Feeling-Thinking Balance and Inquiry Learning

Master's Thesis by

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To my Family of Friends and God

Abstract

There are societal, educational and occupational needs for graduates with 21st Century Skills, which majorly involves Inquiry Skills. However, there is a knowledge gap regarding which common learner personality characteristics can facilitate optimal Inquiry Performances in heterogeneous populations. Innovative research is needed to enrich knowledge on the equitable importance of Feeling and Thinking in Inquiry Learning, which could be beneficial to researchers and designers of 21st Century Curriculum. The research goal was to test whether Feeling-Thinking Balance could be considered a distinct Personality Trait in addition to Feeling and Thinking, and whether Balanced Feel-Thinkers would perform the most effectively on Inquiry Tasks. This was a quantitative research with between-groups experimental design. A convenience sample of online participants with diverse backgrounds will be recruited through social media. An Online Learning Environment with two Inquiry Tasks were especially designed for data collection purposes. Modified Myers-Briggs Type Indicator (Myers et al., 1998) measured Personality Trait, the independent variable with three levels (Feeling, Thinking and Feeling-Thinking Balance). The Flexible Inquiry Learning Environment (Wilhelm et al., 2005) with the Inquiry Tasks measured three dependent variables (Inquiry Outcome, Process and Speed). Independent ANOVA with Post Hoc analyses showed significant differences in Inquiry Outcomes and Processes between the three Feeling-Thinking Personality Trait groups. Balanced Feel-Thinkers outperformed Feelers and Thinkers in delivering the highest Inquiry Outcomes for the price of more mentally resourceful Inquiry Process.

Keywords: Feeling-Thinking Balance, Inquiry Learning, iScience, 21st Century Skills, Online Learning Environment, Emotion, Cognition

Abstract (Dutch)

Er zijn maatschappelijke, educatieve en beroepsmatige behoeften voor afgestudeerden met 21e eeuw vaardigheden, waarbij vooral onderzoeksvaardigheden vereist zijn. Er is echter een kennisklоof over gemeenschappelijke persoonlijke kenmerken van de leerling, en hoe dit optimale onderzoek prestaties kan mogelijk maken in heterogene populaties. Een innovatief onderzoek is nodig, om kennis te verrijken over het gemeenschappelijk belang van voelen en denken in onderzoekend leren, wat gunstig kan zijn voor onderzoekers en ontwerpers van het curriculum van de 21e eeuw. Het doel van het onderzoek was, om te testen of de voel-denken balans kan worden beschouwd als een aparte persoonlijkheidstrek, naast voelen en denken, en of gebalanceerde voel-denkers het meest effectief zouden presteren op onderzoekstaken. Dit was een kwantitatief onderzoek met een experimenteel ontwerp tussen groepen. Een eenvoudige steekproef, wordt afgerond door online deelnemers met verschillende achtergronden, die door middel van sociale media zijn gerekruteerd. Een online leeromgeving met twee onderzoekstaken, waren speciaal ontworpen voor het verzamelen van gegevens. Een gemodificeerde Myers-Briggs type indicator (Myers et al., 1998), heeft de persoonlijkheidstrek en de onafhankelijke variabelen met drie niveaus (voelen, denken en voel-denken balans) gemeten. De flexibele onderzoek-leeromgeving (Wilhelm et al., 2005) met onderzoekstaken, heeft drie afhankelijke variabelen gemeten (onderzoeksuitkomst, proces en snelheid). Onafhankelijke ANOVA met Post Hoc-analyses, toonden significante verschillen in onderzoeksuitkomsten en processen tussen de drie voel-denken persoonlijkheidskenmerk groepen. Evenwichtige voel-denkers presteerden beter dan voelers en denkers, bij het leveren van de hoogste onderzoeksresultaten voor de prijs van een meer mentaal vindingrijk onderzoeksproces.

Trefwoorden: Voelen-Denken Balans, Onderzoek Leren, 21e Eeuw Caardigheden, iScience, Online Leeromgeving, Emotie, Cognitie

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Introduction

Problem Statement. The inventory of mental skills needed to succeed in today's world is rapidly changing with technological advancements, and the evolving eco-socio-political demands. "Knowledge Societies" require individuals to take decreasingly less time to actively obtain information, transform it into applied knowledge and use it to educate others in online courses, traditional classroom or business training (Erstad et al., 2016). Information is becoming increasingly more accessible thanks to the internet, and its acquisition by the learners themselves could have never been more cost- and time-effective. This situation fuels a growing body of research on the topic of the 21st Century Curriculum, as learning materials need to be adapted to support a healthy development of the specific target skills that are sought in graduates by the modern international job market (von Schomberg, 2011a; Voogt & Roblin, 2012). Educational policy-makers, designers and practitioners need to deliver up-to-date curricula and learning instructions that can effectively cover a whole heterogeneous population whilst paying attention to individual educational needs of unique learners.

Analysis of the current Dutch curriculum conducted by the Netherlands Institute for Curriculum Development (Thijs, Fisser, & Hoeven, 2014) shows that besides applied self-regulation and computer literacy, there are two main categories of 21st Century Skills that fit the theoretical framework of the current research: Thinking-based abilities, such as critical evaluation and problem analytics, and Feeling-based competencies, such as creative collaboration and inter-cultural communication. Various degrees of these qualities are inherent to different unique learner personalities. However, collectively they are key elements of Inquiry Skills, which are skills utilized by a cognitively active, self-directed and problem-based learning method called Inquiry Learning (Chu et al., 2017). This method is suitable for teaching traditional principles via external guidance, as well as for learning to innovate via internal self-Inquiry (de Jong, Sotiriou, & Gillet, 2014). As appropriately guided Inquiry Learning is an integral part of modern educational practices, it is important to understand the way individuals learn through Inquiry, and the fundamental Cognitive (Thinking) and Emotional (Feeling) Processes that contribute to the personal application of Inquiry Skills.

Much historical focus of educational researchers has been placed on the students' Thinking and General Intelligence (IQ), its assessment (Wechsler, 1949) and adaptive development (Canivez, Watkins, & Dombrowski, 2016). However, researchers, curriculum designers and teachers are starting to explore the significance of Feeling Processes in learning (Voogt & Roblin, 2012), as the emotional world of learners is vital to applying knowledge-

sharing skills and inter-personal understandings, such as following the meanings communicated by a designer of a learning instruction even in Online Learning Environments (Artino, 2012). A cross-sectional research shows that Feeling and Emotional Intelligence (EQ) also plays an important role in quasi-independent learning, e.g. during University studies, because it can ignite the Intrinsic Motivation to learn and sustain the management of difficulties during the Learning Process (Chew, Zain, & Hassan, 2013).

While the educational role of Feeling in learning is historically less understood than the role of Thinking, even less is known about Feeling and Thinking as two fundamental and equally important learner characteristics, their symbiotic interdependence, and the way in which it could be related to the way people normally learn and inquire. While there are existing theories that Thinking and Feeling are distinct mechanisms, which can affect (learning) behaviors through an influential interplay between the two (Schwarz, 2002; Zajonc, 1980; Lazarus, 1882), not a single research has been conducted on the topic of equitable importance of Feeling and Thinking in Inquiry Learning.

Therefore, this study conceptualizes and tests a new psychological construct, Feeling-Thinking Balance, as a third element alongside the separate measures of extreme Feeling and Thinking. Furthermore, pairing these findings to measures of Inquiry Performance could serve as a predictor of the success on Inquiry tasks. While research has previously focused on studying various functional aspects of Inquiry Learning, such as its effectivity in online settings as a learning and teaching method (Pedaste et al., 2015), this topic is far from being exhausted as a research area. Specifically, little is yet known about how Inquiry is impacted by fundamental learner characteristics, such as Feeling-Thinking Personality Traits. This knowledge gap in the Psychological and Educational literature calls for an innovative research that aids the understanding of learner characteristics and Personality Traits, such as Feeling-Thinking Balance, that can influence success through modern learning methods.

Theoretical Conceptual Framework. Inquiry Learning can be defined as learning by resolving complex issues, asking questions about the analyzed problem attributes, conducting investigations to answer these questions, creating evidence-based interpretations and drawing theory-based conclusions (Marx et al., 2004), rather than simply presenting the established facts or portraying a direct path to knowledge. Focus on Inquiry, therefore, allows to move away from memorizing encyclopedic knowledge through passive and ineffective Rote Learning, and towards self-guided construction of innovative knowledge through active and meaningfully engaging learning, which makes it a suitable method to respond to the shifting economic, technological, and socio-political realms of the modern world. Inquiry is only

effective, however, when it involves appropriate scaffolds for activating the executive mental processes, such as critical Thinking and Feeling-based communication, and engaging personal self-regulation and learning transference (Hmelo-Silver, Duncan, & Chinn, 2007).

Since the 1950's, researchers in learning and instruction have used Bloom's taxonomies of learning (Bloom et al., 1956). His landmark paper identified three learning domains: Cognitive, Affective and Psychomotor domain. The Cognitive domain is a Thinking domain, as it involves the acquisition of rational facts, knowledge comprehension, practical application, contextual analysis, synthesis and evaluation. The affective domain is a Feeling domain for managing attitudes and motivations with levels ranging from initial awareness to a commitment to emotional values that guide behavioral decisions. The psychomotor domain of learning includes observable movement, physical coordination, motor-, and sensory-skills that are based on the joint utilization of the Cognitive and Affective domains. Despite these early taxonomies outlining the wide range of comprehensive learning aspects, the focus of Psychologists has largely been on the role that Thinking (Cognition) plays in Intelligence and Learning, making it one of the most studied scientific topics.

Labelled as General Intelligence, rationality or logic, Thinking was previously believed to be the single most important mental ability, and its progressive maximizing seemed to be the ultimate goal in most educational and professional settings (Smith, 2015; Artino, 2012). Up to this date the Dutch Primary Schools have been using IQ tests to predict learning aptitude and success in Secondary education (Dutch Intelligence Test for Educational Level, 2017). However, there is still much debate whether studying Cognition as a strictly emotionless center of personal intellect represents the most comprehensive way of assessing learning abilities. In fact, recent evidence does not support this position, especially when it comes to the need for young students to flexibly respond to mental pressures, such as developmental changes and academic challenges (Stuebing, et al., 2015). Thus, the sole impact of Thinking on effective learning is not as definitive as previously thought.

The role of feeling in learning and the importance of Emotion in Cognition are only now starting to be recognized, with scholars and practitioners in education beginning to regard Feeling as integral to the meaning-making process (Artino, 2012). Feeling can serve as Self-Determination and can create a purpose to learning experiences and shape the learning activities (Merriam & Caffarella, 1999; Reeve, 2001). Feelings were also empirically found to significantly affect a learner's choice of a more or less effective study mode, and therefore can, and should inform instructional designs (Gläser-Zikuda et al. 2005; Meyer & Turner, 2002). Furthermore, Emotion plays a critical role in the meaning and knowledge construction

of the "healthy self" in a normal adult Learning Process (Dirkx, 2001). Entering the higher cognitive system, Feelings are recognized, and consequently alter Thinking patterns, affecting the experience of how people learn (Opengart, 2005).

Previously it has been assumed that Thinking and Feeling are opposite and competing forces with a clear distinction between their behavioral expressions and learning contributions. While the roles of Emotion and Cognition in Learning have been separate interests of many schools of the psychological thought, Feeling and Thinking as two fundamental and equally important learning constitutes, has been less explored. However, recent studies from Cognitive Psychology (Moore, 2000) start to show more of a symbiotic, processual inter-dependency between Feeling and Thinking as a mechanism of normal psychological balance.

The key conceptual assumptions in this study are guided by Jung's theory of psychological type (1923), according to which Thinkers and Feelers make different decisions because of the criteria they use to evaluate information. Namely, Feelers prefer to decide based on personal values and subjectivity, while Thinkers prefer rational logic and objectivity. According to contemporary research (Sadler-Smith and Sparrow, 2008), Feelers tend to engage more with intuitive than "reasonable" decision-making, which can be described as instinct, hunch or "gut feeling", and could cause them to rely more on implicit assumptions and informal data, rather than on explicit facts and formal information sought by Thinkers. Kolb (1984) describes Thinkers as learners with learning methods that tend to feed on questions and answers posed during the Learning Process.They are theory-reliant learners who thrive on problem-solving when benefiting from abundant prior knowledge of familiar problems, especially when combined with prior experience of a worked task-resolving strategy, which enables rapid development of specialist skills and technology abilities. Employing a more analytical approach, their learning style is to gather concrete data from questions and answers during the Learning Process. However, they may underperform on open-ended questions and interventions that promote exploration of the unknown, which is a key strength of Feelers and Inquirers in general (Kolb, 1984).

In addition to these two distinct groups of Feelers and Thinkers, the present research proposes and tests a third Personality Trait group, Balanced Feel-Thinkers, i.e. learners who do not operate predominantly in one of the two described cognitive realms. They are distinct from more extreme Feelers or Thinkers, as they are able to and choose to employ strong cognitive skills, such as rational reasoning and judging, as well as emotional skills, such as recognizing, understanding, and managing Feelings when learning through making inquiries.

This means that Balanced Feel-Thinkers have the mental tools to learn and act upon balanced decisions, which are well-advised by two mental channels, and are able to assign a relatively equal importance to both sources. This is in accordance to Sternberg's concept of people alike Balanced Feel-Thinkers (1998), who use the full variety of the two most fundamental (Synthetic and Analytical) Intelligence aspects, in addition to a (Practical) one of an executive nature, which applies the two in everyday contexts. The Synthetic aspect is linked to inductive Feeling responsible for abstract understanding and innovative idea-generation. Contrastingly, the Analytical aspect is rooted in deductive Thinking, which aids analyzing the value of one's own ideas, evaluating their strengths and weaknesses.

Fielding's definition (2012) of the optimal Inquiry learning process involves a choice of open-ended problem investigations, requiring learners to engage in evidence-based reasoning and analytical problem-solving, as well as intuitive "problem-finding" and creative problem-solving. In this sense, Inquiry Learning could require individuals to engage in precise and rational Thinking Processes, as well as in intuitive and creative Feeling Processes. Hence, based on Fielding's definition and Sternberg's theory it can be deduced that individuals with the ultimate problem-finding and resolving skills could be those who inclusively and equitably manage both intelligent learning aspects, Feeling and Thinking. As the two approaches appear to complement each other in an advantageous way, the self-regulation of both processes by an individual, also known as Metacognition and Metaemotion, could be the essential mental management behind the success on Inquiry Tasks.

Metacognition is the skill to learn effectively through the power of "sensing" and "knowing" when and how to use different strategies for problem-solving (Flavell, l976). These powers allow a person to manage and evaluate the available mental resources, and to adjust their implementation, depending on how much of which is required at a time. In Inquiry Process, this could mean utilizing the ability to experiment, "induce" and "comprehend" multiple strategies in the task-resolving attempts, such as Thinking critically upon the utilized strategy and optimizing it in order to attain the desired Inquiry Outcome, which is also Feeling and being intuitive about delivering positive results. Understanding the extent of success to which these strategies are applied by Inquirers with different Personality Traits could aid the understanding of how individual learner characteristics influence approaching and operating on Inquiry Tasks. Implicitly, this knowledge could give an insight on how to design and deliver the historically underutilized Feeling-based learning instructions, teaching materials and educational interventions, and how to balance the 21st

Century Curriculum by stimulating both the student's Feeling-Thinking, and not only Thinking Processes.

Research Questions and Hypotheses. It is now understood that different ratios of a habituated Feeling-Thinking preference demonstrate different Personality Traits and could influence one's aptitude to learn effectively through self-driven Inquiries about the world and about the self. However, what is not yet so well understood is what degree of the Feeling and Thinking Processes in proportion of one to another is required to pursue effective Inquiries. Assuming that the production of ideal Inquiry Outcomes requires Feeling-Thinking Balance, ideal Inquiry Process shows low mental effort spent on making task attempts, and ideal Inquiry Speed demonstrates in short task duration, this leads to the present research question: Are people with Feeling-Thinking Balance better Inquiry Learners than Feelers and Thinkers in the quality of Inquiry Outcomes, mental effectiveness of Inquiry Process, and temporal effectiveness of Inquiry Speed? Can the three levels of the Feeling-Thinking Personality Trait significantly distinguish people across the three measures of their Inquiry Performance? In order to respond to these questions, experimental variables were operationalized and three hypotheses were stated: It was predicted that Balanced Feel-Thinkers, compared to Feelers and Thinkers, would be significantly better Inquirers with: 1) the most correct Learning Outcomes defined by the highest task scores, 2) the most effective Learning Process defined by the least number of task attempts, and 3) the highest Learning Speed defined by the shortest task duration.

Solution Statement and its Scientific and Practical Relevance. There is a practical educational need for the 21st Century Curriculum that can effectively serve the purpose of instructing heterogeneous populations, e.g. elementary classrooms on a national scale. This problem could be initially solved by adopting a macro-adaptive instructional perspective (Vandewaetere, Desmet, & Clarebout, 2011), and by having the curriculum designed according to how people generally learn (Park, & Lee, 2003) through modern teaching methods, such as Inquiry Learning (Pedaste et al., 2015). The new psychological construct of Feeling-Thinking Balance is conceptualized to facilitate success on Inquiry Tasks, and the Inquiry Task Performance is theorized to employ many of the 21st Century Skills. Therefore, the Feeling-Thinking Balance could be used by curriculum designers as a conceptual framework to their (annual) update work by assuring for equivalent Feeling and Thinking learning stimuli in the curriculum core, whilst updating the rest of the curriculum to respond to the rapidly evolving technological and cultural advancements. This would also solve the

problem of the historical over-representation of solely Thinking-based instruction, and re-integrate Feeling as an equally important, fundamental personality component.

Method

This scientific research was performed and reported in the scope of academic studies towards Master's degree in Psychology specialized in Learning Sciences. For the purpose of demonstrating that the selected method is transparent and replicable, this section covers detailed information on how the research study was set up and presented to the participants.

Design

This was a quantitative type of research with between-groups experimental design. Personality Trait was the independent variable and had three levels of measurement: 1) Balanced Feel-Thinkers, 2) Feelers, and 3) Thinkers. There were three dependent variables. 1) Inquiry Outcome, operationalized as a maximum score gained by each participant, 2) Inquiry Process, measured as a number of attempts made in arriving to the final assignment answer, and 3) Inquiry Speed, conceived as the task duration in seconds.

The research was conducted in the form of iScience (Internet Science) in order to benefit from the time- and cost-effective technological advantages that this evolving method has to offer. Besides, the online research method targets a larger sample, providing higher statistical power, as well as more inclusively diverse cross-cultural sample that translates into greater external validity for the study, and a greater generalizability of the research findings to general human population. Arguably, this method also heightens ecological validity, as participants remain in their home or work environments while participating in their own time, which is a more natural and real-world research setting than attending to special appointments at the Psychology lab at certain expected times. This potentially minimized the confounding effects of stress and expectations on the research results and maximized generalizability across situations (Coolican, 2014).

Participants

Sample Characteristics. Power analysis estimated the minimum sample size (N = 82). The maximum sample size was limited by the scheduled deadline for the data collection. The obtained sample (N = 126) included 37% German, 21% Dutch, 10% Slovak, 8% British, 6% Polish, 6% Belgian, 3% Italian, 2% Indonesian, 2% Bulgarian, 2% Czech, 2%

Luxembourgish, and 1% Suriname citizens. The occupational majority was 63% students, followed by 33% employed, 2% unemployed, and 2% retired. The total sample included 35% of males, 63.5% of females and 2 individuals self-identified with another value on the gender spectrum. The mean age of participants was 22.2 years (*SD* = 7.34).

Sampling Method. The researcher's invitation to participate in the study was distributed through various internet social media and the Psychology Test Subject Pool webpage (https://utwente.sona-systems.com). This was a convenience sampling method involving a self-selection bias. This means that people chose to participate based on their interest in the research topic, which in turn is a benefit with regards to making the research humanistic and naturalistic. An unbiased sampling alternative, although perhaps less heterogenous, would be simple random sampling method. This would require a specific sampling frame, e.g. a list of all local University students to randomly select from, which would give each person an equal chance of being studied.

Inclusion Criteria. The inclusion criterion was threefold: 1) attaining the age of majority and legal competency to sign informed consents (Central Committee on Research Involving Human Subjects, 2017), 2) English proficiency, and 3) access and ability to use an online device. All people satisfying these criteria were welcome to participate from any place nationally and internationally. This accounted for a wide range of the natural diversity within global population, including different nationalities, ages, genders and occupations.

Exclusion Criteria and Pilot Testing. Exclusion criteria were determined through a qualitative pilot study with 12 participants, who were interviewed on their research participation experiences in a semi-structured manner. The pilot findings revealed several technical limitations of the research platform. Phone users had to be excluded, as various phone softwares did not interface with different parts of the research platform. This also applied to users with other than the designated internet browser. Participants who logged in incorrectly or accidentally refreshed the research website were naturally excluded due to missing data. Same applied to missing data due to other factors, such as attrition rate.

Apparatus

The electronic location of the online research platform was https://goo.gl/PLfu6Q. It comprised of exclusively online instructions and materials interfaced to the participants. It was configured in the form of an Inquiry Learning Space, which was set up through GRAASP interface (http://graasp.eu/). All data collecting software was password protected and utilized legally. Two sets of empirically tested multimedia design principles (Koumi, 2013; Mayer,

2014) served as theoretical frameworks to creating the ILS. This was done in attempt to maximize engaging and meaningful assignments, and to minimize the risk of presenting cognitively overloading or otherwise ineffective instructions. As effective Inquiry Learning was previously reported to be conditioned by balanced instructions that are not over- and not under-scaffolded, the ILS was intended to be designed accordingly (Hmelo-Silver, Duncan and Chinn, 2007). Furthermore, in order to promote a Macro-Adaptive Learning Environment (Vandewaetere, Desmet, & Clarebout, 2011), the ILS was not limited by time of participation but allowed individual Learning Pace to be influenced by each participant's ability to employ their level of Inquiry Skills.

Materials

Web Request for Ethical Assessment. Using this material was a mandatory step of a standard procedure that applies to all research proposals involving human research participants (University of Twente, 2017). It was to ensure an ethically responsible research practice by assessing whether the intended research conforms to the standards of the Faculty of Behavioral, Management and Social Science.

Participant's Information and Informed Consent. Participant's Information advised on rights linked to volunteering and informed about the nature of the study. Informed Consent was a signed agreement to participate in an online psychological research on learning, demonstrating the participants' willingness to proceed with the participation.

Modified Myers-Briggs Type Indicator (MBTI). The Feeling-Thinking Scale was extracted from MBTI, a standardized instrument with a total of four scales (Myers et al., 1998), in order to measure Personality Trait as the three-level independent variable. This was a 20 item questionnaire identifying self-reported preferences for engaging with either Feeling or Thinking in making decisions. The full list of utilized scale items can be seen in Appendix A. Another modification was that all questionnaire items were fully randomized to prevent order effects in presenting the questions, as well as in the answer choices. In attempt to decrease social desirability bias, a modified instruction stated that there are no right or wrong answers to any of the questions, and guided answering the questions according to "the way [the participants] are and not the way [they] would like to be seen by others". The participants were also advised to go through the items quickly and not over-analyze them, as per original MBTI instruction. The dichotomous answer choices were advantageous in that they did not allow for degrees of sensitivity and differentiation, which aimed to facilitate rapid and disambiguous answering. These were configured in Qualtrics

(https://www.utwente.nl/en/com/qualtrics), an online survey platform, as forced choice answers in order to avoid incompleteness of responses and its influence on the scale's content and construct validity. Previous research (Capraro & Capraro, 2002) reported the Feeling-Thinking dichotomy as a valid and reliable scale. Cronbach's Alpha (1951) computed on $N >$ 10,000 respondents was .74, suggesting its strong internal consistency. Test-retest reliability coefficients based on 1 week to 2.5 year intervals ranged from .89 to .48., proposing the scale's stability over a period of time.

Demographic Questionnaire. The demographic questions were: "Where are you from?", "How old are you?" and "What's your gender?".

Inquiry Tasks designed using the Flexible Inquiry Learning Environment (FILE). FILE (Hulshof et al., 2002) was used as a tool for obtaining the three dependent variables (Inquiry Outcome, Process and Speed) through Inquiry Task performance records. The FILE tasks are reliable at analyzing Inquiry Performances, as their logic supports the participants to discover relationships between variables (Wilhelm et al., 2005). The maximum score in an ideal, task-resolving task attempt was 50, awarding 10 score points per correct variable. This meant recording a combination of the 5 correct variables (out of 15 possible combinations) through inquiring about, deducting and inferring from the task assignment. Each variable combination selected by the participant, also called task attempt, displayed a score depending on its level of correctness. There were unlimited opportunities for task attempts. However, the participants were on both tasks instructed to arrive to their highest score through the least amount of recorded attempts to make sure that the success on the Inquiry Tasks depended on active Inquiry Skills, such as learning about the assignment problem by analyzing it and inducting inferences about its resolution, rather than passive rote strategies, such as gaming the system.

There were two Inquiry Tasks instead of one in order to increase the experimental rigor. Besides, the theme of one task aimed to stimulate Feeling Processes, and the other stimulated Thinking Processes, in order to give an equal opportunity for more predominant Feelers and Thinkers to excel in their naturally preferred domain. Balanced Feel-Thinkers were postulated to be able to excel in either task drawing from their ability to adjust their Feeling-Thinking Processes to the task specifics. The overarching theme of both tasks was Science, supporting all participants to take the role of Inquirers, i.e. to feel, think and act as empirical scientists. The theme of the Feeling task was "Psychology of Dating" and the essential task instruction was to identify the ultimate combination of the dating variables after reading short summaries of psychological studies with notions of successful dating

techniques. A picture of FILE interfacing the Feeling Task can be seen in Appendix B. The theme of the Thinking Task was "Physics of Pendulum" and the instruction was to record a solution to a physical query after learning about pendulum behaviors through an interactive pendulum simulation. A picture of FILE interfacing the Thinking Task can be seen in Appendix C. The Inquiry Tasks slightly varied the instructional format (textual versus multimedia). However, the task difficulty was counterbalanced by using a stem design for both tasks with equal amount of learning stimuli and assignment criteria. Although the domains and complexities of the tasks were flexibly configured to match the scope of this study, the interface FILE factors were held constant, which allows generalizability across the tasks (Hulshof et al., 2002).

Digital Debrief Sheet. Debriefing concluded the research and informed about post-participation rights, as per ethical guidelines (Netherlands Institute for Psychologists, 2015). It expressed the researcher's gratitude to the participants for having donated their time to science. Furthermore, it emphasized the contact information on the researcher for any additional questions, e.g. about the study's results and conclusions. It also revealed the participant's Feeling-Thinking scores and explained how it may relate to their Inquiry Learning Skills.

Procedure

Web Request for Ethical Assessment was submitted and the research was approved by the Ethics Committee prior to the data collection (University of Twente, 2017). All participants received identical research instructions, including how to correctly enter the research platform, and that they have unlimited time to complete the study. Scrolling down the ILS tabs and engaging with them in a sequential manner was stressed to assure for full exposure to all research stimuli, as intended. Participant's Information was displayed and Digital Informed Consent was obtained in the first ILS tab prior to introducing any research stimuli, as per ethical guidelines (American Psychological Association, 2017). In the second ILS tab, participants were instructed to complete the Modified MBTI and the Demographic Questionnaire. The third and fourth ILS tabs contained the Feeling Task and the Thinking Task. A disadvantage was that the tasks had to be presented to the participants in this order, as it the task order randomization was not technically available. The ultimate ILS tab displayed a Digital Debrief Sheet, which ethically concluded the participation.

Data Analysis

All generated data, such as raw Personality Trait data and raw Inquiry Performance data were of a quantitative nature except of the signed Informed Consents. They were all downloaded in separate logs and stored in a password protected computer.

Personality Trait. The independent variable emerged from the data obtained from the Modified MBTI questionnaire. For each answer out of 20 questions, Qualtrics automatically assigned a point towards either Feeling or Thinking, returning a Feeling-Thinking ratio with a total of 20 points per participant. The higher number out of the two is divided by 20 and multiplied by 100 to yield a Personality Trait percentage, with scores calculated in 5% increments. This percentage was used to categorize the participants in one of the three levels of measurement. Participants with Personality Trait equal to or below 60% were classified a Balanced Feel-Thinkers. Personality Trait equal to or over 65% was classified as either Feeler or Thinker. The criteria for the data division into Personality Trait groups were decided arbitrarily, which could be considered a limitation. However, there is no precedent set for construct norm of Feeling or Thinking Balance and its category boundaries in relation to extreme Feeling and Thinking, hence this research is pioneering in that respect.

Inquiry Outcome. This dependent variable is based on the participant's last recorded task attempt, as per the instruction that participants' last learning attempt will be considered their ultimate outcome. The Inquiry Outcomes are calculated for each participant on individual tasks, as well as Average by averaging their scores on both tasks.

Inquiry Process. This dependent variable is each participant's sum of attempts on individual tasks, as well as Average by averaging their attempts on both tasks.

Inquiry Speed. This dependent variable is each participant's task duration in seconds on individual tasks, as well as Average by averaging the time taken for both tasks.

Results

Three types of analyses were run on the sample of 126 participants, involving descriptive statistics, analyses of variance (ANOVA), and Post Hoc analyses. Firstly, descriptive statistical measures are structured in order of result importance, as of Average Inquiry Performances, Feeling Inquiry Performances, and Thinking Inquiry Performances, in the three successive tables. Table 1 shows means and standard deviations of three Average Inquiry Performance measures, such as Outcome, Process and Speed, that were averaged on both, Feeling and Thinking tasks, and presented per three types of Personality Trait groups, such as Balanced Feel-Thinkers, Feelers and Thinkers. Balanced Feel-Thinkers achieved the

highest Inquiry Outcomes, followed by Feelers and Thinkers. However, their Inquiry Process required the most attempts out of the three groups, and they took the most time on the tasks, demonstrating low Inquiry Speed.

Table 1

Average Inquiry Performances across Personality Traits: Averaged means and standard deviations on Feeling and Thinking task.

		Inquiry Outcome*		Inquiry Process**		Inquiry Speed***	
Personality	*N*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Feel-Thinkers	54	45.65	6.15	6.85	3.19	513	283
Feelers	48	40.83	9.01	5.05	2.65	410	195
Thinkers	24	41.46	8.91	5.17	2.80	473	246

**Maximum scores out of 50; **Number of task attempts; ***Measured in seconds*

Table 2 below shows means and standard deviations of Inquiry Performances on the Feeling task per Personality Trait. Similarly to previous results, Balanced Feel-Thinkers achieved the best Outcome results, and also confirmed their arguably less favorable Process and Speed position when compared against Feelers and Thinkers. Furthermore, Feelers outperformed Thinkers on Inquiry Outcome, but their Inquiry Speed and Process involved marginally more task-resolving time and attempts.

Table 2

Feeling Inquiry Performances across Personality Traits: Means and standard deviations.

		Inquiry Outcome*		Inquiry Process**		Inquiry Speed***	
Personality	*N*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Feel-Thinkers	54	47.59	5.12	6.78	4.53	528	363

Feelers	48	43.52	8.63	5.71	3.56	467	215
Thinkers	24	42.92	9.99	4.33	4.37	460	277

**Maximum scores out of 50; **Number of task attempts; ***Measured in seconds*

Table 3 shows means and standard deviations of Inquiry Performances on the Thinking task per Personality Trait. The results for Feel-Thinkers are once again the highest of all groups, similarly to the Average and Feeling Inquiry Performances. Furthermore, Thinkers outperformed Feelers on Outcome, but their Process involved more attempts and their Speed was slower.

Table 3

Thinking Inquiry Performances across Personality Traits: Means and standard deviations.

		Inquiry Outcome*		Inquiry Process**		Inquiry Speed***	
Personality	*N*	Mean	*SD*	Mean	*SD*	Mean	*SD*
Feel-Thinkers	54	43.70	8.96	6.93	3.85	498	351
Feelers	48	38.13	11.97	4.92	2.98	354	224
Thinkers	24	40.00	10.63	6.00	3.06	487	336

**Maximum scores out of 50; **Number of task attempts; ***Measured in seconds*

Secondly, one-way independent ANOVA analyses were conducted to determine the degree of differences in Inquiry Performance (Inquiry Outcome, Process and Speed) per Personality Trait (Balanced Feel-Thinking, Feeling and Thinking). A table summarizing all ANOVA results regarding the degree of differences in Inquiry Performances between Feel-Thinkers, Feelers and Thinkers can be seen in Appendix D. Levene's tests were carried out showing that the null hypothesis of equality of variances was not violated for Average Outcome $F(2,123) = 2.737$, $p = 0.069$, Average Process $F(2,123) = 0.822$, $p = 0.442$, and for Average Speed $F(2,123) = 0.445$, $p = 0.642$, indicating that the assumption of homogenous variances is valid. Three categories of ANOVA results (both tasks on Average, Feeling task

and Thinking task) are presented, as follows. The main effect for the Average Inquiry Outcome yielded an F ratio of $F(2, 123) = 5.319$, $p = .006$, indicating significant differences between the three Personality Trait groups. Similarly, for Average Inquiry Process this was $F(2, 123) = 5.619$, $p = .005$, indicating significant differences across the Personality Traits. The second ANOVA dataset was on the Feeling task and also revealed significant differences between the Personality Trait groups with regards to Outcome [$F(2, 123) = 4.848$, $p = .009$] and Process [$F(2, 123) = 3.479$, $p = .034$]. Similarly, the third dataset for ANOVA showed significant differences between groups for all three Thinking Inquiry Performances, with $F(2, 123) = 3.681$, $p = .028$ for Outcome, $F(2, 123) = 4.452$, $p = .014$ for Process, and $F(2, 123) = 3.182$, $p = .045$ for Speed.

Thirdly, Post Hoc two-tail *t*-tests confirmed notable differences at $p < .05$ significance level in pair comparisons with regards to averaged Inquiry Tasks, Feeling Task and Thinking Task. Average Inquiry Performance Post Hoc results showed significant differences between Balanced Feel-Thinkers and Feelers in Outcome ($p = 0.002$), Process ($p = 0.003$), and Speed ($p = 0.038$), as well as between Balanced Feel-Thinkers and Thinkers in Outcome ($p = 0.019$) and Process ($p = 0.028$).–Inquiry Performance Post Hoc results on the Feeling task revealed significant differences in Outcome between Balanced Feel-Thinkers and Feelers ($p = 0.004$), as well as Balanced Feel-Thinkers and Thinkers ($p = 0.008$) and Process ($p = 0.029$). Inquiry Performance Post Hoc results on the Thinking task revealed a significant variance between Balanced Feel-Thinkers and Feelers in Outcome ($p = 0.009$), Process ($p = 0.004$), and Speed ($p = 0.016$), as well as a significant difference between Feelers and Thinkers in Speed ($p = 0.049$). The main results from all Post Hoc tests mostly confirmed the findings from the above described ANOVA analyses, showing that there are statistically significant differences between Balanced Feel-Thinkers and the other groups, especially when it comes to Inquiry Outcome and Process.

Discussion and Conclusion

Discussion. This research study investigated the differences in Personality Traits of Balanced Feel-Thinkers, Feelers and Thinkers, and their influence on Inquiry Performance measures (Outcome, Process and Speed) on two Inquiry Tasks analyzed separately and on average. As predicted by the first hypothesis, Balanced Feel-Thinkers achieved the highest-quality Inquiry Outcomes compared to people with a less psychologically balanced Personality Trait, i.e. Feelers and Thinkers. Surprisingly, the second and third research hypotheses that the Inquiry Process and Speed of Balanced Feel-Thinkers, compared to

Feelers and Thinkers, would be the most effective in terms of spending mental resources and time on task attempts, were not supported. In fact, significant results on Inquiry Process and non-significant for Inquiry Speed showed that Balanced Feel-Thinkers took the highest amount of attempts and time across all groups and tasks. Thus, the main findings are that people with Feeling-Thinking Balance were better Inquiry Learners than Feelers and Thinkers in producing high quality Inquiry Outcomes despite higher mental investment in processual and temporal terms. Additionally, one other interesting finding was that although Feelers and Thinkers were found to be significantly different from the Balanced Inquirers, there were no significant differences between the two more extreme Personality Trait groups in all average and individual task measures of Inquiry Learning Skills (Outcome, Process, and Speed) except one significant difference in Inquiry Speed on the Thinking Task.

The main finding was that Feeling-Thinking Balance is linked with a significant quality increase in Inquiry Outcomes, and that this distinguished Inquiry Performance was significantly different from either of the less balanced Personality Traits, Feeling and Thinking. This could be explained in terms of the nature of Inquiry Learning, which, as Fielding (2012) points out, requires both Feeling-related "problem-finding", and Thinking-related problem-solving. Jung (1923) together with the original designers of the Feeling-Thinking Personality Trait instrument (Myers et al., 1998) believed that Thinkers' and Feelers' decision-making, whether in life or in learning settings, originates in two different criteria sets used for evaluating the problematic (Inquiry) information. Thinkers thrive on theoretical approaches to problem-solving and employ a more analytical approach, which benefits from questions and answers (Kolb, 1984). Open-ended questions and interventions that promote exploration of the unknown, which are key elements of Inquiry, could be seen as disadvantageous to Thinkers, as they may overanalyze task details and not grasp the "bigger picture" (Kolb, 1984), and struggle to flexibly respond to changing academic challenges (Stuebing, et al., 2015). Conversely, resolving the task as a single abstract unit is a key strength of Feelers (Sadler-Smith and Sparrow, 2008). With their Inquiry Process being led mostly by intuitive decision-making, Feelers rely more on tacit and informal data than on formal facts, which could lead to irrational decisions. In contrast to both of these types of learners, Balanced Feel-Thinkers utilize both criteria sets for evaluating problems. Therefore, it appears that Inquiry learning in its nature is more suited to Balanced learners, as they engage in both essential aspects of the process. The way in which this processual symbiosis of Feeling and Thinking (Schwarz, 2002; Zajonc, 1980; Lazarus, 1882) may be giving them a

distinct advantage on Inquiry Learning could be explained by Sternberg's concept of Intelligence in learning (1998).

Sternberg's Synthetic (Feeling) Intelligence (1998) involves brain-storming as the creative ability to generate ideas that are novel, raw and abstract, which can redefine problems effectively as a larger picture in a holistic manner. In turn, Analytical (Thinking) Intelligence is engaged in problem-solving as the insightful ability to judge the value of one's own ideas, to evaluate their specific strengths and weaknesses, and suggest ways to improve them in a great detail. However, only if both of these Intelligences are joint in the Practical Intelligence as the ability to apply them on a behavioral level, the (Inquiry) Learning Process can be fruitful in its full sense. The main findings of the present research confirm these theories and add that it is the relatively equitable application of Feeling and Thinking that boosts the Learning Outcomes through Inquiry.

Another way to interpret the superior Inquiry Outcome achievement of Balanced Feel-Thinkers is their usage of metacognitive strategies. Flavell (l976) defined Metacognition as the knowledge a problem-solver has about their own cognition during its utilization, including data, such as Thinking Processes and their "products", such as Inquiry Outcomes. Activated Metacognition summons, manages and evaluates the available mental resources as a brain power to execute Outcome adjustments (Flavell, l976). From this definition result two basic aspects of the Metacognition concept: knowing of the own cognitive processes and their products, and adjusting of the own cognitive processes. The implications of utilizing these aspects in the Inquiry Process is the ability to conceptualize and understand the strategies of the experimentation, and the skill of reflecting critically upon the utilized process and optimizing the strategy in order to attain the desired resolution or outcome. Balanced Inquirers might be capable of implementing metacognitive strategies in a more effective way than Feelers or Thinkers due to their ability and preference to apply both personality structures in equal measure. As discussed, the Inquiry Process requires application of both Feeling and Thinking intellectual skills, as they are responsible for different aspects of Inquiry Outcomes, e.g. Feeling aids creativity, conceptualization and intrinsic motivation (Chew, Zain, & Hassan, 2013), while Thinking enhances strategy evaluation. Metacognition, therefore, seems to lend itself better to a Balanced mindset, which is inherent to Feel-Thinkers who employ it more fully, successfully, and continuously, as they constantly re-evaluate the need for application of a particular personality structure.

The other main findings of the present study were that Balanced Feel-Thinkers took the highest amount of attempts and time across all groups and tasks. This was unexpected

because in the context of 21st Century Skills and ideal "Knowledge Societies", inordinate Inquiry Process and Speed could be considered rather mentally resourceful and hence *in*effective (Erstad et al., 2016; Voogt & Roblin, 2012). However, in the context of cost-benefit model, this evidence would be judged as an efficient Learner Strategy to gain the maximum quality Outcomes through Inquiry, "costing" mental effort and time applied into the Learning Process. These findings are congruent with previous educational research, showing that the time and effort investments are two generally necessary prerequisites for maximized Learning Outcomes (Cole et al., 2008; Siahi & Maiyo, 2015). As discussed, the apparent use of metacognitive strategies by the Balanced Feel-Thinkers could also be used to explain the observed higher number of attempts and time spent on Inquiry, since the metacognitive approach requires Inquierers to continuously evaluate and adjust their task process in order to obtain the best possible Outcome. This naturally leads to the necessity to perform more task attempts as of experiments cause-effect observations, since knowledge is directly derived from interacting with the variables and the combinations between them, i.e. applying Control-of-Variables Strategy, or CVS (Chen & Klahr, 1999). Usage of the CVS is a prerequisite for the valid interpretation of experimental outcomes, and the results for both, Average Inquiry Outcomes and Processes suggest that Balanced Inquirers adopted this approach more fully than Thinkers or Feelers.

The Personality Traits of the two groups of more extreme learners could also have played a part in the apparent lower mental investment (in the form of a process involving less inquiry attempts, and thus less time) on Inquiry Tasks. As discussed, Feelers make more impulsive decisions and tend to rely more on "instinct", "gut feeling", or strong irrational emotion (Sadler-Smith and Sparrow, 2008), leading to less Inquiries than in the Balanced Feel-Thinking group, and consequently less time spent on their Average Inquiry Process, and, as seen, final Outcomes which are not necessarily supported by the Inquiry-derived evidence. On the other hand, the focus of more extreme Thinkers on data-gathering and analysis of individual task components, and less so on the overall task concept (Kolb, 1984) may be the underlying cause for them to perform less attempts in their Learning Process and thus to spend less time on Inquiry.

Conclusion. The findings of this study conclude that Feeling-Thinking Balance can be considered a distinct psychological construct, as evidenced by the significant differences observed between the Inquiry Outcomes and Inquiry Process of Balanced Feel-Thinkers and the more extreme Feelers and Thinkers. This shows that Feeling and Thinking can be placed on a meta-continuum from psychological balance to effective Inquiry.

Given the significantly superior Inquiry Outcomes of Balanced Inquirers compared to Feelers and Thinkers, Feeling-Thinking Balance could be considered a facilitator of success on Inquiry Tasks. Inversely, personality imbalances leading to an extreme engagement with either Feeling or Thinking Processes could be considered disadvantageous to Inquiry Performance, hence also the 21st Century Skills.

Contrary to the popular belief that General Intelligence is the ultimate facilitator of success in traditional and modern classrooms, this research shows that engaging with sole Thinking, without equitably complementing it with Feeling Processes, does not yield high-quality Inquiry (Learning) Outcomes. Therefore, the proportionate utilization of Feeling-Thinking Processes through learner's personal choice and teacher's balanced instruction is an important remark that has implications on future educational research, design, and practice.

Educational Implications. One of the main implications of the study is the validation of a new psychological construct, Feeling-Thinking Balance, as a third element alongside the separate measures of Feeling and Thinking. This means that Feeling-Thinking Balance can be added as a third element to the Personality Scale alongside the discrete measures of Thinking and Feeling, allowing to assess learners' approach to (learning related) decision making in a more specific and less binary manner. This finding also has a direct bearing in future educational research and curriculum design, as it highlights the importance of treating Feeling and Thinking as two elements of the same continuum, and the benefits of stimulating both Feeling and Thinking-rooted aptitudes during modern learning methods, such as Inquiry learning. For holistic student development, novel educational designs could cease the historical over-representation of solely cognitive instructions in traditional classrooms, and recognize the equally important value of emotional instructions, such as motivation (Artino, 2012). However, this intervention should not trend as a growing over-representation of emotional stimuli. Research shows that Feeling-related motivation and Thinking-related cognitive performance improve when the instruction is adapted to student learner characteristics, learning preferences and styles (Hayes & Allinson, 1996; Smith et al., 2002). Educators have a responsibility to acknowledge the diversity of their class and to present information in a variety of ways in order to accommodate and maximize the cumulative learning potential inclusively. However, if teaching instruction is heavily biased towards certain extremes in the learning styles, mismatched students may be too uncomfortable to learn effectively and may lose motivation, leading to a cognitive dis-engagement (Ainley, 2006). However, neither the students whose learning styles perfectly match the teaching style might not be helped to develop critical skills in their less preferred learning style categories

(Felder, 2005). Therefore, the optimal teaching style is a balanced one that sometimes matches students' preferences, so their discomfort level is not too great for them to learn effectively, and sometimes goes against their preferences, forcing them to stretch and grow in directions they might be inclined to avoid if given the option.

With regards to Feeling-Thinking Personality Traits as three levels of unique learner characteristics and individual differences in learners' decision-making, assessing the learning style profile of Inquirers with Feeling-Thinking scales can provide additional support for effective instructional design (Gläser-Zikuda et al. 2005; Meyer & Turner, 2002). Additionally, having teachers share their evaluations with the learners can provide them with a valuable insight about their possible strengths and weaknesses in Inquiry, and hence with indications of ways they might improve. However, precautions should be taken with labelling and determining student learning styles. No psychological instrument is infallible, and if the student's perceptions of how they learn differ from what was measured, this would not invalidate the learner's own self-assessment. Students should also be assured that their learning style bias is not a reliable indicator of what they are and are not capable of doing, and that people with every possible personality can succeed in any profession or endeavor (Felder & Brent, 2005).

Advantages and Limitations. Analyzing Inquiry Outcomes on the two individual Inquiry Tasks, which were designed especially for the purpose of this research, revealed that both, Feelers and Thinkers perform better on the task with the theme corresponding to their strong Feeling or Thinking preference. In other words, Feelers outperformed Thinkers on the Feeling Task, and Thinkers outperformed Feelers on the Thinking Task. This could suggest that the two Inquiry Tasks were well designed to target two different populations with diverse learner characteristics detectable as more extreme Feeling-Thinking Personality Traits.

Limitations of this research mostly represent some detected and some potentially undetected technical difficulties with the online platform, as described in the Method section. An advantage was that the website was tested by the researcher on various devices for the correctness of displaying the research stimuli. Additional pilot testing with 12 participants identified specific types of incompatible devices and internet browsers. However, because there is such a wide range of popular hardware and software, which the participants could have used to access the research platform despite being instructed to use only specific technology, there is no certainty that all participants were presented with all research stimuli. Furthermore, the arbitrary division of participants' data into three distinct personality groups (Balanced Feel-Thinkers, Feelers and Thinkers) could be considered a limitation given that

there is no precedented research norm of how much Feeling or Thinking preference of mental engagement would be an either extreme or balanced Personality Trait.

Future Research. Future quantitative research could establish a more direct, causal relationship between Feeling-Thinking Balance and Inquiry Learning. Possible method adjustments can include measuring Feeling-Thinking Balance as an observed skill rather than a self-measure of preference, and the testing could be extended to a variety of Learning Environments. Contrastingly, another strand of future research could adopt the qualitative approach and investigate rich subjective Inquiry experiences described freely in great detail by a sample of Inquirers, who could differentiate even by more levels of Feeling-Thinking Balance. In this case, categorization of the participants by Personality Traits could be aided by having the participants primed on the concept of Feeling-Thinking continuum before being able to self-identify with a certain level of the Personality Trait. These qualitative results could also provide an in-depth insight into the diverse, self-reported origins of some functional, and some dysfunctional Feeling-Thinking Personality Trait levels across individuals. Thirdly, in case some of the suggestions in this paper become implemented, e.g. integration of Feeling-Thinking Balance in the 21st Century Curriculum, this action would need to be evaluated retrospectively in a systematic, scientific manner.

References

American Psychological Association. (2017, August 12). *Ethical Principles Of Psychologists And Code Of Conduct.* Retrieved from APA Ethics Code: http://www.apa.org/ethics/code/ethics-code-2017.pdf

Artino, A. R. (2012). Emotions in online learning environments: Introduction to the special issue. *The Internet and Higher Education*, *3*(15), 137-140.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain.* New York: David McKay Company. Inc.(7th Edition 1972).

Canivez, G. L., Watkins, M. W., & Dombrowski, S. C. (2016). Factor structure of the Wechsler Intelligence Scale for Children–Fifth Edition: Exploratory factor analyses with the 16 primary and secondary subtests. *Psychological Assessment*, *28*(8), 975.

Capraro, R. M., & Capraro, M. M. (2002). Myers-Briggs type indicator score reliability across studies: A meta-analytic reliability generalization study. *Educational and Psychological Measurement*, *62*(4), 590-602.

Central Committee on Research Involving Human Subjects. (2017, August 16). *Research with Incapacitated Adults*. Retrieved from http://www.ccmo.nl/en/research-with-incapacitated-adults

Chew, B. H., Zain, A. M., & Hassan, F. (2013). Emotional intelligence and academic performance in first and final year medical students: A cross-sectional study. BMC medical education, 13(1), 44.

Chu, S. K., Reynolds, R. B., Tavares, N. J., Notari, M., & Lee, C. W. (2017). *21st Century Skills Development Through Inquiry-Based Learning: From Theory to Practice.* Singapore: Springer Science.

Cole, J. S., Bergin, D. A., & Whittaker, T. A. (2008). Predicting student achievement for low stakes tests with effort and task value. *Contemporary Educational Psychology, 33*(4), 609-624.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297-334.

Coolican, H. (2014). *Research methods and statistics in psychology*. London: Psychology Press.

de Jong, T. (2010). Cognitive load theory, educational research, and instructional design: Some food for thought. *Instructional science*, *38*(2), 105-134.

de Jong, T., Sotiriou, S., & Gillet, D. (2014). Innovations in STEM education: the Go-Lab federation of online labs. *Smart Learning Environments*, *1*(1), 3.

Dirkx, J. (2001). The power of Feelings: Emotion, imagination, and the construction of meaning in adult learning. *New Directions for Adult and Continuing Education, 89,* 63-72.

Dutch Intelligence Test for Educational Level (2017, October). Retrieved from http://www.testresearch.nl/nio/niogivo.html

Erstad, O., Kumpulainen, K., Mäkitalo, Å., Schrøder, K. C., Pruulmann-Vengerfeldt, P., & Jóhannsdóttir, T. (2016). *Learning Across Contexts in the Knowledge Society.* Rotterdam: Sense Publishers.

Felder, R. M., & Brent, R. (2005). Understanding student differences. *Journal of engineering education*, *94*(1), 57-72.

Fielding, M. (2012). Beyond student voice: Patterns of partnership and the demands of deep democracy. *Revista de Educación, 359,* 45–65.

Flavell, J. H. (1976). Metacognitive aspects of problem solving. *The nature of intelligence*, 231-235.

Gläser-Zikuda, M., Fuß, S., Laukenmann, M., Metz, M. and Randler, C. (2005). Promoting students' emotions and achievement – Instructional design and evaluation of the ECOLE-approach. *Learning and Instruction 15(5),* 481-495.

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.

Hmelo-Silver, CE, Duncan, RG and Chinn, CA. (2007). Scaffolding and achievement in problem-based and Inquiry Learning: A response to Kirschner, Sweller, and Clark (2006). *Educational Psychologist*, 42(2), 99–107.

Hulshof, C. D., Wilhelm, P., Beishuizen, J. J., & Van Rijn, H. (2002). FILE: A tool for studying Inquiry Learning. *Computers in Human Behavior, 21(6),* 945-956.

Jung, C. G. (1923). *Psychological types*. Routledge & Kegan Paul.

Kolb, D. (1984). Experiential education: Experience as the source of learning and development. *Englewood Cliffs, NJ*.

Koumi, J. (2013). Pedagogic design guidelines for multimedia materials: A call for collaboration between practitioners and researchers. *Journal of Visual Literacy*, *32*(2), 85-114.

Lazarus, R. S. (1982). Thoughts on the relations between emotion and cognition. *American psychologist*, *37*(9), 1019.

Marx, R. W., Blumenfeld, P. C., Krajcik, J. S., Fishman, B., Soloway, E., Geier, R., & Tal, R. T. (2004). Inquiry-based science in the middle grades: Assessment of learning in urban systemic reform. *Journal of research in Science Teaching*, *41*(10), 1063-1080.

Mayer, R. E. (2014). *Cambridge Handbook of Multimedia Learning (2nd Edition).* Cambridge: Cambridge University Press.

Merriam, S. B., & Caffarella, R. S. (1999). *Learning in adulthood: A comprehensive guide* (2nd ed.). San Francisco: Jossey-Bass.

Meyer, D K. and Turner, J C. (2002). Discovering Emotion in Classroom Motivation Research. *Educational Psychologist 37(2),* 107-114

Moore, J. (2000). Thinking about thinking and feeling about feeling. *The Behavior Analyst*, *23*(1), 45-56.

Myers, I. B., McCaulley, M. H., Quenk, N. L., & Hammer, A. L. (1998). *MBTI Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator (Vol. 3).* Palo Alto, CA: Consulting Psychologists Press.

Netherlands Institute for Psychologists. (2015, February). *Code of Ethics.* Retrieved from https://www.psynip.nl/en/wp-content/uploads/sites/3/2016/10/150330

Opengart, R. (2005) Emotional intelligence and emotion work: Examining constructs from an interdisciplinary framework. *Human Resource Development Review, 4,* 49-62.

Park, O. C., & Lee, J. (2003). Adaptive instructional systems. *Educational Technology Research and Development*, *25*, 651-684.

Pedaste, M., Mäeots, M., Siiman, L. A., De Jong, T., Van Riesen, S., Kamp, E., . . . Tsourlidaki, E. (2015). Phases of Inquiry-Based Learning: Definitions and the Inquiry Cycle. *Educational Research Review, 14*, 47-61.

Reeve, J. (2001). *Understanding motivation and emotion.* Fort Worth, TX: Harcourt College.

Sadler-Smith, E., and Sparrow, P. R., 2008. Intuition in organizational decision making. In Hodgkinson, G. P. and Starbuck, W. H. (eds), The Oxford Handbook of Organizational Decision Making, Oxford, Oxford University Press, 305-324.

Schwarz, N. (2002). Situated cognition and the wisdom of feelings: Cognitive tuning. *The wisdom in feelings*, 144-166.

Siahi, E. A., & Maiyo, J. K. (2015). Study of the Relationship between Study Habits and Academic Achievement of Students: A Case of Spicer Higher Secondary School, India. *International Journal of Educational Administration and Policy Studies, 7*(7), 134-141.

Smith, N. G., Bridge, J., & Clarke, E. (2002, June). An evaluation of students' performance based on their preferred learning styles. In *Proceedings, 3rd Annual Conference of the UNESCO International Centre for Engineering Education, Melbourne, Australia: UICEE*.

Smith, E. E. (2015). Cognitive Psychology: History. In J. E. Wright, International Encyclopedia of the Social & Behavioral Sciences (pp. 2140-2147). New York: Elsevier.

Sternberg, R. J., O'Hara, L. A. (1998). Creativity and Intelligence. In *Handbook of Creativity*. Cambridge University Press.

Stuebing, K. K., Barth, A. E., Trahan, L. H., Reddy, R. R., Miciak, J., & Fletcher, J. M. (2015). Are child cognitive characteristics strong predictors of responses to intervention? A meta-analysis. *Review of educational research*, *85*(3), 395-429.

Thijs, A., Fisser, P., & Hoeven, M. v. (2014). *21e Eeuwse Vaardigheden in het Curriculum van het Funderend Onderwijs.* Enschede: Slo.

University of Twente. (2017). *Research Ethics*. Retrieved from https://www.utwente.nl/en/bms/research/ethics/.

Vandewaetere, M., Desmet, P., & Clarebout, G. (2011). The contribution of learner characteristics in the development of computer-based adaptive learning environments. *Computers in Human Behavior*, *27*(1), 118-130.

Van de Vijver, F. J., & Leung, K. (2000). Methodological issues in psychological research on culture. *Journal of cross-cultural psychology*, *31*(1), 33-51.

von Schomberg, R. (2011a) 'Towards Responsible Research and Innovation in the Information and Communication Technologies and Security Technologies Fields'. Brussels: European Commission, <http://ec.europa.eu/research/science-society/document_library/pdf_06/mep-rapport2011_en.pdf> accessed 12 November 2017.

Voogt, J., & Roblin, N. P. (2012). A Comparative Analysis of International Frameworks for 21st Century Competences: Implications for National Curriculum Policies. *Journal of Curriculum Studies, 44 (3)*, 299-321.

Wechsler, D. (1949). *Wechsler intelligence scale for children.* New York: The Psychological Corporation.

Wilhelm, P., Beishuizen, J. J., & Van Rijn, H. (2005). Studying Inquiry Learning with FILE. *Computers in human behavior, 21 (6)*, 933-943.

Zajonc, R. B. (1980). Feeling and Thinking: Preferences need no inferences. *American psychologist*, *35*(2), 151.

Appendix A

Modified Myers-Briggs Type Indicator (Myers et al., 1998)

Are you more impressed by:

- ○ Principles
- ○ Emotions

Are you more drawn towards the:

- ○ Convincing
- ○ Touching

In judging others are you more swayed by:

- ○ Laws than circumstances
- ○ Circumstances than laws

In approaching others is your inclination to be somewhat:

- ○ Objective
- ○ Personal

Which appeals to you more:

- ○ Consistency of thought
- ○ Harmonious human relationships

Are you more comfortable in making:

- ○ Logical judgments
- ○ Value judgments

Are you more often:

- ○ A cool-headed person
- ○ A warm-hearted person

Is it worse to be:

- ○ Unjust
- ○ Merciless

In making decisions do you feel more comfortable with:

- ○ Standards
- ○ Feelings

Are you more:

- ○ Firm than gentle
- ○ Gentle than firm

Which is more satisfying:

- ○ To discuss an issue thoroughly
- ○ To arrive at agreement on an issue

Which rules you more:

- ○ Your head
- ○ Your heart

Which is more of a compliment:

- ○ “There is a very logical person.”
- ○ “There is a very sentimental person.”

Do you value in yourself more that you are:

- ○ Unwavering
- ○ Devoted

Which person is more to be complimented – one of:

- ○ Clear reason
- ○ Strong feeling

Are you inclined more to be:

- ○ Fair-minded
- ○ Sympathetic

Which seems the greater error:

- ○ To be too passionate
- ○ To be too objective

Do you see yourself as basically:

- ○ Hard-headed
- ○ Soft-hearted

Which do you wish more for yourself:

- ○ Clarity of reason
- ○ Strength of compassion

Which is the greater fault:

- ○ Being indiscriminate
- ○ Being critical

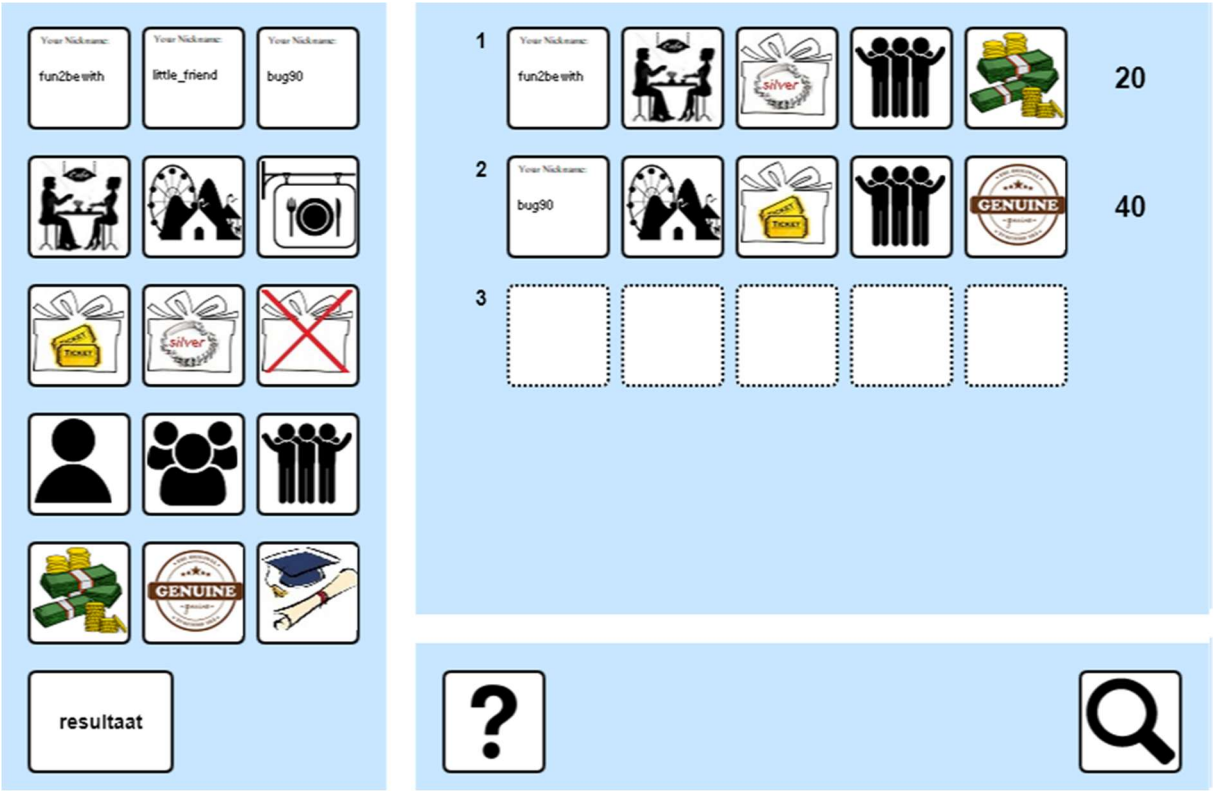
Appendix B

Feeling Inquiry Task designed in FILE

Answer the following:

Which picture from each row represents effective dating?

1. Your nickname
2. Dating place
3. The gift you give
4. Your profile photo
5. Way you advertize yourself



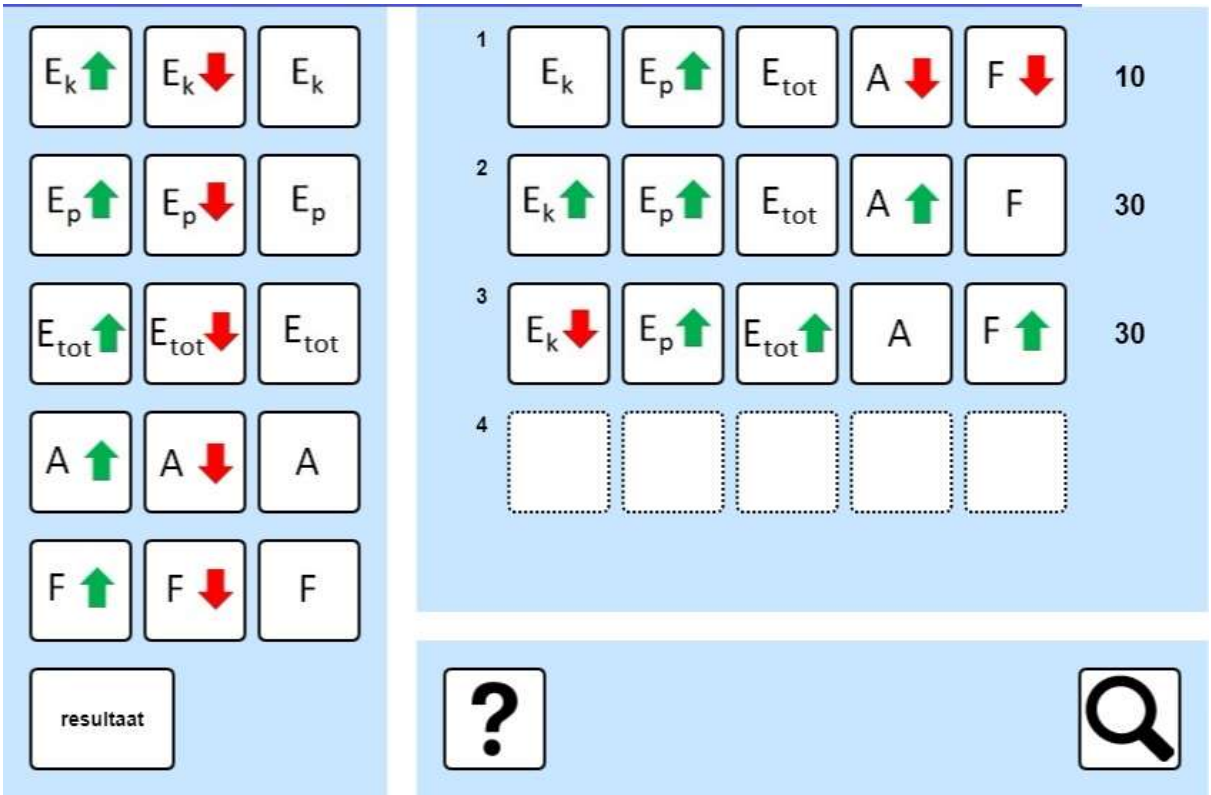
Appendix C

Thinking Inquiry Task designed in FILE

Answer the following:

For a given displacement from the equilibrium position (marked with 0), what happens to the following variables at the mass ***m*** increases?

1. The Kinetic energy of the pendulum ***Ek***
   (increases, decreases, or remains constant)
2. The Potential energy of the pendulum ***Ep***
   (increases, decreases, or remains constant)
3. The Total energy of the pendulum ***Etot***
   (increases, decreases, or remains constant)
4. The Maximum Acceleration of the pendulum's mass ***A*** after the first oscillation
   (increases, decreases, or remains constant)
5. The Frequency of the oscillations ***F*** energy of the pendulum
   (increases, decreases, or remains constant)



Appendix D

Table X

Degree of differences in Inquiry Performances between Feel-Thinkers, Feelers and Thinkers

	Sum of Squares	df	Mean Square	*F*	*p* value
Average Inquiry Outcome				5.319	0.006
Between Groups	661.03	2	330.51		
Within Groups	7642.9	123	62.138		
Average Inquiry Process				5.619	0.005
Between Groups	95.964	2	47.982		
Within Groups	1050.3	123	8.539		
Average Inquiry Speed				2.228	0.112
Between Groups	268864	2	134432		
Within Groups	7420861	123	60332		
Feeling Inquiry Outcome				4.848	0.009
Between Groups	566.04	2	283.02		
Within Groups	7180.79	123	58.38		
Feeling Inquiry Process				3.479	0.034
Between Groups	120.156	2	60.078		
Within Groups	2123.98	123	170268		
Feeling Inquiry Speed				0.701	0.498
Between Groups	124702	2	62351		
Within Groups	10935e3	123	88907		
Thinking Inquiry Outcome				3.681	0.028
Between Groups	813.46	2	406.73		
Within Groups	13591	123	110.49		
Thinking Inquiry Process				4.452	0.014
Between Groups	102.6	2	51.299		
Within Groups	1417.4	123	11.523		
Thinking Inquiry Speed					
Between Groups	593037	2	296518	3.182	0.045
Within Groups	11461e3	123	93181		