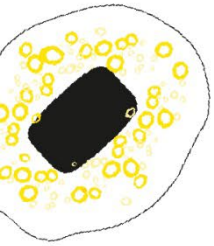
Master thesis



Can alignment in individual team ratings predict team performance?

Measuring the correlation between the team variance of individual ratings of team performance and observed team performance.

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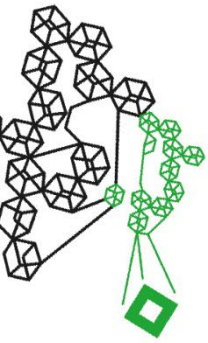

Keywords: Professional development, self-directed learning, team learning, team performance, team alignment

Abstract

There is increasing criticism on students' preparedness for the workplace. Students need to develop professional skills to bridge the gap between formal education and their professional careers. The University of Twente developed a course for third year undergraduate students to improve their professional development through self-directed learning and teamwork. As part of this course, students completed weekly self-report questionnaires on items relating to team competencies, performance, and efficacy over the course of five weeks and received weekly team reports. To add to existing theory on shared mental models and its implications for team performance, this study aimed to discover the effects of team alignment on observed performance. Team alignment was determined by calculating the variance between team members' scores and compared to the team's project grade and individual course grade. This study showed a significant positive linear relation between team alignment on performance at the start of the project and observed team performance. There was a significant positive linear relation between efficacy and observed team performance at the end of the project. No significant results were found for team alignment in relation to individual performance. This study provides a new method for predicting team performance by measuring team alignment through variance. Further theoretical and practical implications are discussed, as well as directions for future research.

Keywords: Professional development, self-directed learning, team learning, team performance, team alignment

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Acknowledgement

Finally I can present to you my thesis. It was a long process, but a valuable and teachable one, and dare I say I did have fun in the process! Combining all of the lessons learned throughout the courses that I followed during the Masters programme Educational Science and Technology and further discovering that data analysis is not scary and can actually be a fun puzzle!

First and foremost, I would like to thank my first supervisor Nick Goossen. I am very grateful for how you guided me throughout the process of writing this thesis, giving valuable feedback and suggestions. Without your support I would not have been able to reach this level of quality in my thesis. I would also like to thank dr. Sebastian Dennerlein for the feedback towards the end of my writing process, making my line of arguing stronger and helping me elaborate on all of the different theories included in this thesis.

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And now I proudly present my thesis. I hope you enjoy reading it as much as I enjoy being able to share it with you!

1. Introduction

1.1 Background

There is an increased awareness that workplace learning and lifelong learning, both individually and as a team, are of great importance to the development of organisations (Jaldemark et al., 2022; Khousa et al., 2015; Neal & Martz, 2016; Shuffler et al., 2020). Employees are expected to stay up to date with the latest developments and newest technologies within the field, meaning that learning extends and continues beyond formal education. While formal education is aimed at preparing students for work life, this connection to the work field is not without hurdles, as there is an increasing amount of criticism on students' preparedness for the workplace (Okolie et al., 2019; Plotnikova & Strukov, 2019). Learning the theory does not mean that it is directly applicable in practice. Besides, learning does not stop after completing formal education, but continues at the workplace. Organizations recognize the importance of lifelong learning and often offer training and coaching programs to support the development of their employees (Roche, 2017; Tvenge & Martinsen, 2018). But the same issue applies here, what is learned in an outside-of-the-workplace training is not always directly transferrable to an on-the-workplace setting (Berge, 2008; Kitching, 2008).

To improve this preparedness for the workplace, there is a need for students to build up competence in self-directed professional development to increase self-responsibility as a professional at the workplace. Thus, next to the traditional curriculum, there should be attention for the professional development of students. Duncheny et al. (1997) define professional development as *"… an ongoing process through which an individual derives a cohesive sense of professional identity by integrating the broad-based knowledge, skills, and attitudes [within psychology] with one's values and interests."* (p. 89). When it comes to professional development, two main topics are recurrent in literature: lifelong learning and self-directed learning. In fact, many researchers treat these topics as interdependent (Aşkin Tekkol & Demirel, 2018; Greveson & Spencer, 2005; O'Shea, 2003; Patterson et al., 2002; Van Veldhuizen, 2011; Watkins, 1999). When it comes to lifelong learning, Aşkin Tekkol and Demirel (2018) discuss the importance of learning to learn and how the lifelong learning mindset helps individuals to make informed decisions about their learning needs. It is especially relevant for those who pursue self-development, both within and outside of the formal education context (Aspin & Chapman, 2001, as cited in Aşkin Tekkol & Demirel, 2018). Self-directed learning connects to that, as it highlights the need for the individual to take initiative in identifying these learning needs and planning how to acquire the necessary knowledge or skills (Knowles, 1975, as cited in O'Shea, 2003).

The development of self-directed learning through project-based and team-based learning is a widely discussed approach to stimulate the professional development of students, leading to the development of skills relevant to employability (Bagheri et al., 2013; Larson et al., 2020; Okolie et al.,

2019; Reid-Brown, 2017). It is imperative that students develop the professional skills needed to improve workplace preparedness, and, consequently, their employability (Fraser et al., 2019; Jaldemark et al., 2022; Neal & Martz, 2016; Okolie et al., 2019; Watkins, 1999). In literature, many theories are being discussed in support of learning on the job. For example, by learning through social interaction, both in formal and informal settings, for example in communities of practice, learning through observation or apprenticeship, and through organisational and team learning (e.g. Dennen & Burner, 2008; Edmondson, 1999; Khousa et al., 2015; Kostopoulos et al., 2013; Lave & Wenger, 1991; Smith, 2003), as it has been recognized that team-level skills are progressively important in today's workplace (Neal & Martz, 2016; Noe et al., 2014). Consequently, team-based projects are increasingly applied in tertiary education, which relates positively with the critical-thinking skills and performance of students (Carlson, 2016; Cheng et al., 2022; Opdecam et al., 2014; Snyder & Wiles, 2015; Snyder et al., 2016). Besides, Cheng et al. (2022) found that applying team learning in an undergraduate course decreased anxiety and helped regulate the cognitive load.

When discussing team learning, many references are made to the work of Senge (1990) on learning organisations. Senge (1990) proposes that there are 5 aspects which are of importance for the establishing of a learning organisation: (1) *personal mastery*, focusing on individual learning, and especially on the personal motivation to continuously work on professional development; (2) *mental models*, which includes how individuals view the world, bringing that to the surface, and letting others influence their views; (3) *building shared vision*, which is the generation of a shared view of future goals, values, and missions, which has the ability to bring people together by formulating a common identity and developing commitment to that identity; (4) *team learning,* in which the goal is that the collective knowledge exceeds the intelligence of individual team members, causing not only better results at the team level, but also elevated individual learning; (5) *systems thinking,* which is the realization that every aspect, change, or decision has an impact on the system, with organisations and even individuals being recognized as systems and, therefore, being part of a whole.

Whereas personal mastery (professional development and self-directed learning) and team learning are widely researched and applied theories, the presence of mental models and shared vision is more difficult to grasp. Research suggests that having a shared mental model increases team situational awareness and leads to higher team performance, especially in interdisciplinary or action teams performing in high-stress situations (Bolstad & Endsley, 1999; Cannon-Bowers et al., 1993; Lim & Klein, 2006; 1993; Salas et al., 1997; Santos et al., 2015). In current literature, shared mental models mostly relate to similarity of thinking and conformity in the structuring of knowledge (e.g. Bolstad & Endsley, 1999; Cannon-Bowers et al., 1993; Lim & Klein, 2006; 1993; Salas et al., 1997; Santos et al., 2015). However, as a reflection of shared mental models, this study seeks to use team alignment, related to the amount of agreement on the rating of team performance, for which literature is scarce.

While studies have been conducted on the similarities of individual mental models and their implications for shared mental models (e.g. Jonker et al., 2011a; Lim & Klein, 2006; Mathieu et al., 2000), there is still a gap in research when it comes to alignment of the individual team members' perceptions of team performance and its implications for observed team performance. Besides the potential effect of shared mental models on team performance, literature shows that high team performance often leads to improved individual learning, and, consequently, improved individual performance (Carboni & Ehrlich, 2013; Lin & Huang, 2020). Lee et al. (2021) make the link between team shared mental models and individual performance, and found that a high sharedness in the team shared mental model at the end of a project is a significant factor contributing to individual performance.

In the current study, students enrolled in a project-based learning course are followed using experience sampling to assess individual ratings of team performance over time. Students filled out a weekly questionnaire over the course of five weeks and received a weekly report on the teams' scores to use to benefit their team. This study aims to fill the gap in research by linking the alignment in individual ratings of team performance to observed team performance. Additionally, as the course is geared towards the professional development through self-directed learning of individuals in a team-based setting, the effect of team alignment on individual performance will be considered.

2. Theoretical Framework

2.1 Team Learning

The modern workplace engages increasingly in interdisciplinary projects, leading to work becoming more complicated and requiring more collaboration in the workplace (Shuffler et al., 2020). With that comes an increased focus on team-based projects, in which individuals with different backgrounds need to collaborate while organisations demand efficiency and quality (Delarue et al., 2003; Fapohunda, 2013; Sanyal & Hisam, 2018). In order to meet these new workplace demands, teams need to develop an effective working environment, in which communication skills and continuous development are essential. Theory on team learning provides insight in what is needed to build effective teams that foster knowledge-sharing, continuous development, and high performance (e.g. Koeslag-Kreunen et al., 2018; Puente-Palacios & Barouh, 2021; Van Woerkom & Croon, 2009).

When it comes to team learning, several definitions can be found in literature. Edmondson (1999) defines team learning as a process of reflection and adaptation within a team. Others add to that the creation of knowledge within that team through experience, the creation of a collective metacognition, and the importance of learning as a social process (e.g. Kayes et al., 2005; Knapp, 2010; McCarthy & Garavan, 2008; Van den Bossche et al., 2006). The current study defines team learning as the learning from and within a team through experience and social interaction, potentially developing a form of shared cognition.

With team learning becoming increasingly important for the workplace, there is a growing need for teamwork skills development in education to better prepare students for the workplace (Hart Research Associates, 2010; Hughes & Jones, 2011). This is also why team learning has been gaining popularity in undergraduate education. Collaborative learning combined with project-based learning are implemented into undergraduate courses more and more, and team learning has been found to have benefits for the professional development of students (Hart Research Associates, 2010; Hughes & Jones, 2011; Britton et al., 2017). For example, team learning has shown to improve the critical and creative thinking skills of students, as well as problem-solving and communication skills. It fosters collaboration and helps build relationships and knowledge through increased engagement in meaningful dialogue and debate (e.g. Janotha, 2015; Rezaee & Mosalanejad, 2015). Johnson & Johnson (1994) discuss how team learning has the potential to improve self-efficacy and motivation in individuals, leading to students taking ownership of their learning, therefore, contributing to self-directed learning. In conclusion, team learning is an invaluable strategy to help students be more successful in their studies as well as in their future work.

Besides the benefits for individual development, perhaps the most important aspect of team learning is the fact that teams can develop new skills collaboratively. When teams consist of the same

members for an extended period of time and have meetings regularly, they tend to develop a certain coordination in the way they learn and interact, even if an individual is a member of multiple teams (Flowers et al., 2000; Wageman et al., 2012). This development allows teams to not just access individual expertise but learn from the expertise of other team members, thus the individual expertise contributes to the learning and experience of the other team members, which is also referred to in literature as a transactive memory system (Kozlowski & Ilgen, 2006). This alignment in knowing who knows what closely relates to theory on shared mental models (Flowers et al., 2000; Kozlowski & Ilgen, 2006; Wageman et al., 2012). As stated by Kozlowski and Ilgen (2006) *"… team mental models refer to knowledge structures or information held in common, whereas transactive memory refers to knowledge of information distribution within a team (i.e., knowledge of who knows what)."* (p. 83). In fact, Kozlowski and Ilgen (2006) discuss how shared knowledge, team mental models and transactive memory structures can be treated as emergent states of team learning. Pinheiro et al. (2023) suggest that there are two sides to team learning *"… one concerning learning behaviors that occur in members' interaction, through which they collectively identify, discuss, and solve problems to provide solutions. The other side, concerning the outcomes that emerge as a collective property of the team, such as the team's shared cognitions that are built through members' participation in team learning activities."* (p. 3) (Decuyper et al., 2010, as cited in Pinheiro et al., 2023).

What must be noted is that, while previous research shows that team learning positively relates to team performance, Bunderson and Sutcliffe (2003) found that team learning has potential negative effects on short-term teams when there is too much focus on the learning and competence development. Savelsbergh et al. (2009) suggest that team learning has positive or negative effects based on what developmental stage the team is in.

2.1.1 Conceptualisation of Team Learning.

Underlying team learning is the ability of individuals to engage in teamwork. Widmann et al. (2016) state that team learning, and innovation are interdependent components of teamwork. This closely aligns with the current study, as students work on innovations in a team formation. As found by Widmann et al. (2016) the main behaviours leading to the team engaging in innovation development can be categorized in (1) *social interactions*, (2) *work design*, and (3) *visibility*. More practically, this means that (1) the team fosters social interaction through activities as information sharing, reflecting and implementing new and innovative ideas, (2) the environment in which the team works is structured, including clear tasks and having a climate of safety and trust, (3) the team needs to be properly organised and able to communicate and make their progress visible both internally and externally, for example towards a supervisor or client (Widmann et al., 2016).

Savelsbergh et al. (2009) identified five behavioural components of team learning; *(1) exploring and co-construction, (2) reflecting, (3) discussing errors and unexpected outcomes of actions, (4) seeking feedback, and (5) experimenting within and as a team.* These dimensions seem to be more focused on the social side of team learning. Making the connection to team performance, Wageman et al. (2005) determined five main contributors to team effectiveness based on Hackman (2002), as cited in Savelsbergh et al., 2009); (1) *real team*, meaning that there are clear boundaries to what it means to be a part of the team, there is an interdependence between team members, and there is a stability of membership, (2) *compelling direction*, there is a clear purpose or goal to work towards, (3) *enabling structure*, meaning that a team needs to have a clear task, a composition that aligns with this task, and clear rules about expected behaviour, (4) *supportive organisational context*, there is a need for a positive outcome when the team performs well, as well as the availability of resources and information to support the team fulfilling their task, (5) *available expert coaching*, in order to support team processes, for example when it comes to motivation or knowledge sharing (Savelsbergh et al., 2009). In fact, Savelsbergh et al. (2009) discuss how expert coaching may help team members to *"… share their expertise to build the team's repertory of skills."* (p. 7), which moderately relates to transactive memory systems and the theory on shared mental models. Connecting that to the previously discussed social interaction and other behavioural components as exploring and co-construction contributing to the learning of the team as a whole, it becomes clear that the creation of a shared mental model is an integral part of team learning (Kozlowski & Ilgen, 2006; Savelsbergh et al., 2009; Widmann et al., 2016).

2.2 Shared Mental Models

Senge (1990) proposed that mental models and shared vision are essential components of organisational learning. Mental models are the basis of thinking and interaction of an individual with the environment, as it gives structure to a person's reasoning and worldviews (Norman, 1983; Johnson-Laird, 2005). Mental models are built upon knowledge and assumptions gathered through experience, but also form the basis for assumptions about new situations and continue to develop through new interactions (Gentner & Stevens, 1983; Norman, 1983). Thus, the mental model strongly influences behaviour and, with that, workplace skills such as decision-making, problem solving, and strategic thinking (Gentner & Stevens, 1983; Johnson-Laird, 2005).

With multiple mental models situated in a team, there is a need to establish a common ground, with certain rules about communication and team behaviour (Decuyper et al., 2010). It is theorized by Denzau and North (2000) that having similar mental models allows for better communication and knowledge exchange. This similarity in mental models within a team aligns with theory on shared mental models, which entails the team members having similar mental models when it comes to task orientation and team expectation (Cannon-Bowers et al., 1993, as cited in Jonker et al., 2011b). This

sharedness allows them to make decisions in accordance with the teams' needs, where sharedness relates to the compatibility of these mental models rather than them being identical (Cannon-Bowers et al., 1993, as cited in Jonker et al., 2011b). Converse et al. (1993) discuss how it is not always necessary for team members to agree with each other in the process of team decision making.

Van Den Bossche et al. (2011) proposed a model in which the most important team learning behaviours contributing to the creation of a shared mental model are *construction, co-construction*, and *constructive conflict*, which should then lead to an increased team-effectiveness. Here, construction and co-construction are focused on the active sharing of and listening to the views of different team-members and the refining of these views, which leads to a new and shared meaning for the team (Van den Bossche et al., 2011). After this process, constructive conflict may follow. This is the process of disagreement, due to different views (individual mental models), and negotiation in which the team works towards a shared meaning (shared mental model) (Van den Bossche et al., 2011). However, Guenter et al. (2016) state that task conflict may only benefit the team relationship when the initial perceived team performance is low. Van den Bossche et al. (2011) also found that the development of a shared mental model through team learning behaviour led to a better team performance. This is in line with the findings of Mathieu et al. (2000) who found that shared mental models and task-based mental models relate positively to team process and performance.

2.2.1 Conceptualisation of Shared Mental Models.

Cannon-Bowers et al. (1993, as cited in Mathieu et al., 2000) explain that having a team shared mental model allows the individual to make decisions in accordance with the mental models of team members. In which the main categories of mental models relate to knowledge of technology or equipment, job or task procedures, team interactions, and team-specific knowledge, which can be summarized as *(1) task-related knowledge* and *(2) team-related knowledge* (Cannon-Bowers et al., 1993, as cited in Mathieu et al., 2000). This notion suggests that the team does not require similar mental models, but rather an understanding of the mental models of their team members. In literature several factors of shared mental models are discussed. Johnson et al. (2007) created an instrument focusing on the 5 emergent factors of shared mental models, these factors entail: *(1) team knowledge*, *(2) general task and communication skills*, *(3) attitude towards teammates*, *(4) task dynamics and interactions*, and *(5) team resources and working environment.* Again, it is possible to summarize these factors as posed by Mathieu et al. (2000), in task-related knowledge and team-related knowledge.

Research on measuring shared mental models mostly focuses on the alikeness of thought processes of team members, especially entailing interdisciplinary action teams performing under high pressure (e.g. Mathieu et al., 2000; Santos et al., 2015; Stout et al., 1996; Waller et al., 2004). For example, methods used for measuring team shared mental models include the elicitation method,

structure representation, and representation of emergence, with the method affecting the accuracy in which team process or team performance can be measured (DeChurch & Mesmer-Magnus, 2010; Gisick et al., 2018). Assessment techniques used include concept mapping, card sorting tasks, and questionnaires, including similarity ratings and rating scales (DeChurch & Mesmer-Magnus, 2010; Gisick et al., 2018). While not all measurement tools are able to predict team process, all methods of measurement allow prediction of team performance (DeChurch & Mesmer-Magnus, 2010). However, none of these methods include the individuals' perception of the team and what that means for team performance.

2.3 Team performance

When it comes to team performance, the review by Pavez et al. (2022) showed that in literature the most common measurements of team performance relate to the efficiency and effectiveness of the team. When connecting team performance to team learning, Offenbeek (2001) and DeCuyper et al. (2010) discuss team learning as a process in which both the learning of the team and improved team performance are the outcomes. Connecting team performance to team alignment, literature on the extent of agreement of individuals within a team when it comes to team performance encompasses several topics. There is research on team alignment, team cohesiveness, and factors which contribute to team performance, in which team alignment concerns the extent to which individual team members share success criteria and goals, also referred to as goal congruence (Griffith & Gibson, 2001; Schreuder et al., 2023; Williams & Castro, 2010). However, this does not exactly align with the current study, in which team alignment is defined as the extent to which individual team members agree about the performance of the team.

Williams and Castro (2010) describe that team cohesiveness *"… requires members to feel bonded and reflects shared perceptions of trust, cooperation and unity it reflects the atmosphere within the team."* (p. 130), thus characterizing cohesiveness as perceived team functioning, which aligns more closely with the intentions of the current study, focusing on perceived team performance. Guenter et al. (2016) discuss the importance of perceived team performance and its effects on the team members' self-confidence, team identification and the related team behaviour. Having a higher perception of team performance is theorized to lead to less team conflict, due to the members wanting to maintain high performance through preventing or resolving conflicts (Guenter et al., 2016). However, there is a risk that team members may sacrifice their individual goals in order to avoid conflict and maintain their team identity (Guenter et al., 2016).

Factors contributing to improved team performance include the effective sharing of information, for which openness is required, as well as individual agreeableness, moderated by design processes such as planning, cooperation, and creation (Mesmer-Magnus & DeChurch, 2009; Peeters et al., 2008, as cited in Bradley et al., 2013). Diedorff et al., (2011) emphasize the importance of goal

priority as a strong indicator of team performance. Michinov and Michinov (2020) discuss the influence of emotional intelligence and Gevers et al. (2019) add how perception of being on the same page when it comes to the teams' collaborative task, as well as temporal elements (the 'what' and 'when') improves the quality and timeliness of the product. In conclusion, a certain cognitive consensus is needed to achieve a quality product. Gully et al. (1995, as cited in Williams & Castro, 2010) describe how the interdependence of team members is of importance for team efficacy and team performance. Gully et al. (2002) found that increased interdependence positively affected team-efficacy and performance, however, this positive influence was less distinct in relation to personal performance.

Other factors affecting (perceived) team performance and time and, related to that, familiarity. Harrison et al. (2003) compared the performance of familiar teams, with members who previously worked together *"… on a variety of activities"* (p. 639), continuing teams, with members who did not previously work together but would work together for this study over the course of 3 weeks, and one-shot teams, who had not previously worked together and did not get the chance to develop familiarity over time. Harrison et al. (2003) found that familiar teams had an initial better speed, quality, and performance than both the continuing and one-shot teams, however, by week 3 the continuing teams managed to catch up with the familiar teams at least on the aspect of speed. While an overall positive relation between time-familiarity and quality and task performance was found, they did not specifically discuss the quality and task performance of the continuing teams, though an increase in both factors can be assumed based on the provided data (Harrison et al., 2003).

Going beyond team familiarity and developmental stages, Huang (2009) found that team cohesiveness has a significant positive effect on team performance. Thompson et al. (2015) found the same significant positive effect of team cohesiveness on a teams' test scores. Al-Rawi (2008) conducted a case study on the effects of team cohesiveness on several factors and found a positive relation between cohesiveness and attitude towards the organisation as well as towards value commitment. However, a negative effect on performance commitment was found (Al-Rawi, 2008).

2.3.1 Conceptualisation of Perceived Team Performance.

In the meta-analysis conducted by Beal et al. (2003) 3 components of team cohesiveness were identified, including *(1) interpersonal attraction,* which relates to the extent to which team members like the group, *(2) task commitment,* relating to the extent of the group's commitment towards achieving a shared goal, and *(3) group pride,* which entails the team members liking what the team stands for in terms of norms, as well as the significance of being a member of that team. Additionally, they found that an increased task-based interaction within the team led to a higher cohesiveness-related team performance (Beal et al., 2003). However, high team performance is not necessarily an outcome of team cohesiveness. Beal et al. (2003) discuss how a strong focus on individual performance

combined with pooled tasks may lead to a better team performance without there being strong cohesiveness, nonetheless, there is still a need for a shared commitment, or motivation, towards team performance.

Van Rees (2020) constructed a tool for the measurement of an individual professional identity through individual self-ratings during an intervention in technical student project teams. This questionnaire included individual self-rated items on several topics including *(1) subjective team performance,* consisting of questions relating to the teams' confidence, and *(2) team efficacy,* including questions relating to the teams' confidence (Appendix I). Other topics included in the study by Van Rees (2020) are *team inclusion, team membership self-esteem, team identification, team learning, and team leader support.*

However, it must be noted that individual characteristics may affect these self-ratings. For example, Harzer and Ruch (2014, as cited in Gander et al., 2020) discuss how character strengths such as perseverance, teamwork, and honesty relate directly to both self-rated performance and actual performance. Gander et al. (2020) found that teamwork and fairness were the two aspects contributing the strongest to self-rated team performance.

2.4 Professional Development and Self-Directed Learning

Senge (1990) discusses the importance of personal mastery for team learning. However, perhaps development is a better fitting term, as 'mastery' indicates that a final level of expertise can be reached. Lave and Wenger (1991) discuss this in their theory on legitimate peripheral participation in Communities of Practice, where in order for an individual to learn they need to develop themselves within a community or team, in which the mastery refers to the proper structuring of knowledge within the community. They state that learning is not a one person act and, even in a master-apprentice relationship, masters can keep developing themselves by taking the role as a colearner (Lave & Wenger, 1991). It has been established throughout literature that continuous learning, which describes the ongoing process of learning, thinking, and reflecting, is an important aspect of individual development, especially in more complicated, fast-developing, and interdisciplinary environments (Greveson & Spencer, 2005; Jain & Martindale, 2012; Razaee & Mosalanejad, 2015; Watkins, 1999). In which the individual development can take place both individually and in team settings.

Throughout literature, it has been recognized that team learning and individual professional are intertwined, with self-directed learning being a critical instigator for both. In fact, these theories are all related and interact with each other, with self-directed learning being viewed as a prerequisite for lifelong learning, which concerns the continued learning of an individual throughout their lifetime in any setting (formal and non-formal) (Eraut, 2000; Greveson & Spencer, 2005; Laal, 2011; Laal et al., 2014; O'Shea, 2003; Patterson et al., 2002; Van Veldhuizen, 2011; Watkins, 1999). Eraut (2000) explains learning as *"… the process whereby knowledge is acquired."* (p. 114), which can take place in *formal*

settings, which covers any structured learning setting in which conscious learning takes place, and *non-formal learning*, which is the implicit learning in which there is no clear intention to learn or in which there is no structured learning setting. Though Eraut (2000) discusses that non-formal learning can also be deliberative, through activities including decision-making, planning and problem-solving.

Taking deliberative action over ones learning can be connected to theory on self-directed learning. According to Knowles (1975) *"Self-directed learning describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes."* (p. 18, as cited in O'Shea, 2003). Important here is the emphasis on the initiative coming from the individual, as this is not something that is necessarily taught in formal education, where students follow a predetermined study plan and are often not included in the design of their curriculum (Jagersma, 2010). Therefore, it is regularly discussed that, while students acquire the necessary knowledge, the transition to the work field is often challenging due to a lack of certain qualities, in which individual decision-making and intrinsic motivation are essential (Fraser et al., 2019; Jaldemark et al., 2022; Neal & Martz, 2016; Okolie et al., 2019; Watkins, 1999). Both individual decision-making and intrinsic motivation have been identified as vital components of becoming a self-directed learner (Deci & Ryan, 2008; Lemmetty & Collin, 2020).

Central to self-directed learning is the intentional direction of the learning process, important aspects of include the recognizing of personal development needs as well as the ability to monitor and reflect on the learning process (O'Shea, 2003; Tabatabaei & Parsafar, 2012; van Woezik et al., 2019). Taking ownership of personal development has shown to improve critical thinking abilities as well as creative thinking and helps individuals identify opportunities for growth (O'Shea, 2003; Tabatabaei & Parsafar, 2012; van Woezik et al., 2019), thus being an essential part of professional development. Self-directed learning does not only have implications for individual learning, as a positive interaction with team learning has been found throughout literature (e.g. Confessore & Kops, 1998; Hutasuhut et al., 2021; Senge, 1990). Van Woezik et al. (2021) underline the importance of self-directed learning in team settings, for example, they found that interpersonal contact within a team-setting stimulated self-directed learning by encouraging critical thinking. Vithayaporn et al. (2021) further discuss how communication and the development of a shared vision contribute to self-directed learning in the workplace, aligning with Senge (1990) who views the formation of a shared vision as an important prerequisite of individual commitment towards the teams' goal, in which individual commitment should lead to intentional (self-directed) learning aligning with their goal (Masier, 2013).

2.4.1 Conceptualisation of Self-Directed Learning

While it is possible to assess the extent to which skills and knowledge have been developed, it is more difficult to assess the extent to which a person engages in self-directed learning (McGaghie & Menges, 1975; Robinson & Persky, 2020). McGaghie and Menges (1975) suggest the use of *goal-attainment-scaling*, which is an assessment method which takes the difference in goals between individuals or groups into account. Ayyildiz and Tarhan (2015) developed a self-directed learning skills scale to measure the self-directed learning skills of high school students. This scale is based on factors from the Self-Directed Learning Readiness Scale (SDLRS) as developed by Guglielmino et al. (1987, as cited in Ayyildiz & Tarhan, 2015) and the Self-Rating Scale of Self-Directed Learning developed by Williamson (2007, as cited in Ayyildiz & Tarhan, 2015). The main factors they identified as components of self-directed learning are *(1) attitude towards learning, (2) learning responsibility, (3) motivation and self-confidence, (4) ability to plan learning, (5) ability to use learning opportunities, (6) ability to manage information, (7) ability to apply learning strategies, (8) assessment of learning process, (9) evaluation of learning success/results* (Ayyildiz & Tarhan, 2015, p.673).

Kicken et al. (2009) defined three basic skills related to self-directed learning: *(1) assessing quality of own performance, (2) formulating learning needs,* and *(3) selecting future learning tasks.* These factors relate somewhat to the factors defined by Ayyildiz and Tarhan (2015). Dynan et al. (2008) discuss the higher order thinking skills that are necessary for self-directed learning: *(1) application*, which relates to being able to translate concepts to the real world, *(2) analysis*, relating to the ability to identify and explain underlying assumptions, *(3) synthesis*, which describes being able to construct (mental) models of theories and *(4) evaluation*, meaning that the individual can come to substantiated conclusions.

Combining these different defined factors contributing to self-directed learning, there appears to be a general agreement that self-directed learning requires the initiative from the individual when it comes to the goal setting, learning process, and evaluation of their own development. While the above components focus on the individual process, Van Woezik et al. (2021) clarify that team processes can benefit self-directed learning through stimulating individual responsibility, self-monitoring and critical thinking, in which emotions, openness and relatedness are important contributors.

2.5 Research questions

The specific definition of team alignment used in the current study has not been studied in-depth yet. Other studies use the similarity of knowledge or thinking structures in the form of team shared mental models or team cohesiveness in the form of goal congruence (e.g. Mathieu et al., 2000; Griffith & Gibson, 2001; Waller et al., 2004; Williams & Castro, 2010; Santos et al., 2015; Schreuder et al., 2023). However, this study focuses on the alignment in perception of individual team members on components of team performance, in which alignment could form an interesting addition to theory on

shared mental models. To add to current knowledge on team performance, it would be interesting to include the effects of individual ratings of team performance and, specifically, if the alignment between team members affects actual team performance. Since the current study is longitudinal and collects data over the course of five weeks, it is especially interesting to consider how the alignment within teams develops over time. Therefore, this study aims to answer the following research question:
To what extent does the alignment of individual ratings of team performance predict the observed team performance among 3rd year undergraduate students at the University of Twente in a course geared towards professional development through self-directed learning?

To help answer this question, the following sub-questions have been formulated:

RQ 1: How does the alignment (variance) of perceived team performance change over time?

RQ 2: To what extent does the change in alignment of perceived team performance over time predict team performance?

RQ 3: To what extent do initial and final team alignment predict team performance?

RQ 4: To what extent does the change in team alignment predict individual performance?

3. Methodology

3.1 Research design

The current research design is a correlational study based at the University of Twente in a course focused on the professional development of 3rd year undergraduate students through self-directed learning. The students filled out a weekly self-report questionnaire over the course of 5 weeks, individually rating the performance of their team, on which they received a weekly report that they could use to benefit their teamwork. The outcomes of this questionnaire were used to give insight into the individual rating of team performance over time and allowed for quantitative research into team alignment represented by variance. This alignment was compared to the teams' project grade as well as the individual grades that the students received for their final exam. The alignment and grades were used to determine the correlation between team alignment and observed team performance, as well as individual performance. Also, comparisons were made between initial and final team alignment and its effect on observed team performance.

3.2 Specification of variables

The table below elaborates on the variables:

Table 1

Elaboration of variables

Variable	Conceptualisation
Time (weeks)	Time is measured by the number of weeks that the teams work together on their project. Ranging from week 1 to week 5.
Team alignment (variance)	Team alignment is represented by the variance between individual ratings of team performance within a team at each measurement point across the five weeks. Higher variance suggests lower team alignment. Team alignment is divided into components adapted from a questionnaire produced by Van Rees (2020), namely *(1) Competencies*, *(2) Performance*, and *(3) Efficacy*.
Team performance (grade)	Teams received a grade on their project tackling a learning challenge within an organisation. This grade was used as an indication of team performance.
Individual performance (grade)	Students received an individual grade on the final exam of the course. This grade was used as an indication of individual performance.

Figure 1

Tested interaction of variables

RQ 1 entails the relation between time and team alignment, aimed at discovering if team alignment changes over time. RQ 2 and RQ 3 consider the relation between team alignment and team performance, here the aim is to discover if team alignment can predict team performance and if higher initial team alignment results in a higher team performance. Lastly, RQ 4 focuses on the relation between team alignment and individual performance, aimed at discovering if higher team alignment also has implications for individual performance.

3.3 Participants and context

This study was conducted during a ten-week module among 3rd year undergraduate students at the University of Twente. It had 25 undergraduate students divided over 6 teams ranging from 2-5 students in size, with each team working on a learning challenge at one of five different organisations, ranging from education to healthcare institutions. Data collection started in week 3 of the module and lasted for a total of five weeks during which data was gathered weekly through a questionnaire. These students joined this course as an elective and 22 of these students consented to the anonymized processing of data stemming from the questionnaires for educational and research purposes. 3 students did not consent to the use of their data and are therefore excluded from this study.

3.4 Instrumentation

The team-based questionnaire of the professional development course was pre-constructed, prior to the current study, and based on the questions as posed by Van Rees (2020) (See Appendix I), who constructed team learning questions following the research conducted by Van den Bossche et al. (2011, as cited by Van Rees, 2020), Van Offenbeek (2001, as cited by Van Rees, 2020) and Edmonson (1999, as cited by Van Rees, 2020). The current study adapted questions from this tool into three general factors: (1) *Competencies*, mostly consisting of questions surrounding the collaborative performance on a list of competencies *(2) Performance*, consisting of questions relating to perceived performance and team processes, and *(3) Efficacy*, including questions relating to the teams'

confidence (Appendix I). The questionnaire used in the course includes 17 items on a 7-point Likert-scale on team performance and team-confidence and one open-ended question (See Appendix II). The questions have been split up, relating to the different components of team performance as determined by Van Rees (2020), as is represented in Table 2.

Table 2

Components of Team Alignment and Sample Items

Components of Team Alignment	Sample Items
Competencies (5 items)	How would you rate your team's performance on client communication this week?
	How would you rate your team's performance on (collaborative) design this week?
Team performance (9 items)	How would you rate your team's performance on accomplishing project goals this week?
	How would you rate your team's performance on the quality of (accomplished) project work this week?
	How would you rate your team's performance on the quantity of (accomplished) work this week?
Team efficacy (3 items)	As a team, we have the confidence to perform well on the project.
	My project team believes it can achieve an excellent performance on the project.

3.5 Procedure

The students had already been informed and agreed to the gathering of their data for educational and research purposes upon entering the course at the University of Twente. There were no interventions from the researcher, meaning this is a non-experimental correlational study.

Students were asked to individually fill out a questionnaire at the end of every week for the duration of 5 weeks, starting in week 3 of the module, and was conducted using the Twente Intervention and Interaction Machine (TIIM) (see Appendix II) (University of Twente, 2024). The questionnaire contained 17 questions about three components relating to the performance of their team. At the start of each week the team received a report on the previous week's ratings of perceived team performance within their team to be used as feedback geared towards the improvement of the team. Students finalized the course with an individual exam and the group project, and they received a grade for each.

After the finalization of the course, the data from the team-based weekly questionnaire was analyzed using IBM SPSS Statistics 28 and compared to observed team performance (the project grade), as well as individual performance (the individual grade).

3.6 Data analysis

The gathered data is of quantitative nature, specifically; the outcomes of the questionnaires in the form of ranked items using the 7-point Likert-scale, and final individual and team project grades on a scale of 1-10. First, descriptive analysis was conducted on the demographics, including frequencies,

percentages, means, and standard deviations. Afterwards, inferential analysis was conducted to answer the research questions.

To answer RQ1: 'How does the alignment (variance) of perceived team performance change over time?', it was necessary to first determine the team variance per week and per component. Because of missing values among participants, repeated measures ANOVA could not be used to determine the variance per team over time. This is because in repeated measures ANOVA a case is dropped if a single measurement is missing. A mixed-methods approach was considered as well as missing data imputation, however, due to the number of missing values these methods would increase the chance of interpretation errors. To include all measurement points in the calculation of variance, the sample variance was calculated by hand following the formula $\sigma^2 = \frac{\sum(X-\mu)^2}{n-1}$ for each team at every moment of measurement. These variance outcomes were also used for the remaining research questions.

For RQ2: 'To what extent does the change in alignment of perceived team performance over time predict team performance?', the variance in week 2 was compared to the variance in week 5 per component of team performance. The variance in week 1 could not be used as an indication for initial team alignment due to the number of missing values, which also applies to the remaining RQs. The difference score between variance of week 2 and 5 was used to determine the correlation between the change in variance and team performance, in which the change in variance on the three components was the independent variable and the project grade the dependent variable. Due to the low amount of data points, a normal distribution could not be assumed, this was confirmed by creating a scatterplot, therefore Spearman's Rho was applied (Spearman, 1987). Due to the difference score being negative at several of the measurement points and the data not being normally distributed, a Yeo-Johnson transformation was performed on the difference scores to subsequently perform a linear regression (Yeo & Johnson, 2000).

RQ 3: 'To what extent do initial and final team alignment predict team performance?'. To determine if there was a correlation between initial team alignment and the team performance Spearman's Rho was used comparing the variance in week 2 to the team's final project-grade (Spearman, 1987). Additionally, Spearman's Rho was performed comparing the variance in week 5 to the team's final project-grade (Spearman, 1987). For further analysis, a simple linear regression was performed. On the data in week 5 it was necessary to first perform the Yeo-Johnson transformation due to variance at one of the time-points being zero (Yeo & Johnson, 2000). After which a simple linear regression was performed.

RQ 4: 'To what extent does the change in team alignment predict individual performance?', the difference score between week 2 and week 5 was used and compared to the individual exam grade.

The difference score was used to determine the correlation between the change in variance and individual performance by applying Spearman's Rho (Spearman, 1987). Due to the difference score being negative at several of the measurement points and the data not being normally distributed, a Yeo-Johnson transformation was performed on the difference scores to perform a simple linear regression (Yeo & Johnson, 2000).

4. Results

This chapter discusses the results of the descriptive analysis to portray the response rates, means, and standard deviations on all components. Afterwards, data analysis was conducted to answer RQ1 through RQ4. Throughout the study, a significance level of 0.05 was used.

4.1 Descriptive statistics

Table 3 shows the response rates per week, ranging from a response rate of 36.36% in week 1 to 86.36% in week 5. At no moment was a response rate of 100% achieved. Due to the low response rate in week 1 (36.36%), this data point was not used to answer the research questions. Instead, week 2 (86.36%) was used as the starting data-point.

Table 3

Response rates per week

Week	Frequency	Percentage
1	8	36.36%
2	19	86.36%
3	19	86.36%
4	11	50.00%
5	19	86.36%
Total	76	69.09%

Table 4 shows the mean score and standard deviation each week per team and per component. Where the mean score falls on a 7-point Likert scale. The *N-value* shows the amount of respondents per team at each timepoint, which demonstrates that the questionnaire was not filled out by every team member at each of the timepoints.

Table 4

Self-report questionnaire outcomes

Week		Components																	
		Competencies						Performance						Efficacy					
	Team	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
1	Mean	5.6	4.5	4.6	5.4	6.2	-	6.3	5.3	5.6	5.9	6.3	-	6.0	5.8	5.0	6.0	6.3	-
	SD	0.8	0.4	0.8	-	-	-	0.2	0.6	0.5	-	-	-	1.4	1.2	0.0	-	-	-
	N	2	2	2	1	1	-	2	2	2	1	1	-	2	2	2	1	1	-
2	Mean	5.5	5.6	5.1	5.5	6.7	5.2	6.1	6.2	5.7	5.4	6.3	4.6	6.3	5.8	5.4	5.9	6.7	5.7
	SD	5.3	0.6	0.4	0.2	0.4	0.3	0.4	0.4	0.4	0.4	0.6	0.3	0.8	0.7	0.8	0.4	0.5	0.5
	N	4	5	3	3	2	2	4	5	3	3	2	2	4	5	3	3	2	2
3	Mean	6.1	5.7	6.0	6.1	6.7	5.4	6.4	6.3	6.1	6.0	6.6	5.4	6.3	6.2	5.7	5.8	6.9	5.5
	SD	0.8	0.6	0.2	0.1	0.4	0.3	0.6	0.2	0.4	0.2	0.5	0.2	0.5	0.6	0.5	0.2	0.2	0.7
	N	4	4	4	2	3	2	4	4	4	2	3	2	4	4	4	2	3	2
4	Mean	6.3	5.8	5.2	5.9	6.4	4.4	6.0	6.2	6.0	6.1	5.9	4.1	5.8	5.8	5.0	6.0	6.0	5.0
	SD	0.4	0.3	-	0.4	0.8	0.8	0.6	0.1	-	0.2	0.4	0.6	0.2	0.2	-	0.0	0.9	0.5
	N	2	2	1	2	2	2	2	2	1	2	2	2	2	2	1	2	2	2
5	Mean	6.3	5.7	5.7	4.5	5.2	4.4	6.4	5.8	6.2	4.4	5.0	3.7	6.6	5.7	5.9	5.0	5.8	5.0
	SD	0.4	0.3	0.5	0.8	0.2	0.8	0.9	0.5	0.3	0.8	0.6	0.2	0.5	0.5	0.2	0.3	0.7	0.0
	N	3	4	3	3	4	2	3	4	3	3	4	2	3	4	3	3	4	2
Total	Mean	5.9	5.5	5.4	5.4	6.1	4.9	6.3	6.0	5.9	5.4	5.9	4.4	6.3	5.9	5.5	5.7	6.3	5.3
	SD	0.6	0.6	0.6	0.7	0.8	0.7	0.5	0.5	0.4	0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.7	0.5
	N	15	17	13	11	12	8	15	17	13	11	12	8	15	17	13	11	12	8

4.2 Correlations and regressions

4.2.1 RQ 1: How does the alignment (variance) of perceived team performance change over time?

The results of the manual computation of variance are presented in Table 5. The change in variance over time is visualized in Figure 2, 3, and 4.

Table 5

Variance per team per component of perceived team performance

Team	Component	Variance per week				
		Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**
1	Competencies	0.72	0.28	0.60	0.18	0.17
	Performance	0.05	0.16	0.34	0.39	0.76
	Efficacy	2.00	0.59	0.22	0.06	0.26
	N (=4)	2	4	4	2	3
2	Competencies	0.18	0.31	0.33	0.08	0.11
	Performance	0.40	0.14	0.06	0.01	0.22
	Efficacy	1.39	0.48	0.33	0.06	0.22
	N (=5)	2	5	4	2	4
3	Competencies	0.72	0.17	0.04	-	0.21
	Performance	0.22	0.16	0.12	-	0.10
	Efficacy	0.00	0.59	0.07	-	0.04
	N (=4)	2	3	4	1	3
4	Competencies	-	0.05	0.02	0.18	0.57
	Performance	-	0.15	0.03	0.06	0.67
	Efficacy	-	0.15	0.06	0.00	0.11
	N (=3)	1	3	2	2	3
5	Competencies	-	0.18	0.17	0.72	0.04
	Performance	-	0.40	0.30	0.15	0.35
	Efficacy	-	0.22	0.04	0.89	0.55
	N (=4)	1	2	3	2	4
6	Competencies	-	0.08	0.08	0.72	0.72
	Performance	-	0.10	0.06	0.30	0.06
	Efficacy	-	0.22	0.50	0.22	0.00
	N (=2)	0	2	2	2	2

Figure 2

Variance in self-rated team Competencies

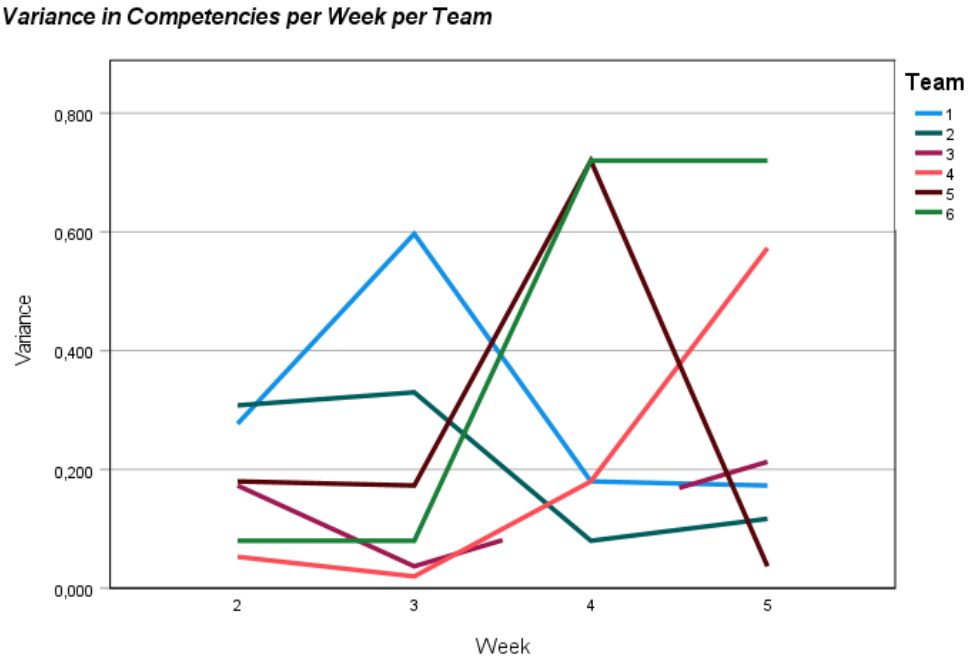


Figure 3

Variance in self-rated Team Performance

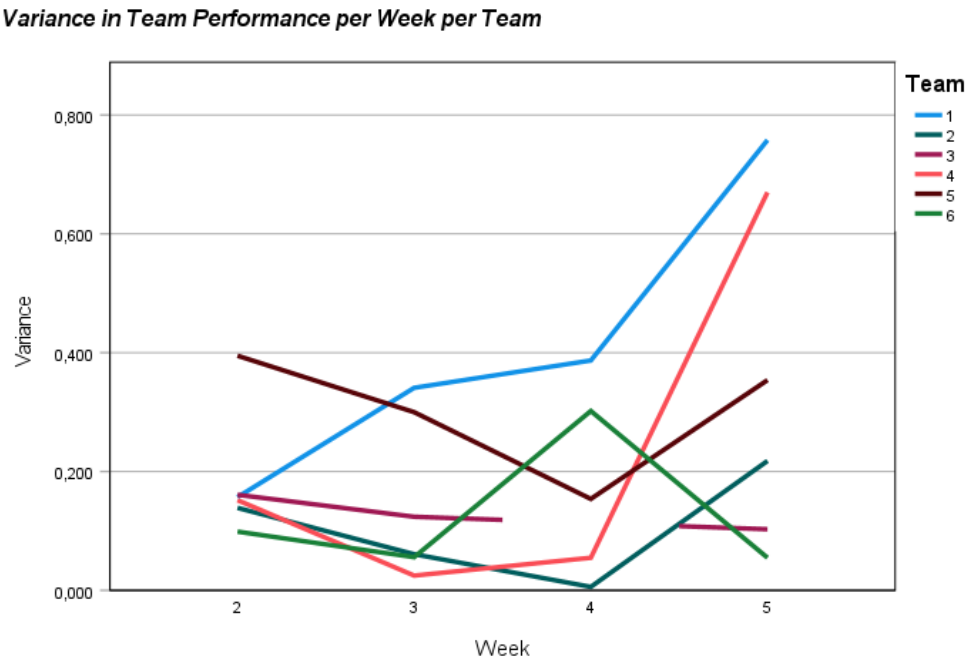
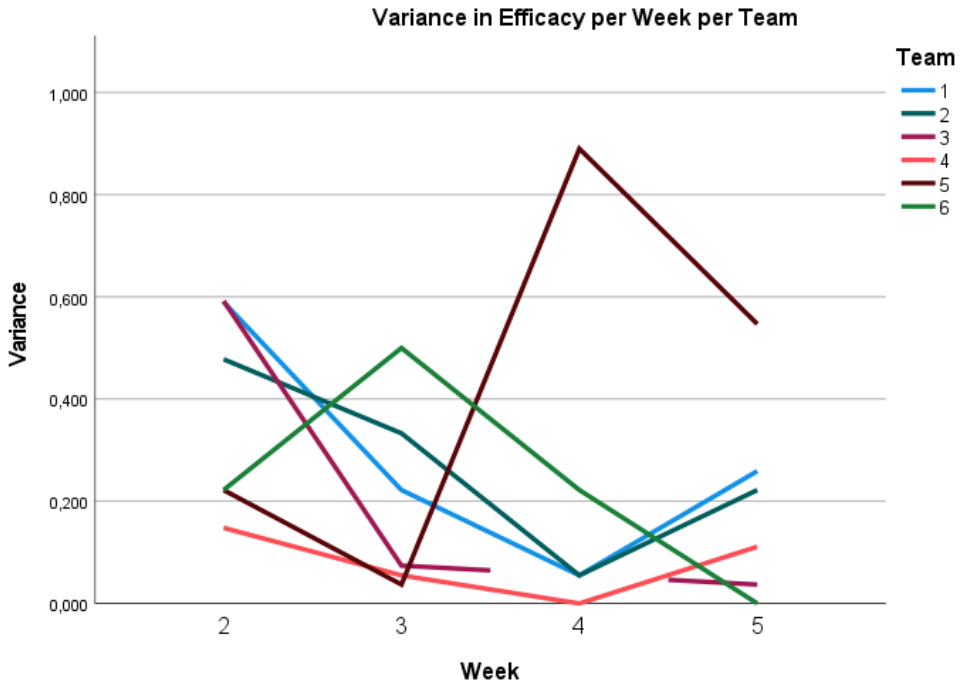


Figure 4

Variance in self-rated Team Efficacy



As can be seen in Table 5, there was a significant amount of data points missing, as a result, for three of the teams there is no value at week 1 in Figures 2, 3, and 4. Consequently, for further data analysis it is necessary to use week 2 as a starting point. Figures 2, 3, and 4 show the change in variance over time per team across the three components. There are changes visible in variance over time for all three components, however, overall there does not appear to be a clear increase or decrease in variance over time as the effects per team differ substantially. For example, as can be seen in Figure 2, team 4 and 6 experienced a strong increase in variance over time on competencies, while teams 1, 2 and 5 showed a decrease in variance, albeit with a large spike in week 4 for team 5. Figure 3 shows that teams 1 and 4 had a considerable increase in variance over time, which means that the individual ratings of team performance differed increasingly over the period of 5 weeks. In Figure 4 team 5 shows a large spike in week 4, meaning that the individual ratings of efficacy differed substantially, however, the alignment improved in week 5. So, while it is clear that variance changes over time, the results per team differ to such an extent that at first glance no clear conclusion about the direction of that change can be made.

4.2.2 RQ 2: To what extent does the change in alignment of perceived team performance over time predict team performance?

To determine the change in alignment over time, the difference in variance was calculated between week 5 and week 2 (Variance week 5 – Variance week 2) and compared with the final project grade achieved by the team. As is portrayed in Table 6, a significant positive correlation was found

between the change in variance of the competencies component and the final project grade, r(4) = [0.82], p = .046, which suggests that a decrease in alignment on competencies positively affects the project grade. The correlation between the change in variance of performance and the final project grade was not significant, r(4) = [-0.03], p = .954. And the correlation between change in variance of efficacy and the final project grade was also not significant r(4) = [-0.03], p = .954.

Table 6

Spearman's Rho Correlation per Component and Project Grade

Variance Component		Competencies	Performance	Efficacy	Grade
Competencies	Correlation Coefficient	1.00	-0.26	-0.03	0.82*
	Sig. (2-tailed)	-	.623	.957	.046
	N	6	6	6	6
Performance	Correlation Coefficient		1.00	0.14	-0.03
	Sig. (2-tailed)		-	.787	.954
	N		6	6	6
Efficacy	Correlation Coefficient			1.00	-0.03
	Sig. (2-tailed)			-	.954
	N			6	6
Grade	Correlation Coefficient				1.00
	Sig. (2-tailed)				-
	N				6

** Correlation is significant at the .05 level (2-tailed).*

As the data was not normally distributed, it was necessary to transform the data. Due to the change in variance leading to negative scores, a regular log transformation could not be used, therefore, a Yeo-Johnson transformation was performed in R (Yeo & Johnson, 2000). Afterwards, a simple linear regression was conducted in SPSS to determine if any of the change of variance in the components significantly predicted the final project grade at the team level. Change of variance in competencies did not significantly predict the final project grade, R^2 = 0.49, $F(1, 4) = 3.80$, p = .123. Change of variance in performance did not significantly predict the final project grade, R^2 = 0.00, $F(1, 4) = 0.02$, p = .900. And change of variance in efficacy also did not significantly predict the final project grade, R^2 = 0.21, $F(1, 4) = 1.08$, p = .357.

Table 7

Linear Regression on Yeo-Johnson Transformation of Change in Variance

Model	Unstandardized Coefficients		Standardized Coefficients			95,0% Confidence Interval for B	
	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
(Constant)	7.32	0.26		28.43	<.001	6.61	8.04
Competencies	0.55	0.28	0.70	1.95	.123	-0.23	1.33
(Constant)	7.32	0.36		20.41	<.001	6.33	8.32
Performance	0.05	0.39	0.07	0.13	.900	-1.04	1.14
(Constant)	7.32	0.32		22.95	<.001	6.44	8.21
Efficacy	-0.36	0.35	-0.46	-1.04	.357	-1.33	0.61

4.2.3 RQ 3: To what extent do initial and final team alignment predict team performance?

To determine the effect of initial team alignment on team performance the variance in week 2 was compared with the final project grade achieved by the team. Due to the low amount of data points, a normal distribution could not be assumed. Therefore, Spearman's Rho was used to examine the correlations between the components: competencies, performance, and efficacy, in relation to the final project grade. As is portrayed in Table 8, the correlation between the variance in week 2 of the competencies component and the final project grade was not significant, $r(4) = [-0.64]$, $p = .173$. The correlation between performance variance and the final project grade was significant, $r(4) = [-0.82]$, $p = .046$, suggesting that high initial alignment on performance positively affects the project grade. And the correlation between efficacy variance and the final project grade was not significant $r(4) = [-0.37]$, $p = .471$.

Table 8

Spearman's Rho Correlation per Component and Project Grade Variance Week 2

Variance Component		Competencies	Performance	Efficacy	Grade
Competencies	Correlation Coefficient	1.00	0.14	0.55	-0.64
	Sig. (2-tailed)	-	.787	.257	.173
	N	6	6	6	6
Performance	Correlation Coefficient		1.00	0.29	-0.82*
	Sig. (2-tailed)		-	.577	.046
	N		6	6	6
Efficacy	Correlation Coefficient			1.00	-0.37
	Sig. (2-tailed)			-	.471
	N			6	6
Grade	Correlation Coefficient				1.00
	Sig. (2-tailed)				-
	N				6

** Correlation is significant at the .05 level (2-tailed).*

As the data was not normally distributed, it was necessary to perform a log transformation. Afterwards a simple linear regression was used to determine if any of the variance in components at week 2 significantly predicted the final project grade at the team level. Variance in competencies did not significantly predict the final project grade, R^2 = 0.19, $F(1, 4)$ = 0.94, p = .388. Variance in performance did significantly predict the final project grade, R^2 = 0.92, $F(1, 4)$ = 47.31, p = .002, with β = -0.96, which suggests that there is a positive linear relation between the alignment on performance at the start of the project and the project grade. Variance in efficacy did not significantly predict the final project grade, R^2 = 0.00, $F(1, 4)$ = 0.01, p = .917.

Table 9

Linear Regression on Log(10)transformation of Variance in Week 2

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	6.39	1.02		6.26	.003
Competencies	-1.13	1.17	-0.44	-0.97	.388
(Constant)	4.37	0.44		9.93	<.001
Performance	-3.78	0.55	-0.96	-6.88	.002
(Constant)	7.24	0.82		8.81	<.001
Efficacy	-0.17	1.52	-0.06	-0.11	.917

Additionally, to determine the effect of final team alignment, the variance in week 5 was compared with the final project grade achieved by the team. Due to the low amount of data points, a

normal distribution could not be assumed. Therefore, Spearman's Rho was used to examine the correlations between the components: competencies, performance, and efficacy, and related to the final project grade. As is portrayed in Table 10, a significant positive correlation was found between the variance in the competencies component and the final project grade, r(4) = [0.94], p = .005, suggesting that a low final alignment on competencies positively affects the project grade. The correlation between performance variance and the final project grade was not significant, r(4) = [-0.33], p = .518. And the correlation between efficacy variance and the final project grade showed a significant negative correlation r(4) = [-0.82], p = .046, suggesting that a high final alignment on efficacy positively affects the project grade. Furthermore, a significant negative correlation was found between the variance in competencies and the variance in efficacy r(4) = [-0.89], p = .019.

Table 10

Spearman's Rho Correlation per Component and Project Grade Variance Week 5

Variance Component		Competencies	Performance	Efficacy	Grade
Competencies	Correlation Coefficient	1.00	-0.37	-0.89*	0.94*
	Sig. (2-tailed)	-	.468	.019	.005
	N	6	6	6	6
Performance	Correlation Coefficient		1.00	0.71	-0.33
	Sig. (2-tailed)		-	.111	.518
	N		6	6	6
Efficacy	Correlation Coefficient			1.00	-0.82*
	Sig. (2-tailed)			-	.046
	N			6	6
Grade	Correlation Coefficient				1.00
	Sig. (2-tailed)				-
	N				6

** Correlation is significant at the .05 level (2-tailed).*

Due to the variance of one of the teams being zero on the efficacy component a Yeo-Johnson transformation was performed, after which a simple linear regression was done to determine if any of the variance in components in week 5 significantly predicted the final project grade at the team level. Variance in competencies did significantly predict the final project grade, R^2 = 0.75, $F(1, 4) = 11.80$, p = .026, with β = 0.86, suggesting that there is a negative linear relation between alignment on competencies at the end of the project and the project grade. Variance in performance did not significantly predict the final project grade, R^2 = 0.13, $F(1, 4) = 0.61$, p = .477. Variance in efficacy did significantly predict the final project grade, R^2 = 0.75, $F(1, 4) = 12.01$, p = .026, with β = -0.87, which

suggests that there is a positive linear relation between alignment on efficacy at the end of the project and the final project grade.

Table 11

Linear Regression on Yeo-Johnson Transformation of Variance in Week 5

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	7.32	0.18		40.47	<.001
Competencies	0.68	0.20	0.86	3.44	.026
(Constant)	7.32	0.34		21.87	<.001
Performance	-0.29	0.37	-0.37	-0.78	.477
(Constant)	7.32	0.18		40.73	<.001
Efficacy	-0.68	0.20	-0.87	-3.47	.026

4.2.4 RQ 4: To what extent does the change in team alignment predict individual performance?

To determine the effect of team alignment on individual performance, the difference in variance was calculated between week 5 and week 2 and compared with the individual course grade achieved by the individual student. Due to the low amount of data points, a normal distribution could not be assumed. Therefore, Spearman's Rho was used to examine the correlations between the components: competencies, performance, and efficacy, and related to the final individual course grade. As is portrayed in Table 12, no significant correlation was found between competencies variance and the individual grade, $r(20) = [0.03]$, $p = .894$. The correlation between performance variance and the individual grade was not significant, $r(20) = [-0.09]$, $p = .685$. And the correlation between efficacy variance and the individual grade was also not significant $r(20) = [-0.35]$, $p = .109$.

Table 12

Spearman's Rho Correlation per Component and Individual Grade

Variance Component		Competencies	Performance	Efficacy	Grade
Competencies	Correlation Coefficient	1.00	-0.18	-0.10	0.03
	Sig. (2-tailed)	-	.418	.668	.894
	N	22	22	22	22
Performance	Correlation Coefficient		1.00	0.10	-0.09
	Sig. (2-tailed)		-	.653	.685
	N		22	22	22
Efficacy	Correlation Coefficient			1.00	-0.35
	Sig. (2-tailed)			-	.109
	N			22	22
Grade	Correlation Coefficient				1.00
	Sig. (2-tailed)				-
	N				22

As the data was not normally distributed and the change in variance led to negative scores, a Yeo-Johnson transformation was performed in R. Afterwards, a simple linear regression was conducted in SPSS to determine if any of the change in variance of the components significantly predicts the final course grade at the individual level. Variance in competencies did not significantly predict the individual course grade, $R^2 = 0.00$, $F(1, 20) = 0.02$, $p = .886$. Variance in performance did not significantly predict the individual course grade, $R^2 = 0.00$, $F(1, 20) = 0.15$, $p = .787$. A marginally significant effect of variance in efficacy on the individual course grade was found, $R^2 = 0.13$, $F(1, 20) = 4.14$, $p = .055$.

Table 13

Linear Regression on Yeo-Johnson Transformation of Change in Variance

	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
(Constant)	7.21	0.31		23.55	<.001
Competencies	0.05	0.31	0.03	0.15	.886
(Constant)	7.21	0.31		23.58	<.001
Performance	-0.09	0.31	-0.06	-0.27	.787
(Constant)	7.21	0.28		25.85	<.001
Efficacy	-0.58	0.29	-0.41	-2.03	.055

5. Discussion

This study aimed to discover whether team alignment, in the form of variance between individual self-ratings of team performance, can predict team performance and individual

performance. Weekly questionnaires using a 7-point Likert-scale on the components competencies, team performance, and efficacy, were used for the data analysis, in which the variance per team was determined and used for further data analysis.

5.1 Outcomes

In answer to RQ 1 'How does the alignment (variance) of perceived team performance change over time?', it was found that there is a clear change over time in variance across the different components. However, at first glance this change did not show a clear direction. In several teams the variance on certain components increased over time, suggesting there is less alignment between the individual team-members, while on those same components the variance decreased for other teams. Linking this to the research by Van den Bossche et al. (2011), what may have occurred is that these teams were engaging in team learning but entered a phase of conflict. Van den Bossche et al. (2011) discuss how a phase of argument and disagreement is part of team learning behaviour, and while it was hypothesized that this leads to an increased shared mental model, their study initially found the opposite, which is congruent with the decreased alignment in the current study. Though, when going through this process of conflict in a constructive manner, this did eventually positively affect the team shared mental model. However, as the current study did not include factors proving the phases of team learning, that statement would require additional research.

Further analysis to answer RQ 2 'To what extent does the change in alignment of perceived team performance over time predict team performance' suggested that there is a strong positive association between the change of variance in competencies and the project-grade. This suggests that when the team alignment on team competencies decreases, the final project grade increases. However, the simple linear regression did not find any significant results. This may have occurred due to the low amount of data points, because of which no outliers were identified. Though, when assuming the outcome is correct, this suggests that the relation between these two variables may have a different nature than linear. Thus, there is a strong association between the change in variance of competencies and the project grade, however, decreased alignment on competencies does not directly predict a higher project grade.

To answer RQ3, when looking at initial team alignment, a negative linear relation was found between the variance in team performance and the project-grade. This suggests that higher initial team alignment on team performance leads to a higher project grade. This outcome aligns with the studies by Mesmer-Magnus and DeChurch (2009) and Peeters et al. (2008, as cited in Bradley et al., 2013), who discuss that individual agreeableness on several team performance processes contributes to team performance. Gevers et al. (2019) further describe the importance of team alignment on the teams' collaborative task, especially concerning the project planning. Altogether, this suggests that initial agreement on performance expectations positively affects the teams' performance.

A comparison between final team alignment, in week 5, and the project-grade showed a significant correlation between variance in competencies and efficacy and the project-grade. The simple linear regression suggests that the relation between variance in competencies and the project grade is positive, while the relation between variance in efficacy and the project grade is negative. This implies that alignment on competencies negatively affects team performance. Savelsbergh et al. (2009) discussed how team learning may have a negative effect at certain developmental stages of the team, suggesting that this negative effect of alignment on competencies may not be found as the team continues to work together. It was also found that the relation between variance in efficacy and the project-grade is negative. This implies that alignment on efficacy positively affects team performance. Gully et al. (2019) discuss how interdependence positively affects team-efficacy, and while the current study did not observe interdependence within the teams, it seems logical that the team interdependence is higher towards the end of the project. Therefore, it would make sense that alignment on efficacy increases towards the end of the project and will subsequently lead to better team performance. Altogether, it shows that alignment on team performance is more relevant at the start of the project, and the extent of alignment in efficacy is more relevant at the end of the project. At the same time, a strong focus on the development of competencies may negatively affect team performance.

Finally, for RQ4 a comparison was made between the change in variance over time and individual performance in the form of the exam grade. Here, no significant results were found, suggesting that the change in team alignment does not affect individual performance. However, the p-value of efficacy was marginally significant, suggesting that there is a tendency. Gully et al. (2002) discuss that while interdependence positively affects team performance, this effect is much less strong on individual performance, which would explain the p-value being close to significant. Concerning that there are no significant outcomes on individual performance, what may have occurred is that team performance was prioritized over individual learning, as suggested by Guenter et al. (2016), who stated that team members may sacrifice individual goals to avoid team conflict.

In summary, this study found reasons to support the notion that team alignment on components of perceived team performance does relate to observed team performance in the form of a team project grade, though different components are relevant at different timepoints. Initial alignment on team performance is important, which makes sense following several studies that prove that initial agreement on planning, task and other performance aspects leads to better team performance (Gevers et al., 2019; Mesmer-Magnus & DeChurch, 2009; Peeters et al., 2008, as cited in Bradley et al., 2013). At the end of the project, alignment on efficacy is of importance, which may be caused by the forming of interdependence within the team over time (Gully et al., 2019). Curiously, at the end of the project, alignment on team performance on competencies seemed to be negatively

related to team performance, which may either be caused by focusing too much on the development of competencies or may be influenced by the developmental stage that the team is at (Bunderson & Sutcliffe, 2003; Savelsbergh et al., 2009).

5.2 Theoretical Implications

Throughout literature, many suggestions are made that the extent of teamwork is related to the performance of the team. Senge (1990) specifically discusses the importance of a team mental model, which is a recurring topic in many other papers (e.g. Denzau & North, 2000; Decuyper et al., 2010; Cannon-Bowers et al., 1993, as cited in Jonker et al., 2011b). While research has been conducted on shared mental models and team cohesiveness (e.g. Mathieu et al., 2000; Griffith & Gibson, 2001; Waller et al., 2004; Williams & Castro, 2010; Santos et al., 2015; Schreuder et al., 2023), there is not much research into the importance of team alignment, with team alignment being defined as the extent to which individual team members agree about the performance of the team. Rather, research has been conducted on the effects of similarity of individuals (e.g. Mathieu et al., 2000; Lim & Klein, 2006; Jonker et al., 2011a), while research does suggest that similarity of individuals does not necessarily lead to better team performance, instead it is about understanding the teams' mental models and anticipating the teams' needs (Cannon-Bowers et al., 1993, as cited in Mathieu et al., 2000; Stout et al. 1996). It is for that reason that this study contributes something new to the meaning of team alignment and its connection to team performance.

Additionally, this study used variance as an indication of team alignment, with lower variance suggesting higher team alignment. Other research has used interrater agreement or the awarding of points to the completion of certain tasks to identify team cohesion or shared mental models (e.g. Mathieu et al., 2000; Griffith & Gibson, 2001; Waller et al., 2004; Williams & Castro, 2010; Schreuder et al., 2023). Though, in these studies, shared mental models and the definition used for team cohesion concern the alikeness of thinking within the team, which does not align with the use of team alignment in the current study. Shared mental models relate to the sharedness of knowledge within a team, in which team members think alike and are able to make decisions in accordance with the needs and behaviour of the team (Cannon-Bowers et al., 1993), the current study discusses the extent at which team members agree on different team performance components. This sense of agreement poses an interesting addition to the theory on shared mental models, as it can be argued that in order for an individual to make decisions in accordance with the team's needs, there must be alignment on how the team is performing.

Additionally, variance poses as an interesting new method of measuring the extent of agreement within a team, as it offers an approach that does not study the alikeness of mental models, but rather the alikeness of opinion. Variance is a relatively easy measure that allows for comparison between teams and over time, as well as a calculation of the difference score between different

timepoints. Therefore, this study presents a different method for the measurement of alignment, through the calculation of variance.

5.3 Practical Implications

This study has not only shown that agreeableness on team performance aspects between team members is an important factor for observed team performance. The results indicate that different components are of importance at different timepoints. One practical takeaway is that in this study alignment on perceived team performance at the start of the project positively affected the observed team performance. As suggested by Mesmer-Magnus and DeChurch (2009) and Peeters et al. (2008, as cited in Bradley et al., 2013), factors contributing to improved team performance include the effective sharing of information, for which openness is required, as well as individual agreeableness, moderated by design processes such as planning, cooperation, and creation. Additionally, Gully et al. (2002) found that increased interdependence positively affected team-efficacy and performance. Showing that it could be beneficial for teams to discuss their expectations and agree on what good performance looks like at the start of the project.

Additionally, high alignment on efficacy at the end of the project led to higher observed team performance, which may be caused by the forming of interdependence within the team over time (Gully et al., 2019). The questions relating to efficacy concerned the confidence and trust regarding the teams' performance, showing that the development of a sense of efficiency and trust in the teams' performance and the project is of importance to improve the final product developed by the team. This aligns with several studies who indicate the importance of an effective, supportive, and safe team environment for team learning and team performance (Mesmer-Magnus & DeChurch, 2009; Peeters et al., 2008, as cited in Bradley et al., 2013; Savelsbergh et al., 2009). Therefore, it could prove advantageous to invest in effective collaboration and trust within teams.

5.4 Limitations and Suggestions for Future Research

Although this study has significant results, several limitations must be highlighted. Firstly, the dataset was limited, both due to the low number of students partaking in the course as well as these students not filling out all of the weekly questionnaires, which made data analysis substantially more challenging. Additionally, it may be necessary to have the data collection during the project last for more than five weeks to limit the effects of short-term conflict within the teams. As suggested by Van Den Bossche et al. (2011), it is common for teams to go through a phase of constructive conflict when engaging in team learning and working towards a shared mental model. Additionally, all data is self-reported and no observational factors are included, such as the number of meetings a team has over the course of the project or the potential conflicts the team goes through, and these may influence the team members individual ratings. Furthermore, week 1 of the data was gathered at week 3 of the module, combining that with the fact that the current study was not able to use data from week 1 of

collection, only 4 weeks of data were used for data analysis, while a potential 8 or 9 weeks of data could have been gathered. This also means that students were somewhat familiar with each other before the first moment of measurement, which may have affected team formation and, with that, the team alignment at week 1 of measurement. What must be considered is that this study only included undergraduate students, which limits the usability of these conclusions for workplace settings. Furthermore, in correlational studies it is of importance to be aware of the effects of hidden and extraneous variables that may affect these outcomes.

For future research, it could prove to be interesting to connect the method used in the current study to methods from research into shared mental models. The current study has aimed to make connections to theory on shared mental models, however, while the measurement of team alignment and the use of variance add to research on team learning, the connection to shared mental models is not as distinct. It would be interesting to see if there is a correlation between team alignment and shared mental models, more specifically, if teams who improve their team alignment (decreased variance) also increase the alikeness of their mental models.

Additionally, this study has encountered the effects of team conflict on team alignment, where the theory by Van den Bossche (2011) on the creation of shared mental models through *construction, co-construction, and constructive* conflict poses as a logical explanation. Above, the lack of observational methods has already been mentioned as a shortcoming and it could be useful to include these. However, it could prove even more helpful to make the connection with other team development models, such as the *forming-storming-norming-performing* process as discussed by Tuckman (1965), and the extent to which teams encounter these phases during the project stage of the undergraduate course. Besides, this study mostly discusses team factors that affect team alignment and performance, however, discovering the effects of individual professional development, which the course was aimed at, such as self-efficacy and individual goal attainment throughout the course could provide valuable input on which factors influence team alignment.

Despite several limitations, this study has provided evidence for the relation between team alignment on perceived team performance and observed team performance and has applied variance as a measurement of team alignment. Both of which are links that have not directly been made in previous studies regarding team performance. Hopefully, this study stimulates further research into the implications of team alignment, represented by the agreement between individual team members, on performance aspects, specifically in team settings.

6. Conclusion

This study has discovered the correlation between the variance of individual ratings of team performance and its implications for observed team performance as well as individual performance.

Throughout literature, many suggestions are made that the extent of teamwork is related to the performance of the team. While research has been conducted on shared mental models and team cohesiveness (e.g. Mathieu et al., 2000; Griffith & Gibson, 2001; Waller et al., 2004; Williams & Castro, 2010; Santos et al., 2015; Schreuder et al., 2023), there is not much research into the importance of team alignment, with team alignment being defined as the extent to which individual team members agree about the performance of the team. It is for that reason that this study contributes something new to the meaning of team alignment and its connection to team performance, with perceived team performance being divided into three components: competencies, performance, and efficacy. This study found a significant linear relation between initial team alignment on team performance and observed team performance, as well as final team alignment on efficacy and observed team performance. A negative linear relation was found between final alignment on competencies and observed team performance. While more research into team alignment is necessary to form concrete practical suggestions, this study has shown that team alignment is an important factor for team performance and should be considered in future studies on team performance.

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8. Appendices

Appendix I: Questions from Van Rees (2020).

Q7 Now that you have been working together in your project team for the past 4 days, we are **curious** to learn more about the collaborative process. *Please indicate to what extent you agree with the following statements about your project team:*

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
We regularly take time to figure out ways to improve our team's work processes. (1)	○	○	○	○	○
In this team, we share all relevant information and ideas we have. (2)	○	○	○	○	○
Members of this team ask each other for help and advice during the project work. (3)	○	○	○	○	○
If something is unclear, we ask each other questions. (4)	○	○	○	○	○
In this team, we make sure that we reflect on the team's work process regularly. (5)	○	○	○	○	○
In this team we ask critical questions when someone tells something new. (8)	○	○	○	○	○
In a discussion, our team views a topic from different angles and we share that with each other. (9)	○	○	○	○	○
When a team member has a different opinion during a discussion, he or she feels comfortable to voice this opinion. (11)	○	○	○	○	○
The team frequently seeks new information to make important improvements to our project. (12)	○	○	○	○	○
Team members go out and get all the information they possibly can from others, such as the	○	○	○	○	○

Q8 To what extent do you agree with the following statements about your **team**?

	Strongly disagree (1)	Somewhat disagree (2)	Neither agree nor disagree (3)	Somewhat agree (4)	Strongly agree (5)
As a team, we have the confidence to perform well on the project. (1)	○	○	○	○	○
My project team believes it can achieve an excellent performance on the project. (2)	○	○	○	○	○
Achieving this team's goals is well within our reach. (3)	○	○	○	○	○
With focus and effort, this team can do anything we set out to accomplish. (4)	○	○	○	○	○

Q11 In your opinion how well does your project **team perform**? Please grade your project team's performance on...

	Terrible (7)	Poor (8)	Average (9)	Good (10)	Excellent (11)
... accomplishing project goals (1)	○	○	○	○	○
... the quality of the project work (2)	○	○	○	○	○
... the quantity of the project work (3)	○	○	○	○	○
... the efficiency in collaborating (4)	○	○	○	○	○
... the overall performance level (5)	○	○	○	○	○
... the atmosphere in the team (6)	○	○	○	○	○
... the level of trust in the team (7)	○	○	○	○	○
... resolving disagreements (8)	○	○	○	○	○
... the effectiveness of communication (9)	○	○	○	○	○

Appendix II: Questions in the TIIM-app.

Item	Content
Q1	Hi there, great to see you! Let's take a look at the past week.
	[Continue]
Q2	You chose to focus on your professional development in [domain]. How would you rate your competence after this week?
R(1-100)	[1-100] [Novice - Master]
Q3	Okay, enough about you. Let's reflect on the team for a bit. The next items will ask about your rating of the team's performance on several aspects. Try to keep in mind that you are rating **the team as a whole**.
	[Let's go!]
Q4	How would you rate your team's performance on **client communication** this week?
Q5	How would you rate your team's performance on **(collaborative) design** this week?
Q6	How would you rate your team's performance on **interprofessional collaboration** this week?
Q7	How would you rate your team's performance on **evidence-based working** this week?
Q8	How would you rate your team's performance on **critical thinking** this week?
Q9	Nice job! First ratings done. Next up are some ratings related to teamwork and the project during the past week.
Q10	How would you rate your team's performance on **accomplishing project goals** this week?
Q11	How would you rate your team's performance on **the quality of (accomplished) project work** this week?
Q12	How would you rate your team's performance on **the quantity of (accomplished) project work** this week?
Q13	How would you rate your team's performance on **the efficiency in collaborating** this week?
Q14	How would you rate your team's **overall performance level** this week?
Q15	How would you rate **the atmosphere in the team** this week?
Q16	How would you rate **the level of trust in the team** this week?
Q17	How would you rate your team's performance on **resolving disagreements** this week?
Q18	How would you rate your team's performance on **the effectiveness of communication** this week?
Q19	Almost done! There's just a last couple of statements for you to fill in. Please indicate to what extent you agree with the following statements.
Q20	As a team, we have the confidence to perform well on the project
Q21	My project team believes it can achieve an excellent performance on the project
Q22	Achieving this team's goals is well within our reach
Q23	Anything else about the team performance that you want to note?
TB	[Text input]
Q24	That was it, great work! Your report will come in a bit. See you on Monday!