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Review of the Methods and Findings in the Dunn and Dunn Learning Styles Model Research on Perceptual Preferences

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Abstract

Evidence-based teaching methods are in demand in education. As a consequence practitioners and policy-makers are turning to learning styles for an evidence-based teaching technique. The Dunn & Dunn Learning Style Model is a widely used model claiming effectiveness based on findings from experimental research. A central aspect of the model concerns the use of modality-based teaching – i.e. Visual, Auditory, Kinesthetic and Tactual – VAK(T). Although having been debated since its inception no study to date has made a systematic review of the findings in the model literature, which to a large extent consist of unpublished sources, nor of the quality of that research. Findings suggest that the support expressed in published sources cannot be found in the actual studies. The quality of the studies is questioned on a number of counts with implications for existing meta-analyses. In all, with respect to perceptual preferences, the Dunn & Dunn model is not recommended for use in educational practices until a number of issues regarding the model and the model literature have been resolved.

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Review of the Methods and Findings in the Dunn and Dunn Learning Styles Model Research on Perceptual Preferences

1. Introduction

This paper reports a systematic review of the experimental research on matching teaching to student perceptual preferences within the Dunn & Dunn Learning Style Model. Models of learning style are used widely and among these the Dunn & Dunn model is among the most popular (Desmedt & Valcke, 2004). In Denmark the model has received much attention and is used both by individual teachers and school- as well as in district wide educational reforms. For instance in the municipality of Vejle the model was used as the central model for remedial teaching (Vejle Kommune, 2012). The municipality of Aarhus recently finished a five year project in which 10.000 teachers were given courses based on the model (Rådmanden for Børn og unge, 2008).

Within the model literature research evidence has been claimed to support the effectiveness of the model (R. Dunn & Griggs, 2004) – and several meta-analysis have been published that support this conclusion (e.g. R. Dunn, Griggs, Olson, Beasley, & Gorman, 1995; Lovelace, 2005; M. H. Sullivan, 1993). Critiques of these meta-analysis raising serious concerns regarding these conclusions have been made (e.g. Kavale, Hirshoren, & Forness, 1998; Kavale & LeFever, 2007) – however no systematic review of the central research in the model has been made.

The research on perceptual preferences within the Dunn & Dunn model connects the model literature directly with the more general concept of VAK(T) (visual, Auditive, Kinesthetic, Tactual). VAK(T) has become a commonly accepted tool among practitioners for differentiating instruction (Landrum & McDuffie, 2010). It may also be the way the public has come to understand the concept of styles in general (Sharp, Bowker and Byrne 2008; Geake 2007).

Within the Dunn & Dunn model literature perceptual preferences are considered a particularly important aspect of the model (R. Dunn, 1999a). Perceptual preferences therefore offer a convenient subset of the very large number of studies on the model. Within published research on the model references are frequently made to the unpublished research, which is itself only briefly described

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and is often cited as fully supporting the matching hypothesis (e.g., R. Dunn, Beaudry, & Klavas, 1989; R. Dunn & Griggs, 2004; R. Dunn, Thies, & Honigsfeld, 2001). Such unambiguously positive results are surprising in the context of the design used in the research – Aptitude-by-Treatment Interaction (ATI). ATI research has witnessed a lack of replicable results in general (Cronbach & Snow, 1977; Cronbach, 1975), and in modality based research in particular (Kavale et al., 1998, Kavale & Forness, 1987).

A number of critiques have been raised regarding the findings in and quality of the unpublished sources in the model literature (e.g., Coffield et al., 2004; Kavale & LeFever, 2007) – yet no systematic review has dealt with the viability of these concerns. This lack is problematic as the model has gained substantial popularity within educational practices (Landrum & McDuffie, 2010).

The present review has two connected aims. First the results of the Dunn & Dunn Learning Style Model on the experimental research on perceptual preferences the findings will be evaluated; secondly the quality of the research will be discussed.

The present review is divided into four sections. First, a brief introduction to the model will be offered; second the methods of the review will be presented; followed by the results and finally a discussion pertaining to the Dunn & Dunn model and the wider area of modality based teaching.

2. The Dunn and Dunn Learning Style Model

Central to the Dunn and Dunn Learning Style Model is the concept of ‘learning style’ which is

the way in which each learner begins to concentrate on, process, and retain new and difficult information. That interaction occurs differently for everyone. [...] Learning style is a biological and developmental set of personal characteristics that make the identical instruction effective for some students and ineffective for others. (R. Dunn & Dunn, 1992, pp. 2–4)

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Learning style is assumed to be a trait-like phenomenon – i.e. not modifiable by direct intervention and to be central for explaining the effectiveness of different teaching methods for different students. To be most effective teaching must match individuals' preferences – an idea known as the *matching hypothesis* (Hayes & Allinson, 1996). For instance, for optimal achievement, students with a preference for tactual input engaged with learning “new and difficult information” must use tactual resources and *not* resources intended for students with auditory or visual preferences. The experimental studies within the model literature aim at supporting the effectiveness of the prescribed teaching interventions in the model (R. Dunn & Dunn, 1992; R. Dunn, 1999b).

The twenty learning style elements comprising the Dunn and Dunn model are arranged in five strands called stimuli. The *physical stimuli* are the elements of sound, light, temperature, and design (formal/informal); the *emotional stimuli* are the elements of motivation, responsibility/conformity, task persistence, and structure; the *sociological stimuli* are the elements of self, pair, peer, team, adult, and variety; the *physiological stimuli* are the elements of perceptual preference (auditory, visual, tactual, and kinesthetic), time-of-day, intake, and mobility; the *psychological stimuli* are holistic/analytical and reflective/impulsive. Individuals vary in preferences, from strongly not preferring an element to strongly preferring it. The learning style profile of an individual student is in the Dunn and Dunn Model literature assumed to include 6–14 of the learning style elements that require attention in teaching (Dunn & Dunn, 2008). For example, a particular student may prefer low light, formal design, to work with a group of peers, in the afternoon, auditory and kinesthetic input, and holistic presentation of content. Particular teaching strategies, classroom rearrangements, and instructional resource templates have been developed within the model literature to enable teaching to match the various styles in reaching the same teaching objectives (Dunn & Dunn, 1992; Dunn & Griggs, 2004, 2000).

The model is described by its proponents as “practically oriented and conceptually concise” (Griggs & Griggs, 1998, p. 6), and the research on the model as “more extensive and far more thorough than the research on any other educational movement, bar none” (R. Dunn, 1990a, p. 223). Within the twenty elements the perceptual preferences are considered central - this element “may be the most

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important aspect of learning style (R. Dunn, 1999a, p. 15) – (see also Burke (2004) and Dunn Beaudry & Klavas (1989)). It is also the element that has been researched the most within the model literature.

2.1. Dunn and Dunn Learning Styles Research on Perceptual Preferences

The Dunn & Dunn experimental research on perceptual preferences consist of both single studies and meta-analyses. These will be treated separately in the following.

2.1.1. Single experimental studies on perceptual preferences. Central to the educational prescriptions of the Dunn & Dunn model is the matching hypothesis that teaching must match individual preferences to be optimally effective. Experimental methods are the most adequate to test such claims. The experimental research on the elements in the Dunn and Dunn model is conducted using an Aptitude-by-Treatment Interaction (ATI) design intended to reveal a disordinal interaction (R. Dunn, 1990b; Kavale et al., 1998). The procedure of a study employing such a design and the required nature of the findings are summed up by Pashler and colleagues (2008):

First, on the basis of some measure or measures of learning style, learners must be divided into two or more groups (e.g., putative visual learners and auditory learners). Second, subjects within each learning-style group must be randomly assigned to one of at least two different learning methods (e.g., visual versus auditory presentation of some material). Third, all subjects must be given the same test of achievement (if the tests are different, no support can be provided for the learning-styles hypothesis). Fourth, the results need to show that the learning method that optimizes test performance of one learning-style group is different than the learning method that optimizes the test performance of a second learning-style group (Pashler et al., 2008, p. 109).

Above description gives both a framework for judging the necessary *findings* in a study of the effectiveness of matching as well as a starting point for judging the *quality* of the study itself (e.g. randomization). Not only must research on perceptual preferences show students with a preference

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for visual input score statistically significantly higher in a matched (visual) teaching condition than in one that is mismatched (e.g., auditory teaching). It must also be true that students with a preference for visual input should score statistically significantly higher than those with a preference for other modalities (e.g., auditory input) in the matched condition (visual teaching). Individual studies must be of high enough quality to ensure that such findings can reliably be attributed to the differentiation of teaching methods and nothing else.

2.1.1.1. Critiques of individual experimental studies. Existing critiques of the research on and findings in the Dunn and Dunn model research have raised a number of issues related to potential weaknesses. These include: (a) lack of random assignment of participants, including control for variables thought to affect achievement, such as IQ, gender, and previous achievement (Snider, 1992); (b) teacher to student ratio (Stahl, 1988); (c) Hawthorne effect (effect as a result of change of circumstances) or “catalytic validity” (effect of enthusiastic implementers) (Coffield et al., 2004); (d) that studies do not consider alternative explanations for findings (Davidman, 1981; Doyle & Rutherford, 1984; Good & Stipek, 1983); (e) lack of standardized outcome measure (Coffield et al., 2004); (f) limited possible outcome span on measures used (Stahl, 1988); ecological validity (Stahl, 1988); (h) lack of discussion of any outside context to that of styles when researching (Reynolds, 1997). Furthermore, the general support claimed in the Dunn and Dunn model literature regarding the findings in the published literature have been questioned, since a range of research employing the same ATI design has been found not to show consistent, replicable findings (Cronbach & Snow, 1977; Cronbach, 1975) and that matching teaching to modality has been generally found ineffective (Kavale & Forness, 1987).

To the list above one might add further concerns. The first has to do with the fact that the definition of ‘new and difficult information’ is not addressed in the research. ‘New and difficult’ seems to be equated with ‘unknown by students’. This means that different levels of difficulty may be used for different studies. Second there is the question of the possible confounding effects of the instructional intervention. Since it is difficult to separate visual, auditory, and kinesthetic input, teaching resources aimed at a specific modality may be confounded by the presence of other

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perceptual “stimuli”. For instance, tactual teaching, in which tactual resources are employed – e.g., an Electro-board (cf. Bloom, 2009) – also, and necessarily, includes visual stimuli (to identify questions and answers to be connected). Kinesthetic floor-games designed for large-scale movement while engaging with instructional content (cf. Favre, 2009) include tactual input (handling the game resources, including the cards holding the questions), visual input (reading question to peers), and auditory input (having questions read while playing the game). Perhaps ‘richer’ teaching resources make it easier for students to learn irrespective of their identified styles. Third, as a further implication of the possible catalytic validity of enthusiastic teachers is the fact that it remains unclear in most studies to what extent those conducting the teaching is already known to the participants. Prior relationship may be a factor in order to understand the effects of the intervention. Fourth, in some studies it is explicitly stated that learning styles are introduced explicitly to students through presentation and discussion before students answer the self-report questionnaire and before the intervention is started. That is, the logic of the intervention is introduced to participants who may act in expected ways and thus skew results. The fact that learning styles are introduced in some studies as individual differences of equal value may affect student beliefs in self-efficacy (Bandura, 1982) as well as belief in greater autonomy in choosing assignments (Deci & Ryan, 2000; Ryan & Deci, 2000), which may indirectly affect achievement, again irrespective of the causal connections researched, between matched and mismatched teaching. In short, students’ and teachers’ beliefs in styles may affect outcomes for other reasons than those researched.

The issues raised regarding the Dunn and Dunn Learning Style Model are concerned with whether the quality of the studies is adequate to support the findings in the research and the conclusions drawn in the Dunn & Dunn literature in general. Whether this may be the case, however, remains unknown, since external evaluations have stopped short of engaging systematically with the unpublished literature in the model (e.g. Kavale & Forness, 1990; Landrum & McDuffie, 2010).

2.1.2. Meta-analyses of experimental research on the Dunn and Dunn Learning Styles Model. Besides the individual experimental research on the model, three meta-analyses of
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experimental research covering all learning style elements in the Dunn and Dunn model exist, some with published as well as unpublished versions (Sullivan, 1993, 1997; Dunn et al., 1995; Lovelace, 2002, 2004, 2005). The latest of these is Lovelace's (2005) meta-analysis, which identified 76 experimental studies in the model literature complying with the selected inclusion criteria. The timeframe was 1980 to 2000. Key findings reported were: Overall effect size of matching instruction to styles in the model as a whole, $r = 0.37$ (131 individual effect sizes; SD 0.220; CI 95% 0.331-0.407); for combined perceptual preferences, $r = 0.36$ (31 individual effect sizes; SD 0.189; CI 95% 0.288 0.427); for individual preferences, auditory $r = 0.51$ (2 individual effect sizes; SD 0.122; CI 95% -0.585 1.601; visual $r = 0.38$ (2 individual effect sizes; SD 0.160; CI 95% -1.053 1.819); tactual $r = 0.42$ (1 effect size); and kinesthetic $r = 0.24$ (2 individual effect sizes; SD 0.256; CI 95% -2.064 2.536) (Lovelace, 2002, p. 183). The reported effect sizes pertaining to the model in general and the perceptual preferences in particular were judged to be medium-to-large (Lovelace, 2005).

2.1.2.1. Critiques of the meta-analyses. Kavale and LaFever found that the latest meta-analysis on the Dunn & Dunn model conducted by Lovelace (2005) "is well done and possesses no major methodological difficulties [however] several conceptual and practical problems significantly limit findings" (2007, p. 95). In all, the meta-analyses conducted on the model literature, have questioned several issues including: (a) the use of meta-analysis as validation of a single model rather than evaluation of a field consisting of several different models (Kavale et al., 1998; Kavale & LeFever, 2007); (b) the absence of information of standard deviations to assess the variability of the findings (Kavale et al., 1998; Kavale & LeFever, 2007); (c) problems with sampling related to a "dearth of published literature" (Kavale & LeFever, 2007, p. 96), possibly indicating issues with the quality of the included research (Kavale et al., 1998; Kavale & LeFever, 2007); (d) the possible exclusion of valid studies (Kavale & LeFever, 2007); and (e) whether, if the effect sizes reported are accepted, learning styles might be superseded by other instructional interventions that are easier to implement and show larger effect sizes (Kavale et al., 1998; Kavale & LeFever, 2007).

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However, even when raising doubts as to the quality of the included, but unpublished, studies, those studies were not obtained in order to be evaluated – not by Kavale et al. (1998) or Kavale and LeFever (2007), nor by others repeating their concerns (e.g., Coffield et al., 2004; Ivie, 2009; Landrum & McDuffie, 2010). Indeed, the only examples from external literature of a systematic review including unpublished sources appear to be Stahl (1988) and Snider (1992). However, these are concerned with a variant of the Dunn and Dunn model – the ‘reading styles’ by Carbo (1987a, 1987b) – and not on the Dunn and Dunn model proper.

3.0. Aims and Methods

3.1. Aims

The aims of the present study were to review the Dunn and Dunn experimental research literature on perceptual preferences to

- a) Explore the reported support in the experimental research literature of the matching hypothesis central to the Dunn and Dunn Learning Style Model, i.e., whether *findings* show cross-over effects of studied preferences; and
- b) Explore and determine the *quality* of the studies on perceptual preferences in order to discuss the context of the reported findings and, in particular, the meta-analyses in the model literature.

Both aims concern the viability of the use of the Dunn and Dunn model as a prescriptive teaching model and for the support in the model research of the idea that matching teaching to perceptual preferences – VAK(T) – can be considered evidence-based practice.

3.2. Methods

The method used in the present was to select and analyze experimental studies that had used the instruments from within the Dunn and Dunn Learning Style Model to identify perceptual preferences. Findings in the included studies were judged in relation to the desired cross-over effect discussed above, and quality was based on a number of different criteria listed below.

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3.2.1. Procedure

The PsycInfo and ERIC databases were searched using an expanded set of criteria compared to Lovelace (2005). The following search terms were employed: Dunn; Percept*; modal*; tactual*; visual*; Kinesth*; and Audi*. The annotated list of literature kept at the Dunn and Dunn Learning Style website (www.learningstyles.net) was searched using the same search terms. In addition, eleven sources considered by Dunn (2003) to cover all central parts of the literature were included (i.e. Dunn, 1995, 1996; Dunn & DeBello, 1999; Dunn & Dunn, 1992, 1993, 1999, 1998; Dunn et al., 1994; Dunn & Griggs, 1998, 2004, 2000). These sources were read cover to cover, and all references made in-text to studies concerned with perceptual preferences were included in the pool. References in the identified literature were scanned for possible further studies.

The identified studies were then screened using the following inclusion criteria:

- That preferences were measured with instruments developed within the Dunn and Dunn Learning Styles model literature;
- That studies included data on achievement for specific perceptual preferences (all or some of visual, auditory, kinesthetic, or tactual);
- That perceptual preference was the only element from the learning styles model tested;
- That it was possible to ascertain which interventions were employed to match which perceptual preferences; and
- That the design was experimental (not correlational, observational, or qualitative).

The judgment of inclusion or exclusion was made by the author and was, in the case of published literature, based on the reading of that literature. In cases of doctoral theses, the judgment was made on abstracts obtained from Dissertation Abstracts International. In case of doubt, the thesis in question was obtained in full. The search revealed 162 studies, 29 of which met the selection criteria. Of these 29 studies, 7 were published versions of doctoral research. Published versions of research from dissertations contained less information related to the experimental and statistical procedures used, and, hence, dissertations were obtained for the published sources as well. The

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number of separate studies included was 22 – all doctoral dissertations. The list of the included studies can be found in Table 2. Of the studies that falls within the timeline given in the Lovelace (2005) meta-analysis all was identified by Lovelace in her study. This should not come as a surprise as a) very little research on the Dunn & Dunn model has been made which is not included in the official list on the affiliated website, and b) because the Lovelace (2005) study was found to be of good technical quality (Kavale et al., 1998).

Findings in the included studies were categorized according to their findings in relation to the desired cross-over effect. Rather than simply categorizing for the presence or absence of cross-over findings were categorized in six categories. Five of these concerned how ‘close’ the findings were to displaying cross-over. The last concerned studies showing findings explicitly contradicting the Dunn & Dunn model. The categories were: (a) full cross-over effect for all preferences included in the study; (b) partial cross-over effect, where two or more preferences displayed cross over (but other included preferences did not); (c) studies where one or more preferences distinguished themselves from the rest of the preferences, for instance, for noticeably higher achievement in matched condition; (d) showing partial positive results, i.e., that some of the expected significant findings that do not qualify for cross-over or for a “viable” preference finding are listed; (e) studies reporting no significant findings pertaining to matching teaching and perceptual preferences; and (f) findings that contradict the model (for instance because the group of auditory-preferenced students did better in the tactual condition).

As for the quality of the included studies the individual studies were coded on a number of points. The coding included the following: which preferences tested; which teaching methods used; number of participants; length of intervention (from start to finish of study, as well as actual face-to-face teaching); student/teacher ratio; whether the learning style questionnaire used was administered before teaching intervention began; which learning style instrument was used; whether random assignment was used; whether additional variables (besides the ones explicitly studied) were used to aid randomness; whether the researcher served as teacher; whether teaching resources were constructed by the teacher; control group (with separate teaching methods) or repeat measure

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(students serving as their own controls in mismatched conditions); whether “traditional teaching” was part of the included interventions; whether there were attempts at control for novelty; measures; standardized outcome measures; the outcome span; type of statistical analysis; overall findings related to perceptual preferences; whether testing the Dunn and Dunn Learning Style Model was part of research questions; whether other explanations than Dunn and Dunn Learning Styles are explored in relation to finding; whether the study has been published; whether study is part of the meta-analyses made within the model literature; drop-out rate of participants; discussion of the significance of possible drop-out.

4.0. Results

The number of studies included in the present study may seem low compared to the 1,060 references in the list on the Dunn and Dunn website. However, the 22 studies are concerned exclusively with perceptual preferences and must be compared to the number of studies identified by Lovelace (2005) and included in her meta-analysis. Lovelace searched for studies for all elements in the Dunn and Dunn model conducted between 1980 and 2000, and found a total of 76 studies matching her inclusion criteria that collected studies researching all elements in the model. The present study includes studies up till the present and thus includes studies that were not in the Lovelace analysis.

4.1. Findings in Individual Studies Related to Cross-Over Effects

Table 1 displays the results of the coding of the findings in the included studies.

None of the 22 studies had cross-over among all preferences included. One study (Kroon, 1985) came close to displaying complete cross-over effect between three studied preferences. Three studies displayed a preference as viable. Seven studies had findings that showed partial positive results (some of the expected significances were identified). Fourteen studies showed no significant interaction between instruction and preference, and 12 studies displayed findings that may be interpreted as contradicting the model. Of the studies showing contradictory findings, nine did so because tactual and/or kinesthetic teaching proved significantly better for all students, irrespective

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of their identified perceptual preference (i.e. Bauer, 1991; Fine, 2003; Mitchell et al., 2002; O’Connell McManus, 2000; Roberts, 1999a; R. Searson & Dunn, 2001; R. F. Searson, 1999; Tully, 2004; Wood, 2002).

The fact that *none* of the studies display full cross-over is a major concern even more so as only one study came close. Such results cast serious doubts on the conclusions drawn in the Dunn & Dunn literature concerning perceptual preferences; as in the following statement:

It may seem obvious, but three decades of research suggest that teaching strategies and resources should complement individuals’ perceptual strengths when introducing new and difficult academic content. (R. Dunn & Dunn, 2005, p. 276)

In fact, looking at the experimental studies regarding perceptual preferences it seems more appropriate to conclude that there is little evidence supporting matching of perceptual preferences. This conclusion is further supported by the number of studies that show findings *contradicting* the model.

4.2. Findings Pertaining to Quality of Studies

In Tables 2 and 3, findings are reported pertaining to issues of design and procedures in the included studies. Table 2 is concerned with specifics of the individual studies.

When the information was available, the self-report instrument used in the studies was always administered prior to intervention. Random assignment was used in more than half the cases. Resources tended to be teacher-constructed, and the teacher was identical to the researcher in eight cases, but with nine omitting information on this point. The precise amount of intervention time is missing in 15 cases. In only two cases out of 12 possible did authors discuss the findings contradicting the model. Novelty was explicitly controlled for in five cases; however, control for novelty may have introduced other issues. For instance, in one published study (Roberts et al., 2001) it is stated that “students were unaware of their diagnosed learning style preference(s) during the observation period. Rather they were advised at the completion of the study. Therefore,

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students' knowledge of their learning-style preferences could not have had any impact on their achievement or attitudes" (p.13). However, in reading the original source, Roberts' (1999a) dissertation makes it clear that the LSI was administered prior to teaching – and even if the results may have been withheld it is unlikely that students did not form opinions of their own styles in response to the questions asked in the questionnaire.

Although the studies included all aimed at testing the matching hypothesis of the Dunn & Dunn model they displayed a variety of differences in quality and content making a direct comparison of results difficult.

5.0. Discussion

The findings presented in this study have important implications for educational practitioners as well as policy-makers who are considering using the Dunn and Dunn Learning Styles model on the basis of the research supposedly supporting it. Furthermore it holds implications for schools and teachers using teaching based on VAK(T). For researchers interested in the Dunn and Dunn model, the findings also suggest that previous efforts are fraught with problems in dire need of improvement.

Of the 22 studies in the present review, 14 showed no significant interaction between instruction and preference, while 11 studies directly contradicted the model. The majority of these contradictions indicated that tactual and/or kinesthetic teaching improved student achievement irrespective of their perceptual preferences. Below a number of issues regarding the quality of the studies are presented, all indicating problems with the existing experimental research on the perceptual preference in the Dunn and Dunn literature.

Priming: It is generally unclear to what degree participants were introduced to the concept of learning styles before taking the learning style questionnaire used in any specific study. This pertains to the way that styles may have been introduced prior to participants answering the questionnaire. It also regards the explicit nature of the items in the questionnaire that may have primed the participants without their having been provided the learning style profile. It further

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pertains to how teachers would respond if, during the intervention, a student were to ask learning style-related questions either in general or in regard to that student's own learning style. Finally there is the issue of whether the teacher was aware of the styles of participants while teaching. Eight studies explicitly state that learning styles were introduced to participants and discussed with them prior to administering the questionnaire (Ciarletta, 1998; Colarulli, 1998; Mitchell, 1999; Moore, 1999; Perna, 2007; Roberts, 1999a, 1999b; Wood, 2002). In only one of these (Colarulli, 1998) were the teachers not identical to the researcher, while two did not specify who was the teacher (Roberts, 1999b; Wood, 2002).

Prior Relationship: It is unclear in most studies what, if any, relationship the researcher had to the group of participants. In only one study (Perna, 2007) is it explicitly stated that the researcher was the teacher of the students prior to the investigation.

No Standardized Measures and Range of Possible Outcome: All but two studies (Powell, 1987; Roberts, 1999a) used non-standardized achievement tests to measure outcome, and it is unclear if the test used by Roberts was indeed standardized. This means that findings across studies are difficult to compare.

Standard Teaching versus Repeated Measures: Four variations exist in the literature reviewed: Some studies have a "standard" teaching condition, which is not meant as a match for any preferences; in some studies the "standard" condition is stated as matching those with auditory and visual preferences (Carpentier, 1995; Mitchell, 1999); others have a "multisensory" condition (Hill, 1987; Powell, 1987); some have no traditional condition and only introduce different perceptual teaching conditions in which students who are mismatched act as their own controls. These differences raise questions as to the conceptualization in the Dunn and Dunn model of the nature of "standard" teaching, as opposed to teaching matching perceptual preferences. If standard teaching is better for visual and auditory students, then this should be reflected in those studies using a "standard" teaching condition as a control condition. However, those studies (Falzano, 2003; Landy, 2005; Perna, 2007; Roberts, 1999a, 1999b; Wood, 2002) do not make such assumptions.

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Thus, the equivalence of the situations that are considered to be “matched” and “mismatched” with student preferences can be questioned.

Incomparable Instructional Input: Differences are also evident within a specific modality teaching condition. For instance, in some studies specific techniques developed outside the Dunn and Dunn Learning Style Model are considered to be tactual: finger math (Griffin, 1982); graph calculator (Merckling, 1999); or a computer program (Martini, 1986). In other studies, instructional resources developed within the Dunn and Dunn literature were used (Bauer, 1991; E. R. Curry, 1994). Thus, it remains unclear what constitutes a “match” between a specific identified style and an instructional method.

No Discussion of Findings outside the Dunn and Dunn Framework: In none of the included studies is the Dunn and Dunn model questioned on the basis of the findings in the specific study. Most include considerations about what may have caused findings for specific preferences not to reach levels of significance. Even studies with findings explicitly contradicting the matching hypothesis of the Dunn and Dunn model lack any discussion of reasons outside the model itself.

Confounding: One possible explanation for findings related to the tactual and/or kinesthetic teaching as beneficial for all students regardless of style-preference in a number of studies may be connected to confounding effects – for instance and as mentioned earlier of the visual and auditory elements in the kinesthetic teaching conditions.

On the whole, it would appear that the experimental studies on perceptual preferences in the Dunn and Dunn Learning Style Model have a number of issues that may seriously limit the accuracy of the findings reported. Without more transparency in published sources regarding the procedures of the individual studies, it becomes difficult to interpret the findings. The suspicions of questionable quality of the research in the Dunn and Dunn model raised by earlier critiques (Coffield et al., 2004; Kavale & LeFever, 2007; Landrum & McDuffie, 2010) are confirmed in the present study. A number of issues with quality exist that question whether the studies are adequate as research on the matching hypothesis of specifically constructed teaching and perceptual preferences.

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The conclusion regarding the questionable quality of the experimental research on perceptual preferences in the Dunn and Dunn model has important implications for the interpretation of the meta-analyses made in the model literature. The idea behind meta-analysis is to evaluate the effectiveness of an intervention, rather than limit conclusions based on levels of significance. However, this makes meta-analyses particularly vulnerable to the procedure of study inclusion. Since it is the judged quality of studies rather than a measure of, for instance, significance of findings, the quality of a meta-analysis is never better than the quality of the studies comprising it (Littell, Corcoran, & Pillay, 2008). Given the questionable quality of the studies included in the present review, the findings in the meta-analyses of the model (R. Dunn, Griggs, Olson, Beasley, & Gorman, 1995; Lovelace, 2005; Sullivan, 1997) should be approached with great caution.

6.0. Limitations

The studies reviewed here pertain to only one element in the Dunn and Dunn model. Although perceptual preferences are considered by Dunn (1999a) to be particularly important, investigating only one element leaves open the question of whether research on other elements will evidence the same problems as perceptual preferences in relation to cross-over effects. However, being the most important element in the model, and since no indication is given in the model literature to the problems regarding perceptual preferences there may be reason to believe that the problem is more widespread.

In the present study, no researchers in the Dunn and Dunn community were approached about their knowledge of grey literature—over and above the unpublished literature cited. Even though unpublished literature was included, that research consisted of completed studies cited in the literature or found in data-bases. Other un-completed research may exist. It seems unlikely however that such research should contain substantial support for the model and thus give reason to change the findings in this study of an overall lack of support for the model.

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The author was the only one identifying and coding the studies, which must be considered a limitation. Where appropriate the identification of studies were comparable to others (i.e. Lovelace, 2005).

7.0. Conclusion and Recommendations

All in all, the present review, by analyzing the individual studies in the Dunn and Dunn research literature, has supplied information regarding the matching hypothesis of perceptual preferences in the Dunn and Dunn Learning Style Model.

First, the findings in the studies reviewed did not, on the whole, support the matching hypothesis central to the Dunn and Dunn model. Although some studies did show partial support for matching teaching to some perceptual preference, more studies showed no interaction between preference and matched teaching. Also, half the studies had results that directly contradicted the matching hypothesis of the model.

Second, quality of the individual studies was questioned. A number of potential weaknesses were discovered, ranging from the interaction between teacher and students, students' knowledge of their own styles, non-standardized measures, and large attrition rates in some studies. The quality of the individual studies was judged to be a major concern regarding the meta-analyses made in the Dunn and Dunn literature. Although medium-to-large effect sizes were found in the meta-analyses supporting the effectiveness of the matching hypothesis, the issues regarding the general quality of the included studies seriously calls those findings into question.

Third, the findings reported in the unpublished literature are not reported in the published literature in a way that appropriately reflects those findings. In particular, the published literature cites studies in the model as supportive of the model, even when the original studies report no findings pertaining to matching and even when the reported findings contradict the matching hypothesis central to the model. The discrepancy between the reported evaluation of existing research and the findings in the actual research strongly suggest a bias in the published sources on perceptual

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preferences. This finding may further indicate that the reporting of results in the Dunn and Dunn literature in general is biased and, therefore, should not be accepted without independent review.

Practitioners, administrators, and policy-makers are recommended to consider the findings in the present study before implementing the Dunn and Dunn model with reference to purported research findings (Jensen, 2012; Rådmanden for Børn og unge, 2008). Researchers still interested in the Dunn and Dunn model are urged to supply more adequate information of existing studies and to improve on the quality of forthcoming studies. They are also recommended to adjust the Dunn and Dunn Learning Style Model in accordance with the actual findings in the literature. Only by improving the transparency of the model research and its relation to findings in better quality research can the model be a valued part of research into the improvement of educational practices.

References

- Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, 37(2), 122–147. doi:10.1037//0003-066X.37.2.122
- Bauer, E. (1991). *The relationships between and among learning style perceptual preferences, instructional strategies, mathematics achievement, and attitude toward mathematics of learning-disabled and emotionally handicapped students in a suburban junior high school*. St. John's University.
- Bloom, R. (2009). Tactual Instructional Resources: For Whom, Why, and How to Get in Touch. *Insights on Learning Disabilities*, 6(1), 37–44.
- Burke, K. (2004). Research on Multisensory Instructional Packages. In R. Dunn & S. A. Griggs (Eds.), *Synthesis of the Dunn and Dunn learning-style model research : who, what, when, where, and so what?* (pp. 201–202). New York: St. John's University.
- Carbo, M. (1987a). Deprogramming Reading Failure: Giving Unequal Learners An Equal Chance. *Phi Delta Kappan*, 69(3), 197–202.
- Carbo, M. (1987b). Reading Styles Research: “What works” Isn't Always Phonics. *Phi Delta Kappan*, 431–435.

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<http://www.tandfonline.com/10.1080/19012276.2014.997783>

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<http://doi.org/10.1080/19012276.2014.997783>

Carpentier, S. (1995). *Experimental investigation of the relationships among first- and second-grade students' learning style preferences, attitudes, and achievement in reading and writing when using thematic units*. St. John's University.

Ciarletta, M. J. (1998). *Effects on first- and second- grade students' achievement and attitudes toward learning of a learning-style and literature-based approach to multicultural education*. St. John's University.

Coffield, F., Mosely, D., Hall, E., & Ecclestone, K. (2004). *Learning Styles and Pedagogy in Post-16 Learning*.

Colarulli, R. (1998). *Effects of teaching mathematics to learning style perceptual preference on academic achievement of seventh-grade middle school students*. Florida Atlantic University.

Cronbach, L. J. (1975). Beyond the two disciplines of scientific psychology. *American Psychologist*, 30(2), 116–127. doi:10.1037/h0076829

Cronbach, L. J., & Snow, R. E. (1977). *Aptitude and Instructional Methods*. New York: Irvington Publishers.

Curry, E. R. (1994). *Matching chemistry instructional methods with perceptual learning style preferences of eleventh grade women: Effects on attitude and achievement*. New York University.

Davidman, L. (1981). Learning Style: The Myth, the Panacea, the Wisdom. *Phi Delta Kappan*, 62(9), 641–645.

Deci, E. L., & Ryan, R. M. (2000). The “ What ” and “ Why ” of Goal Pursuits : Human Needs and the Self-Determination of Behavior. *Psychological Inquiry*, 11(4), 227–268.

Desmedt, E., & Valcke, M. (2004). Mapping the Learning Styles “Jungle”: An overview of the literature based on citation analysis. *Educational Psychology*, 24(4), 445–464.
doi:10.1080/0144341042000228843

Doyle, W., & Rutherford, B. (1984). Classroom Research on Matching Learning and Teaching Styles. *Theory into Practice*, 23(1), 20–25.

Dunn, K., & Dunn, R. (2008). Teaching to At-Risk Students' Learning Styles: Solutions Based on International Research. *Insights on Learning Disabilities*, 5(1), 89–101.

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<http://www.tandfonline.com/10.1080/19012276.2014.997783>

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<http://doi.org/10.1080/19012276.2014.997783>

Dunn, R. (1990a). Understanding the Dunn and Dunn learning styles model and the need for individual diagnosis and prescription. *Journal of Reading, Writing, and Learning Disabilities*, 6, 223–247.

Dunn, R. (1990b). Bias over substance: a critical analysis of Kavale and Forness' report on modality-based instruction. *Exceptional children*, 56(4), 352–61.

Dunn, R. (1995). *Strategies for Educating Diverse Learners*. Phi Delta Kappa Educational. Bloomington, Ind.

Dunn, R. (1996). *How to implement and supervise a learning style program*. Alexandria, VA: Association for Supervision and Curriculum Development.

Dunn, R. (1999a). Introduction to Learning Styles. In R. Dunn & K. Dunn (Eds.), *The Complete Guide to the Learning Styles Inservice System* (pp. 11–29). Boston: Allyn and Bacon.

Dunn, R. (1999b). How do we teach them, if we don't know how they learn? *Teaching Pre K-8*, 29(7), 50–52.

Dunn, R. (2003). Response to the Project Team Report. Retrieved from
[http://www.learningstyles.net/documents/Response to Coffied Report by Professor R Dunn.pdf](http://www.learningstyles.net/documents/Response%20to%20Coffied%20Report%20by%20Professor%20R%20Dunn.pdf)

Dunn, R., Beaudry, J. S., & Klavas, A. (1989). Survey of Research on Learning Styles. *Educational Leadership*, 46(6), 75–98.

Dunn, R., & DeBello, T. C. (Eds.). (1999). *Improved test scores, attitudes, and behaviors in America's Schools: Supervisors' Success Stories*. Westport, CT: Bergin & Garvey.

Dunn, R., & Dunn, K. (1992). *Teaching elementary students through their individual learning styles : practical approaches for grades 3-6*. Boston ; Toronto: Allyn and Bacon.

Dunn, R., & Dunn, K. (1993). *Teaching secondary students through their individual learning styles : practical approaches for grades 7-12*. Boston ; Toronto: Allyn and Bacon.

Dunn, R., & Dunn, K. (Eds.). (1998). *Practical Approaches to Individualizing Staff Development for Adults*. Westport, Conn.: Praeger.

Dunn, R., & Dunn, K. (Eds.). (1999). *The complete guide to the learning styles inservice system*. Boston: Allyn and Bacon.

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<http://doi.org/10.1080/19012276.2014.997783>
- Dunn, R., & Dunn, K. (2005). Thirty-five Years of Research on Perceptual Strengths: Essential Strategies to Promote Learning. *The Clearing House*, 78(6), 273–276.
- Dunn, R., Dunn, K., & Perrin, J. (1994). *Teaching young children through their individual learning styles: Practical approaches for grades K-2*. Boston: Allyn and Bacon.
- Dunn, R., & Griggs, S. A. (1998). *Learning Styles and the Nursing Profession*. NY: National League of Nursing.
- Dunn, R., & Griggs, S. A. (Eds.). (2000). *Practical Approaches to Using Learning Styles in Higher Education*. Westport, Conn.: Bergin & Garvey.
- Dunn, R., & Griggs, S. A. (Eds.). (2004). *Synthesis of the Dunn and Dunn learning-style model research : who, what, when, where, and so what? (Revised.)*. St. John's University's Centre for the study of Learning and Teaching Styles.
- Dunn, R., Griggs, S. A., Olson, J., Beasley, M., & Gorman, B. S. (1995). A meta-analytic validation of the Dunn and Dunn model of learning-style preferences. *The Journal of Educational Research*, 88(6), 353–362. doi:Article
- Dunn, R., Thies, A. P., & Honigsfeld, A. (2001). *Synthesis of the Dunn & Dunn Learning-Style Model Research: Analysis from a Neuropsychological Perspective*. New York: St. John's Center for the Study of Learning and Teaching Styles.
- Falzano, C. (2003). *Effects of Traditional Instruction versus Teacher-Constructed versus Student-Constructed Tactual and Kinesthetic Resources on the Social Studies Achievement and Attitudes of Sixth Grade Students*. St. John's University.
- Favre, L. R. (2009). Kinesthetic Instructional Strategies: Moving At-Risk Learners to Higher Levels. *Insights on Learning Disabilities*, 6(1), 29–35.
- Fine, D. (2003). A sense of learning style. *Principal Leadership*, 4(2), 55–59.
- Good, T. L., & Stipek, D. J. (1983). Individual Differences in the Classroom: A Psychological Perspective. In *Individual Differences and the Common Curriculum - Aighty-Second Yearbook of the National Society for the Study of Education* (pp. 9–43). NSSE.
- Griffin, K. J. M. (1982). *The effects of fingermath, or chisanbop upon the mathematical computational ability and mathematical attitudes of ninth grade general mathematics slow learners with attention given to the variables of sex and learning styles*. Northwestern State Univeristy of Louisiana.
- This is an Accepted Manuscript of an article published by Taylor & Francis in Nordic Psychology on February 11th 2015, available at:*
<http://www.tandfonline.com/10.1080/19012276.2014.997783>
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<http://doi.org/10.1080/19012276.2014.997783>
- Griggs, D., & Griggs, S. A. (1998). Introduction: Learning Styles and the Nursing Profession. In R. Dunn & S. A. Griggs (Eds.), *Learning Styles and the Nursing Profession* (pp. 3–8). New York: NLN Press.
- Hayes, J., & Allinson, C. W. (1996). The Implications of Learning Styles for Training and Development : A Discussion of the Matching Hypothesis. *British Journal of Management*, 7(1), 63–73.
- Hill, G. D. (1987). *An experimental investigation into the interaction between modality preference and instructional mode in the learning of spelling words by upper-elementary learning-disabled students*. University of North Texas.
- Ivie, S. D. (2009). Learning Styles: Humpty Dumpty revisited. *McGill Journal of Education*, 44(2), 177–192.
- Jensen, A. (2012). *Plan B skolen - Erfaringsopsamling med Plan B-skole-forløbet*.
- Kavale, K. A., & Forness, S. R. (1987). Substance Over Style: Assessing the Efficacy of Modality Testing and Teaching. *Exceptional Children*, 54(3), 228–239.
- Kavale, K. A., & Forness, S. R. (1990). Substance over Style: A Rejoinder to Dunn's Animadversions. *Exceptional Children*, 357–361.
- Kavale, K. A., Hirshoren, A., & Forness, S. R. (1998). Meta-analytic validation of the Dunn and Dunn Model of Learning-Style Preferences: A critique of what was Dunn. *Learning Disabilities Research & Practice*, 13, 75–80.
- Kavale, K. A., & LeFever, G. (2007). Dunn and Dunn Model of Learning-Style Preferences: Critique of Lovelace Meta-Analysis. *The Journal of Educational Research*, 101(2), 94–97.
doi:10.3200/JOER.101.2.94-98
- Kroon, D. K. (1985). *An Experimental Investigation of the Effects on Academic Achievement and the Resultant Administrative Implications of Instruction Congruent and Incongruent with secondary, Industrial Arts Students' Learning Style Perceptual Preferences*. St. Johns University.
- Landrum, T. J., & McDuffie, K. a. (2010). Learning Styles in the Age of Differentiated Instruction. *Exceptionality*, 18(1), 6–17. doi:10.1080/09362830903462441
- Landy, N. A. J. (2005). *Effects of Tactual and Kinesthetic Instructional Resources on Bermudian Middle-School Students' Vocabulary and Attitudes*. St. John's University.
- This is an Accepted Manuscript of an article published by Taylor & Francis in Nordic Psychology on February 11th 2015, available at:*
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<http://doi.org/10.1080/19012276.2014.997783>

Littell, J. H., Corcoran, J., & Pillay, V. (2008). *Systematic Reviews and Meta-Analysis*. Oxford University Press.

Lovelace, M. K. (2002). *A Meta-Analysis of Experimental Research Studies Based on the Dunn & Dunn Learning-Styles Model*. St. John's University.

Lovelace, M. K. (2005). Meta-Analysis of Experimental Research Based on the Dunn and Dunn Model. *The Journal of Educational Research*, 98(3), 176–183. doi:10.3200/JOER.98.3.176-183

Martini, M. (1986). *An analysis of the Relationship(s) Between and Among Computer-Assisted Instruction, Learning Style Perceptual Preferences, Attitudes, and the Science Achievement of Seventh Grade Students in a Suburban, New York School District*. St. John's University.

Merckling, W. J. (1999). *Relationship(s) between the Perceptual Preferences of Secondary Students and Their Achievement in Functions Using a Graphing Calculator*. St. John's University.

Mitchell, D. (1999). *The effects of traditional versus tactual kinesthetic instruction on the short- and long-term achievement in and attitudes toward grammar of suburban learning-disabled junior high and high school students*. St. John's University.

Mitchell, D., Dunn, R., Klavas, A., Lynch, V., Montgomery, N., & Murray. (2002). Effects of traditional versus tactual/kinesthetic instruction on junior high school learning-disabled students. *Academic Exchange Quarterly*, 6(3), 115–122.

Moore, M. (1999). *Effects of Congruent Versus Incongruent Instructional Strategies on Achievement and Attitudes Toward Mathematics of Second-Grade Urban Elementary Students*. St. John's University.

O'Connell McManus, D. (2000). *Effects of Traditional Instruction versus Teacher-Constructed and Student Constructed Instructional Resources on the Short- and Long-term Achievement and Attitudes of Tenth-Grade Science Students*. St. John's University.

Pashler, H., McDaniel, M., Rohrer, D., & Bjork, R. (2008). Learning Styles - Concepts and Evidence. *Psychological Science in the Public Interest*, 9(3), 105–119.

Perna, M. (2007). *Effects of Total Physical Response Storytelling versus traditional, versus initial instruction with primary-, reinforced by secondary-perceptual strengths on the vocabulary- and grammar-Italian-language-achievement test scores, and the attitudes of ninth*. St. John's University.

This is an Accepted Manuscript of an article published by Taylor & Francis in Nordic Psychology on February 11th 2015, available at:

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<http://doi.org/10.1080/19012276.2014.997783>

Powell, L. C. (1987). *An investigation of the degree of academic achievement evidenced when third and fourth grade students are taught mathematics through selected learning styles*. The University of Tennessee.

Reynolds, M. (1997). Learning Styles: A Critique. *Management Learning*, 28(2), 115–133.
doi:10.1177/1350507697282002

Roberts, A. V. (1999a). *Effects of tactual and kinesthetic instructional resources on the social studies achievement and attitude test scores and short- and long-term memory of suburban fourth-grade students*. St. John's University.

Roberts, A. V. (1999b). Effects of tactual and kinesthetic instructional methods on social studies achievement and attitude test scores of fifth-grade students. *National Forum of Teacher Education Journal*, 9(1), 16–26.

Roberts, A. V., Dunn, R., Holtschneider, D., Klavas, A., Miles, B., & Quinn, P. (2001). Effects of tactual and kinesthetic instructional resources on the social studies achievement, attitude test scores, and short-and long-term memory of Suburban fourth-grade students. *National Forum of Applied Educational Research Journal*, 13(2), 10–22.

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *The American Psychologist*, 55(1), 68–78.

Rådmanden for Børn og unge. (2008). *Lyst til at lære - Visionsoplæg om at arbejde med læringsstile*.

Searson, R., & Dunn, R. (2001). The learning-style teaching model. *Science & Children*, 38(5), 22–26.

Searson, R. F. (1999). *Effects of tactual and kinesthetic instructional resources on simple recall and higher-level cognitive science achievement and attitudes-toward-science of third-grade suburban students*. St. John's University.

Snider, V. E. (1992). Learning Styles and Learning to Read: A Critique. *Remedial and Special Education*, 13(1), 6–18. doi:10.1177/074193259201300103

Stahl, S. A. (1988). Is There Evidence to Support Matching Reading Styles and Initial Reading Methods - A Reply to Carbo. *Phi Delta Kappan*, 317–322.

This is an Accepted Manuscript of an article published by Taylor & Francis in Nordic Psychology on February 11th 2015, available at:
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<http://doi.org/10.1080/19012276.2014.997783>

Sullivan, M. (1997). A Meta-Analysis of Experimental Research Studies Based on the Dunn & Dunn Learning Style Model and Its Relationship to Academic Achievement and Performance. *National Forum of Applied Educational Research Journal*, 10(1), 3–10.

Sullivan, M. H. (1993). *A meta-analysis of experimental research studies based on the Dunn and Dunn learning style model and its relationship to academic achievement and performance*. St. John's University.

Tully, D. (2004). *Effects of programmed learning sequenced and tactual and kinesthetic instructional materials on the mathematics fractions test scores of sixth graders in a Bermuda middle school*. St. John's University.

Vejle Kommune. (2012). *PLAN B SKOLEN - Erfaringsopsamling med plan-b-skole-forløbet*. Vejle.

Wood, M. C. (2002). *Effects of Individualized Plans Independent of, and Supplemented by, Learning-Style Profiles in the Mathematical Achievement and Attitudes of Special Education Students in Grades Three through Six*.

This is an Accepted Manuscript of an article published by Taylor & Francis in Nordic Psychology on February 11th 2015, available at:

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Table 1

Findings in Experimental Research on the Perceptual Element in the Dunn & Dunn Learning Style Model

Studies included in the present analysis	N	# preferences tested / # teaching conditions	cross-over effects for all included preferences	Showing partial cross-over effects	Preferences identified as 'viable'				Showing partial positive results	Showing no results	Showing negative (contra) results	Showing design with reasons for concern
Griffin, 1982	50	1 / 2								X		Only tactual preference was tested, thus any potential cross-over could only be with 'the rest' and not other preferences. However, no significant interactions occurred.
Kroon, 1985	65	3 / 3		X (A; t/k)								There is a single non-significant difference (between visuals achievement in visual vs. tactual teaching) – all the rest are significant.
Martini, 1986	30	3 / 3					T		X		X	Matched teaching produced significant results – however, all students scored better using the tactual instructional material. Tactual teaching was significantly better for students with a preference for tactual input than for the rest.
Hill, 1987	117	3 / 4				A			X		X	The finding for the auditory preference pertains to findings on the long-term test rather than the immediately administered post-test. Visual preference did better in tactual/kinesthetic instruction on immediate recall (vs. delayed) – p. 119. Auditory scored higher on own and also tactual teaching (immediate recall) – p. 119.
Powell, 1987	73	4 / 5								X		This study shows a significant effect for auditory students in fourth grade (n=3) however, the study included third and fourth grade and the finding was thus limited to a particular part of the sample rather than the sample as a whole.
Zikmund, 1988	149	2 / 3								X	X	Experimental group as a whole did better than the control group. Per preference computations was not completed in this study because of low number of students with preference for tactual and kinesthetic input in the 3 rd grade.
Bauer, 1991	44	3 / 3								X	X	No significant effects for matching teaching to learning styles – all students did better in the tactual intervention.
French, 1991	104	3 / 3								X	X	Students in the experimental group (n=52), who were taught with tactual/kinesthetic resources did significantly better than the control group (n=52) who did not receive this treatment.
Ingham, 1989	314	2 / 2							X			Auditory preference did better in auditory treatment. For students with a preference for tactual/kinesthetic input there was no significant difference between tactual/kinesthetic and auditory treatment.

Studies included in the present analysis	N	# preferences tested / # teaching conditions	cross-over effects for all included preferences	Showing partial cross-over effects	Preferences identified as 'viable'				Showing partial positive results	Showing no results	Showing negative (contra) results	Showing design with reasons for concern
Curry, 1994	86	5 / 4							X			When students with tactual and kinesthetic preferences were combined (post hoc) that group had significant effect on achievement in congruent conditions but this group had significantly better retention only after tactile instruction (not kinesthetic).
Carpentier, 1995	145	5 / 2								X		Those that show results are from one grade-level and not another.
Ciarletta, 1998	59	4 / 3							X			Kinesthetic students score higher in matched condition. A partial finding for auditory students in second grade (p. 48) is not included here since it excludes the auditory students in first grade.
Colarulli, 1998	81	4 (2) / 2								X		This study was rejected by Lovelace (2002) on the grounds of improper conceptualization and calculations on matched/mismatched teaching. However, if the original four studied modalities are reduced to two (tactual and kinesthetic) then Colarulli's (1998) calculations may be used (with correspondingly reduced n).
Merckling, 1999	160	1 / 2								X		
Mitchell, 1999	100	4 / 2							X		X	An initial significant gain in achievement for students with a tactual preference in the visual teaching condition – which was eliminated by removing those students that also displayed a visual preference. Traditional teaching to auditory and visual preferences (rather than auditory and visual teaching); tactual/kinesthetic teaching to tactual/kinesthetic teaching
Moore, 1999	40	3 / 3								X	X	All groups did better in tactual/kinesthetic teaching.
Roberts, A., 1999	72	2 / 3								X	X	
Roberts, 1999	25	2 / 3							X			Not enough data presented to know if all students did better in tactual and kinesthetic teaching.
Wood, 2002	112	2 / 2								X	X	Testing the difference between auditory/visual vs. tactual/kinesthetic were done as a non-hypothesized findings (p. 85) All students achieve better in tactual/kinesthetic teaching
Falzano, 2003	47	4 / 3								X	X	All students did better using teacher constructed tactual/kinesthetic teaching resources versus traditional teaching
Landy, 2005	53	4 / 2							X		X	Students with tactual/kinesthetic/non-auditory preference did better than the rest. All students performed better in the tactual/kinesthetic condition than in the traditional (Cohen's $d = 0.27$) – however this is a sub-group of the group of students with preference for tactual and kinesthetic input.

Studies included in the present analysis	N	# preferences tested / # teaching conditions	cross-over effects for all included preferences	Showing partial cross-over effects	Preferences identified as 'viable'				Showing partial positive results	Showing no results	Showing negative (contra) results	Showing design with reasons for concern
Perna, 2007	118	4 / 4								X	X	Of two conditions only one shows any results for perceptual preferences; groups on a whole do better on learning styles teaching.

Table 2

*Aspects of Individual Experimental Studies on Perceptual Preferences in the Dunn & Dunn**Learning Style Model*

Study/Variable	Preferences tested (V,A,K,T, non-preference)	Teaching conditions	# participants before/after	Intervention length (active/period)	Student/teacher ratio	Possible outcome span	Attrition
Griffin, 1982	T / non-T	T / non-T	50	6 weeks / 15 h	n/a	Identical 50 pre/prost computational questions	n/a
Kroon, 1985	V, A, T	V, A, T	38	5 weeks / 10 lessons (unclear length)	n/a	6 tests 10 questions each (6 true/false; 4 multiple choice)	n/a
Martini, 1986	V, A, T	V, A, T	30	2 weeks / 4 h 30 min	15 / teacher	n/a	Originally 37 - 3 (8%) low consistency scores; 2 (5%) special education; 1 (3%) non-English speaking; 1 (3 %) not accounted for; Total attrition: 7 (19 %)
Hill, 1987	V, A, K/T, non-preference	V, A, K/T, Multi	117	5 weeks (4 weeks of intervention) / unclear (no longer than one day per teaching condition)	23, 39, 32, 33 / teacher	Identical 10 words pre/posttest for each week	Original 313 - not allowed permission by parents 114 (36 %) - low consistency or test-results missing 69 (22 %) - not accounted for 13 (4%) - total attrition: 196 (63 %)
Powell, 1987	V, A, K, T	V, A, K, T, Multi	73	Unclear / 45 minutes per week	14, 16, 19, 24 / teacher	50 items	Original 91 – Total attrition (move during summer): 18 (19 %)
Zikmund, 1988	V, K/T	V, K/T, Trad.	149	Unclear / Unclear	n/a	two task with each 72 questions	n/a
Bauer, 1991	A, K/T, non-preference	A, T, Multi	44	2 weeks / 4 lessons (unclear length)	n/a - three groups	3 pre/post tests and a final test after the fourth reinforcing lesson - 10 questions each	n/a
French, 1991	A, V, K/T	V, A, K/T	104	6 weeks / Unclear	n/a - 52 participants in experimental group and 52 in control	Identical Pre/posttests 10 vocabulary words each; 6 tests in total	n/a
Ingham, 1989	A, K/T, non-preference	A, K/T	314	1 month / 1 h 30 min	n/a - however only two classes per treatment	15 multiple choice questions	Original 604 - 314 in study - 6 excluded for visual preference (1 %); 200 with mixed preferences not included (33 %); 84 absent for one session (14 %); total attrition: 290 (48 %)
Curry, 1994	V, A, K, T, non-preference	V, A, K, T	86	Unclear / Unclear (16 units broken into 4 by 4)	n/a - 4 groups	10-20 questions per test	n/a

Carpentier, 1995	V, A, K, T	V/A, K/T	145	Unclear / Unclear	n/a - 7 classes included	Pretest/posttest identical; posttest included different types of tests	Original 152 - lack of knowledge of alphabet and absence 7 (5%); unaccounted 3 (2%). Total attrition: 7%
Ciarletta, 1998	V, A, K, T	A, K, T	59	6 weeks / 3 units per 2 weeks (no time given for unit length)	Avagaverage 25 students / teacher	Tests had 10 sentences and students were to supply one word for completion of sentence.	200 students - 141 excluded due to absence. Total attrition: 70%
Colarulli, 1998	V, A, K, T	V, A, K, T	262	Unclear / Unclear	n/a	Identical pre/post-test - 25 multiple choice questions	n/a
Merckling, 1999	T / non-T	T	160	6 days / unclear	n/a	18 questions per achievement test	n/a
Mitchell, 1999	V, A, K, T	K/T, Trad. (V/A)	100	4 weeks / 2 h 36 min - 2 h 56 min	n/a	tests 10-11 questions and a question regarding writing a short piece demonstrating specific skills; long-term: 16 questions	Original 114 - 14 non-complete sets of data - total attrition: 14 (12 %)
Moore, 1999	A, T, K	A, T, K	40	2 months / 6 units (unclear length)	n/a	Between 19 and 22 questions per test	Of 118 - 29 (25 %) eliminated due to low consistency; 49 (42 %) eliminated due to no perceptual preferences. Total attrition: 77 (66%)
Roberts, A., 1999	T, K	K/T, Trad.	72	4 weeks / 9 h	Approx 36 / teacher	15 true/false and three short answer in three tests - 15 multiple choice and 3 short answers in one test - pre/post-tests identical - 20 item long-term test	Original 80 - 8, unclear how many had parents not consenting and how many had consistency under 70. Total attrition 8 (10%)
Roberts, 1999	T, K, non-K, non-T	K/T, Trad.	25	6 weeks - two units / Unclear	25 / teacher	100 (tests of 20 questions)	n/a
Wood, 2002	K, T, non-K, non-T	K/T, Trad.	112	Unclear / 2 lessons	Average class size 25 students / teacher	Identical pre/post-test drawn from textbook (geometry: 8-10 questions; Fractions: 13-23 questions)	n/a
Falzano, 2003	V, A, K, T	K/T, Trad.	47	8 weeks / 26 h	n/a	Post-test only - 4 tests each with 20-25 true/false/multiple choice ; 3-5 short answer; 10 definitions; 2-3 long answers	n/a
Landy, 2005	V, A, K, T, K/T, K/nont-T, T/non-K, T/non-K/non-A, K/T - non-A	K/T, Trad.	53	4 weeks / 1h 40 min	4 groups - 20, 22, 23, 23 students / teacher	4 tests with 20 definition questions (multiple choice)	Original 88 - 23 to low consistency scores – 12 absenteeism - Total attrition: 35 (40%)
Perna, 2007	V, A, K, T	V, A, K, T, Trad., TPRS	118	Unclear / 24 periods	n/a - 118 students in 5 classes	Identical 20 questions for pre/post-test – 12 tests in total	Attrition based on measure - measures had from 3 to 6 absentees. Total Attrition 3 to 6 (3% - 5%)

Table 3

Different Aspects of Quality Regarding Experimental Studies on Perceptual Preferences in the Dunn & Dunn Learning Style Model

	Yes	No	n/a ¹
Was the learning style questionnaire administered before teaching intervention began?	20	0	2
Were specifics about student introduction noted?	8	14	
Was random assignment used?	12	4	6
Were additional variables (besides the ones explicitly studied) used to aid randomness?	2	20	
Did researcher serve as teacher?	8	5	9
Was training of teacher mentioned?	5	16	1 ²
Was teaching resources constructed by teacher?	10	3	9
Was there a control group (with separate teaching methods)?	6	16	
Was intervention time given?	7	15	
Was 'traditional teaching' part of the included interventions?	8	14	
Were there attempts at control for novelty?	5	17	
Were standardized outcome measures used?	1	20	1
Was testing the Dunn & Dunn Learning Style model explicitly part of research questions?	0	22	
Were findings in contradiction to the model used to question the model?	2	10	10 ³
Has the study (or part hereof) been published?	7	15	
Was the study part of meta-analyses made in the model literature?	13	5	4 ⁴
Was the significance of possible drop-out discussed in relation to for the findings in the study?	1	21	

¹ Black box indicating that the question is an either/or with no 'n/a' option available

² Is test only – no teaching

³ Does not have contradictory findings.

⁴ Outside time-span for meta-analyses.

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