: Collaborative Learning, alpha = .92 for factor 2: textile technology area, alpha = .90 for factor 3: Learner-Centred Learning, alpha = .89 for technical technology area and alpha = .82 for Teacher-Directed Learning). The alpha values can be considered high in all factors (Gliner, Morgan & Harmon, 2001).

For this article, the fit of the factor structure was estimated by Confirmatory Factor Analysis, CFA (Kline, 2011; Metsämuuronen, 2009). CFA is a special method of Structural Equation Modelling. It is used to test specified relations between factors. It indicates underlying constructs within, for example, questionnaires with groups of statements. In the CFA method, the researcher must specify both the number of factors and the pattern of loadings for each of the measured variables (Hoyle, 2012). Therefore, CFA models provide strong evidence regarding the validity of a set of measured variables and the theories underlying the structure (Curran, West & Finch, 1996; Morgan, Gliner & Harmon, 2001). The complex analysis type using schools (n = 152) as a cluster variable was set with Maximum Likelihood Robust -estimation in Mplus 6.11 Structural Equation Modelling software.

The indexes of CFA revealed good fit of the factor structures. Chi Square (x^2) describes the difference between theoretical and measured covariance matrixes. The interpretation of the x^2-value is ambiguous and it depends on, for example, sample size so the model fit should be evaluated by several indexes (Hair, Black, Babin & Anderson, 2010; West, Taylor & Wu, 2012; Ullman, 2001). Comparative Fit Index (CFI) and Tucker–Lewis Index (TLI) compare the model fit with the independence model. They indicate how much better the model fit is than it is in the independence model. In this study, the cut-off value of good model fit for both CFI and TLI was .95 (Tucker & Lewis, 1973; Hu & Bentler, 1999; Hoyle, 1995; Bentler, 1990). Root Mean Square Error of Approximation (RMSEA) indicates the model fit in comparison to the degrees of freedom of the model (Steiger, 1990). A cut-off value of .05 indicates good fit of the model (Byrne, 2012; Hoe, 2008; Steiger, 2000). Standardized Root Mean Square Residual (SRMR) indicates the model fit by comparing the averages of standardized residuals of the observed and predicted covariance matrix. A cut-off value of close to .08 indicates good model fit (Hu & Bentler, 1999; Little et al., 1999; West et al., 2012).

The confirmed factor structures were used in Structural Equation Modelling. The advantage of using a structural equation analysis compared to traditional analysis by regression or path modelling is that statistics can be applied on latent variable structures and the measurement error decreases (Kline, 2011; MacCallum & Austin, 2000).

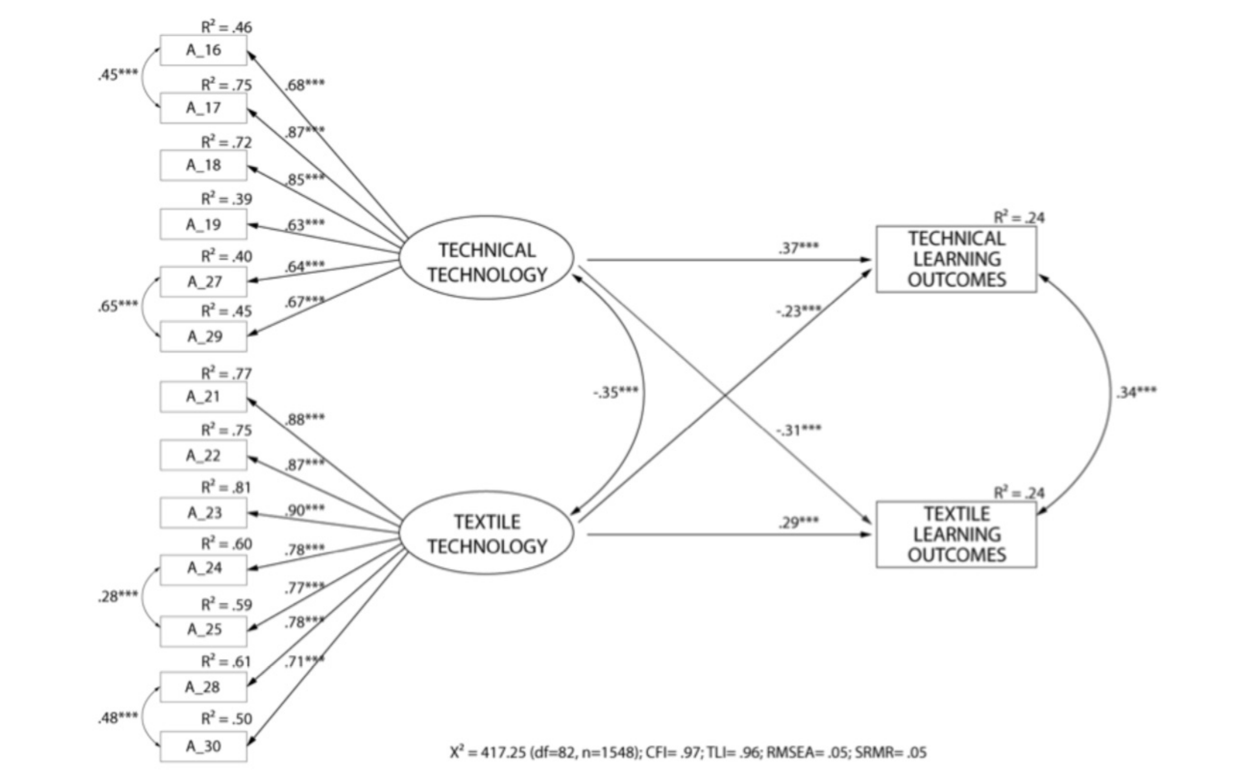

Figure 4: Relations between pupils' experiences of learning in technology areas and learning outcomes (n = 1,548).

Results

The following structural equation model was formed of the factors of learning experiences of technology areas and the learning outcomes.

Statistics show a high level of consistency between the model and the data. According to statistics, the fit of the factor structure is good ($x^2(df) = 417.25(82)$; CFI = .97; TLI = .96; RMSEA = .05; SRMR = .05). All relations in the model were very significant ($p < 0.001$). The regression coefficient of the relation between experiences of technical technology and learning outcomes was .37 and the relation between experiences of textile technology and learning outcomes was .29. The regression was inversed for crossed technologies and learning outcomes ($r = -.23$ and $r = -.31$). There was significant correlation between the learning outcomes for technology areas ($r = .34$) but experiences of technology areas did not correlate ($r = -.35$). The analysis revealed that participating in one of the technology areas predicted success in the other technology area. The regression coefficient was inversed for the learning outcomes of the other technology area but learning outcomes for both technology areas correlated. This indicates that success in one technology area predicts success in the other. This result leads to the question of how learning experiences predict learning outcomes separately for the technology areas. For further analysis, more narrowed sub-samples were formed within both of the technology areas.

The sample of the next analysis was formed from pupils who participated in both questionnaires (n = 1,548). Only pupils who had participated in either technical technology or textile technology throughout secondary school (3 years) were included in the sub-samples. Pupils who had not answered all the statements were removed so finally, the sub-sample of technical technology consisted of 457 pupils and the sub-sample of textile technology of 233 students. As a sample of 200 is suitable for Structural Equation Modelling, these are adequate amounts (Metsämuuronen, 2009).

Statistics for technical technology showed good model fit ($x^2(df) = 271.90(85)$; CFI = .94; TLI = .93; RMSEA = .07; SRMR = .06). The regression coefficient between the factors of both Learner-Centred Learning and Collaborative Learning and learning outcomes were very significant ($p < 0.001$). Experiencing Learner-Centred Learning predicted successful learning outcomes by regression of .34, but Collaborative Learning experiences had an inverse effect

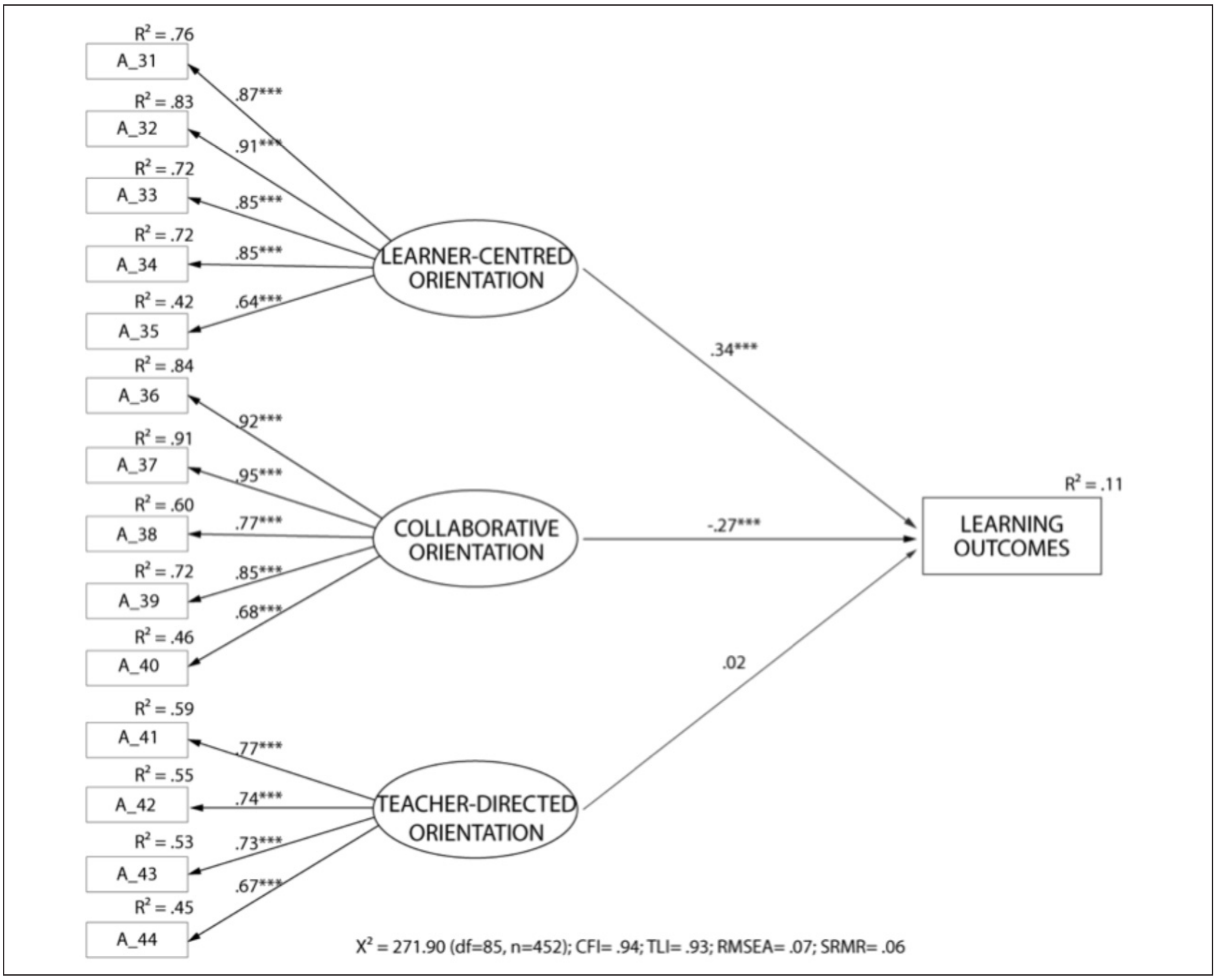

Figure 5: Relations between the experiences of learning orientations and learning outcomes in technical technology (n = 452).

(r = -.27). The regression coefficient for Teacher-Directed Learning was not significant (r = .02, p. = .86).

Analysis for textile technology showed different results. Statistics revealed good model fit (²(df) = 177.34(85); CFI = .95; TLI = .94; RMSEA = .07; SRMR = .05). The regression coefficient between the factors of both Teacher-Directed and Collaborative Learning experiences and learning outcomes were very significant ($p < 0.001$). Unlike in technical technology, experiencing Teacher-Directed Learning predicted successful learning outcomes by regression of .44. As in technical technology, Collaborative Learning experiences had an inverse effect (r = -.38). In textile technology, the regression coefficient of Learner-Centred Learning experiences was not significant (r = .16, p. = .24).

Conclusions

Learning outcomes are related to experiences in separated technology areas. Learning experiences of one technology area are not related to learning outcomes of the other technology area. However, the learning outcomes of both technology areas correlated. This indicates that successful learning outcomes despite the technology area correlate with learning outcomes of the other technology area. This result led to the question of how the experiences of learning orientations predicted learning outcomes for separated technology areas. This is against the general goals of the subject, by which the technologies are not separated on material basis. On traditional and social basis, it is also a question of gender equality (Rasinen et al., 2006). In some schools, the technology areas are studied in equal amount throughout grades. However, this produces a problem as pupils may not achieve an adequate skill level in either technology area. Due to the

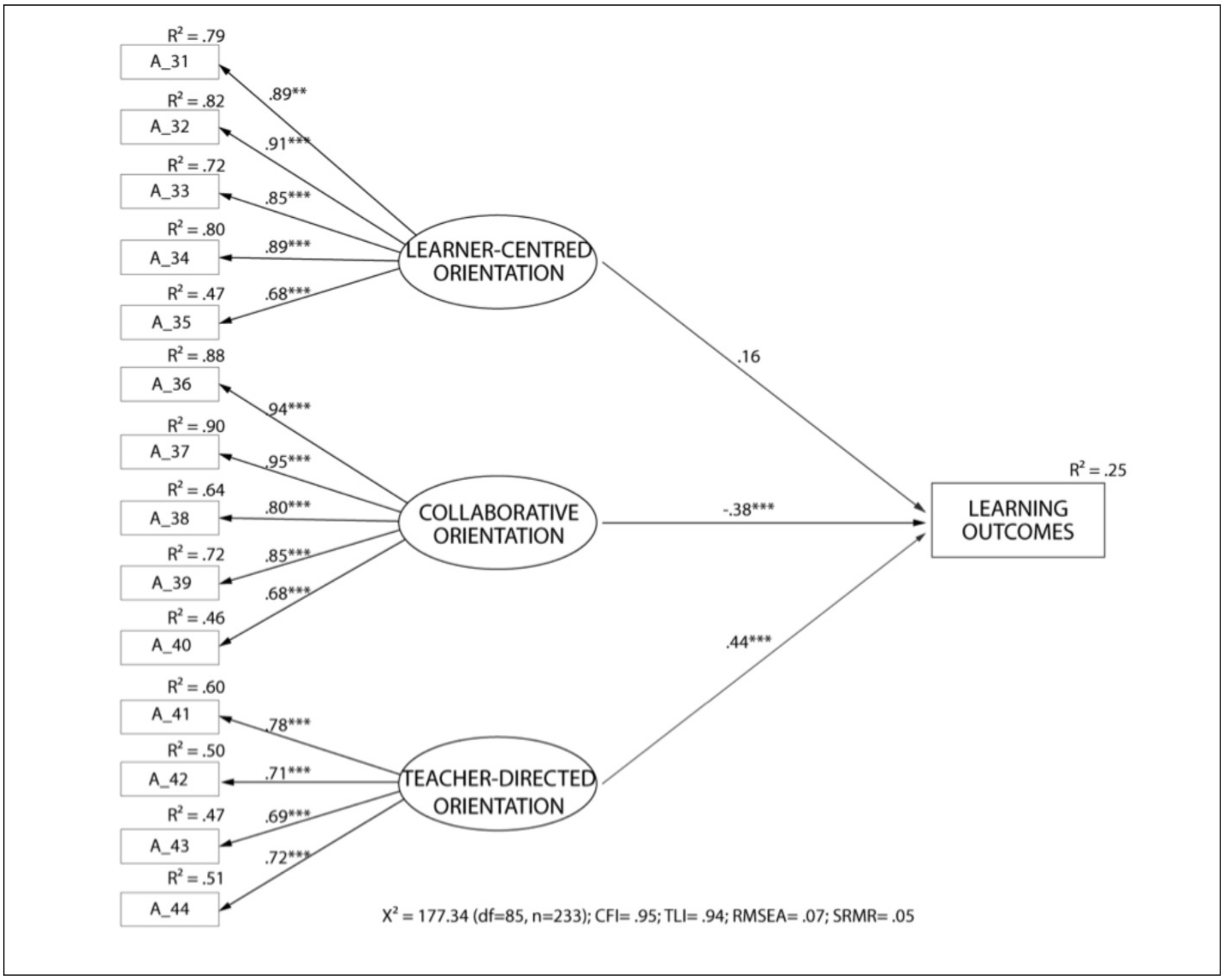

Figure 6: Relations between the experiences of learning orientations and learning outcomes in textile technology (n = 233).

results of this article and earlier results of this research project (Metsärinne & Kallio, 2014; Metsärinne, Kallio & Virta, 2014), pupils' freedom of choice should be increased, not restricted. The paradox of the division between the technology areas has not been solved since the traditional subjects Technical Work and Textile Work were combined into one subject in 1998. There are successful experiences of combining formerly separated subjects Metal Work, Wood Work, Machinery & Electronics and Technical Design into Technical Work in the beginning of 1970's. With Technical Work, the solution was to emphasize the knowledge basis and integrate each share of the material basis.

Another reason for the division of the technology areas may be found in Finnish teacher training in which the divide on material basis still exists. Teacher trainees gain readiness to teach only one of the technology areas in the upper level and high school level. In addition to the division between the material bases in teacher training, the training is arranged in different universities and teacher training departments. Teachers of textile technology have had Crafts Science as their main subject while teachers of technical technology have had Sloyd Education as their main subject in which the general goal is to educate in maintain and reform the environment of life more viable with technology (Metsärinne, Kullas, Kallio & Pirttimaa, 2010; see Peltonen, 2003; 2007). The general task of the teacher is to guide learners towards creating unique technological products or systems for the unknown, ever-changing and renewable world of technology (Metsärinne, 2009a; b). The secondary purpose is in the process of hands-on activity and skilfulness (Metsärinne & Kallio, 2011; comp. Peltonen, 2003). Educating students towards Self-Regulation and

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Self-Direction is emphasized (Metsärinne, Kallio & Virta, 2014). Furthermore the technological contents have been renewed continuously by the newest technological solutions (e.g. 3D modelling and printing, embedded systems and composites) following the international development. Altogether, the relations between pupils' experiences of learning in technology areas and learning outcomes suggest integrating the separated technology areas into modern hybrid Sloyd learning environment.

Previous consideration of integrating learners' experiences with their own life-world and actual modern technology in learning and producing could explain the relation between Learner-Centred Learning and learning outcomes. Prior results in this research project of the relation between learners' leisure-time interests and learning outcomes also support this conclusion (Metsärinne & Kallio, 2014). This encourages applying all kinds of technologies. This has long and continuously renewing traditions in Finland within technical technology area as new areas of technology have been successfully integrated into the subject for over four decades so far. In Finland the technological contents are taught especially in technical area of the subject. Current research is focused on schools that teach technical technology and textile technology in the same course. Internationally, there are several examples of applying electronics and textiles in same project in schools (Buechley, 2006; Buechley, Elumene & Eisenberg, 2006). Furthermore, textile technology can be included within STEM studies as well (Hughes & Bell, 2011: 53).

Perhaps the most critical result of this article is that pupils have not experienced Collaborative Learning and therefore it has not affected their learning outcomes either. On the other hand, teamwork is an obvious routine in classes so students might not recognize it as teamwork. Most often each pupil produces his/her own products and the products are rarely for shared use. Collaborative learning can be one way to develop Explorative Production when learners define and share their learning goals and complete specific tasks and assignments (comp. Johnson & Johnson, 1999: 68). In addition to pursuing Self-Regulated Learning, Social Shared Regulation could also be applied more. Pupils' Self-Regulation could be involved in presenting their knowledge with Collaborative Learning methods. In collaborative learning processes students' can support each other with special knowledge and interest. This could also make pupils' procedural and content knowledge more conscious and visible for other pupils (comp. Grau & Whitebread, 2012; Hadwin & Oshine, 2011). Some research projects have recently focused on these topics (e.g. Kangas, Seitamaa-Hakkarainen & Hakkarainen, 2013b).

These considerations and the results and conclusions of this article are current in Finland where the new National Core Curriculum of Basic Education 2016 is currently being finalised. The results can be applied in developing the subject more towards the learners' point of view.

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Appendix. CTQ correlation matrix.

CLASSROOM TECHNIQUES QUESTIONNAIRE CORRELATION MATRIX

16 Wood techniques	1.00																											
17 Metal techniques	.75	1.00																										
18 Electronics	.59	.74	1.00																									
19 Machinery	.35	.51	.55	1.00																								
20 Safety of technical technology	.65	.56	.49	.26	1.00																							
21 Sewing clothes	-.25	-.36	-.27	-.15	-.15	1.00																						
22 Crocheting	-.21	-.31	-.24	-.12	-.14	.76	1.00																					
23 Knitting	-.25	-.35	-.28	-.12	-.18	.78	.78	1.00																				
24 Clothe-care and repairs	-.19	-.26	-.19	-.04	-.09	.67	.66	.71	1.00																			
25 Safety of textile technology	-.18	-.25	-.18	-.10	-.00	.67	.68	.67	.70	1.00																		
27 Reading of Technical drawings	.48	.55	.54	.41	.39	-.14	-.08	-.13	-.03	-.04	1.00																	
28 Reading of textile diagrams	-.19	-.27	-.21	-.08	-.12	.71	.65	.70	.60	.62	-.00	1.00																
29 Composing technical drawings	.49	.58	.55	.45	.39	-.17	-.12	-.17	-.08	-.07	.79	-.04	1.00															
30 Composing textile diagrams	-.15	-.21	-.10	.01	-.07	.63	.60	.63	.57	.59	.03	.76	.06	1.00														
31 Own ideating of new products	.16	.08	.13	.07	.15	.23	.20	.22	.22	.21	.26	.28	.26	.29	1.00													
32 Own product planning	.17	.13	.16	.12	.14	.22	.17	.18	.19	.19	.31	.26	.32	.28	.80	1.00												
33 Presenting own plannings to teacher	.18	.15	.18	.14	.17	.15	.12	.13	.14	.15	.30	.20	.32	.21	.69	.80	1.00											
34 Manufacturing based on own plannings	.18	.16	.18	.14	.15	.17	.14	.15	.15	.16	.32	.22	.31	.23	.75	.77	.75	1.00										
35 Evauating own manufature-process	.14	.11	.13	.16	.15	.25	.24	.23	.25	.23	.31	.30	.28	.30	.58	.60	.60	.65	1.00									
36 Ideating of new products in teams	.19	.24	.30	.35	.11	.09	.14	.11	.17	.14	.42	.19	.42	.25	.33	.34	.32	.35	.40	1.00								
37 Teamwork product planning	.20	.27	.33	.38	.10	.08	.11	.11	.15	.14	.42	.19	.42	.25	.31	.33	.33	.34	.40	.86	1.00							
38 Presenting own plannings to other students	.16	.25	.31	.42	.08	.09	.12	.13	.17	.14	.38	.20	.39	.28	.23	.27	.26	.27	.32	.62	.69	1.00						
39 Teamwork manufacture	.20	.28	.32	.40	.13	.03	.07	.07	.12	.08	.37	.14	.40	.22	.25	.28	.27	.28	.30	.72	.76	.69	1.00					
40 Evaluating other students products	.18	.26	.27	.35	.12	.00	.06	.06	.12	.09	.35	.12	.35	.18	.22	.26	.28	.28	.30	.53	.56	.56	.57	1.00				
41 Teacher has given product ideas	.23	.19	.18	.15	.21	.14	.15	.16	.17	.16	.26	.23	.23	.19	.44	.44	.46	.46	.44	.33	.33	.23	.29	.31	1.00			
42 Manufacturing products planned by teacher	.23	.17	.16	.13	.20	.05	.07	.06	.09	.11	.22	.09	.20	.06	.25	.24	.23	.23	.27	.19	.19	.15	.20	.18	.52	1.00		
43 Copying products	.18	.15	.15	.11	.16	.13	.15	.17	.14	.15	.23	.17	.20	.17	.27	.24	.23	.26	.29	.28	.27	.19	.25	.21	.51	.56	1.00	
44 Manufacturing products by following teachers guidance	.15	.02	.05	-.02	.21	.21	.20	.19	.19	.22	.11	.21	.09	.15	.30	.28	.24	.27	.30	.10	.08	.03	.08	.09	.45	.55	.55	1.00
	16	17	18	19	20	21	22	23	24	25	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44